On the Valuation of ‘Big Pharma’s’ Research Pipelines

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Abstract

Title: On the Valuation of ‘Big Pharma’s’ Research Pipelines

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Background: Tougher demands from regulators on drugs efficiency and safety, governmental cost cutting and more complex areas of research, has led to that the importance of the pharmaceutical industry’s research pipelines are increasing. Even though the capital markets views on the pharmaceutical industry and its valuation is changing, the authors is not aware of any prior research that has been conducted on the topic of how the market reacts to clinical trial results or how security analysts valuates product pipelines.

Aim: This thesis aims to explain how security analysts valuate research pipelines and analyze whether the publication of clinical trial results significantly affects the pricing of multinational pharmaceutical companies.

Methodology: Three econometric models using an aggregate daily data sample of 27 years for five of the world’s largest pharmaceutical firms distinguish the price effects related to the publication of clinical trial results. Three interviews with security analysts map how security analysts value pharmaceutical research.

Results: Security analysts’ uses a combination of DCF and relative valuation when analyzing pharmaceutical firms. All interviewed analysts uses a risk adjusted net present value approach which is closely linked to the DCF approach, however, financial theory suggests that pipelines should be valuated with contingent claim models. Analysts recognize that all compounds in Phase III and some Phase II projects has a impact on firm value. Clinical trials have a significant short-term impact on firm value. Phase III projects shows significant share price influence whilst early stage clinical trials do not, which shows that analysts are correct in focusing their valuation to later stage clinical trials. However, not all areas of therapy have a significant impact on firm value. Oncology is the only area of therapy where successes raises firm value, whilst failures in oncology and cardiovascular/gastrointestinal significantly lower firm value. Negative news about the research portfolio also tends to have a larger impact than positive news.

Keywords: Big Pharma, Clinical Trials, Econometrics, Valuation, Research & Development.
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Stockholm, June 2009

[Signature]

Martin Löfqvist
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1. Introduction

1.1 Background
Multinational pharmaceutical giants such as AstraZeneca, GlaxoSmithKline, Novartis, Pfizer and Roche are examples of what is often referred to as 'Big Pharma', the worlds leading health care firms. These firms are depending on the continuous development of new drugs in order to generate cash flows that can secure their survival. Drug development requires immense investments in research and development, investments that has no guarantee of successful outcome. In fact, 89 out of a 100 projects in clinical trials fail to deliver substances that can be of use for the pharmaceutical industry (Kola & Landis, 2004). Even after such high rate of failure, seven out of ten drugs fails to generate revenues to cover their development costs (Gabrowski et al, 2002). The average cost associated with the development of a single marketable drug has increased by 55 percent during the last decade to a total of $1.7 billion per drug (Gilbert et al, 2003). The U.S research-based pharmaceutical industry has over the last three decades increased their spending on Research and Development (R&D) from 11 percent to some 17-19 percent of their turnover; still, they are often criticized for their weak product pipeline (Danzon, 2006, Forsman, 2009, Giorgianni, 1997).

In order to finance these risky investments in R&D it is of great importance to hold strong patents on both products as well as on research portfolios in order to hold the generic industry at bay (Dickson & Gagnon, 2004). A generic pharmaceutical firm copies both the compound and the production technology developed by the research-based industry in order to create identical products. The research-based pharmaceutical firm has, once a patent expires, no longer the sole right to their findings and the generic industry are allowed to duplicate the product, creating a product that is identical in dosage, safety and efficiency. Since generic manufacturers have none or small costs related to R&D they can set prices far below those of the research-based pharmaceutical industry. (Food & Drug Administration: 1, 2009)
As a direct result of the limited patent time, pharmaceutical companies need to have a constant flow of products entering the world's pharmaceutical markets and to generate strong cash flows at an early stage of the product's lifecycle to maximize firm value. The current cash flows are also needed in order to finance product development as the entry of generic manufacturers erodes revenues and profits. (Dickson & Gagnon, 2004)

Tougher demands from regulators on drugs' efficiency and safety, governmental cost cutting, and more complex areas of research, has led the research-based pharmaceutical industry towards its biggest challenge in modern history. The industry's growth rates are slowing down and 'big pharma's' late stage research portfolios are growing in importance. (Kola & Landis, 2004)

1.2 Problem Statement
Firm value, which is reflected by the firms' share price, is in theory maximized when managers are maximizing the value of the company's discounted free cash flows generated from operations. Usually, business is assumed to go on in perpetuity, which stresses the importance of having long-term solid cash flows. (Damodaran, 2006). The future free cash flow is depending on the sales and success of both the current product portfolio as well as on the risky substances in the research pipeline. Patents are often limited to 20 years, but the drug is only available to the market under the last seven to ten years of the patent. (Dickson & Gagnon, 2004) The bulk of the firms' value is therefore determined by the discounted cash flow in the perpetual term. Investors are consequently investing in the hopes of future successful drug development. 'Big Pharma' is currently exposed to an increasing amount of operational risk since most of their blockbuster drugs are facing patent expiration in the imminent future and therefore, they are now facing a situation were the importance of the pipeline are increasing. (Bellander, 2009)
The capital markets views on the pharmaceutical industry and its valuation is therefore changing, as a larger part of the firm’s value is determined by the research pipeline and not by the current product portfolio. Theory stresses the importance of using contingent claim or option pricing to valuate undeveloped patents, whilst using other techniques for assets generating cash flows (Damodaran, 2006). How does the market valuate complex firms that in theory need to be valuated by a number of different techniques? How do investors valuate a firm whose future cash flows are determined by the success in high-risk research projects? What is the value of a drug near completion? Is research within different areas of therapy valued differently? How does the market react to news regarding late stage clinical trials?

To the author’s best knowledge, no prior research has examined how security analysts valuate pharmaceutical firms pipelines or how clinical trial results affects the value of a pharmaceutical firm. As investors are turning their eyes towards the research pipelines in the hopes of finding new blockbuster drugs it is therefore of great importance for investors to understand how the market valuates research and reacts to trial results.

1.3 Thesis Purpose
This thesis aims to explain how security analysts valuate ‘Big Pharma’s’ research pipelines and analyze whether the publication of clinical trial results significantly affects the pricing of multinational pharmaceutical companies. The author intends to answer the following questions:

- How does security analysts valuate pharmaceutical companies and their pipelines?
- Is there any discrepancy between their valuation techniques and financial theory?
- Does press releases or other news regarding results from clinical trials in pharmaceutical companies affect firm value?
- If so, does press releases or other news regarding different areas of therapy affect firm value differently?
1.4 Disposition

Chapter 2 – Research Method
This chapter gives the reader an explanation of the authors’ two-fold methodic approach. The chapter also explains the econometric models constructed to measure trial results impact.

Chapter 3 – Theoretical Framework
This part contains the basics and logic behind firm valuation, introducing the reader to how the value of a pharmaceutical firm is determined in theory and a brief summary of earlier research on how investments in R&D affects firm value.

Chapter 4 – The Economics of the Pharmaceutical Industry
This chapter introduces the reader to the pharmaceutical industry and explains the economics of a pharmaceutical company. It covers the drug development process and the industry’s pricing strategies.

Chapter 5 – Data Sample Testing and Method Discussion
This chapter contains the results from econometric testing of the data sample and a discussion about the implications certain data sample characteristics has on this thesis results.

Chapter 6 – Empirical Results
This chapter contains the results from the author’s econometric modeling and summarizes the interviews conducted.

Chapter 7 – Analysis
This chapter analysis the analysts views on valuation with both valuation theory and the econometrical empirical results.

Chapter 8 – Conclusions
This chapter is dedicated to answer the research questions mentioned in section 1.3 Thesis Purpose question by question in order to sum up the main findings. It also contains suggestions to further research related to this topic.
2 Research Method
This thesis has a twofold methodic approach; it is carried out on both a quantitative and qualitative basis, which will be explained in this chapter.

Three different econometric models are used to measure the effect press releases announcing the results from clinical trials has on firm value. The data sample used is an unbalanced panel data set of press releases from five of the world’s largest pharmaceutical firms. The pharmaceutical companies examined are: AstraZeneca, GlaxoSmithKline, Novartis, Hoffmann-La Roche and Pfizer and were chosen at random from a list of the world’s ten largest pharmaceutical firms.

Security analysts’ views on pharmaceutical firm valuation were gathered from interviews. The author choose to conduct three interviews with equity research analysts covering the pharmaceutical sector in order get the most reliable primary data on how investors value information regarding research and development. The interviews were conducted with analysts from ABG Sundal Collier, Carnegie and Danske Markets, which were chosen at random from the major investment banks located in Stockholm.

2.1 The Econometric Study
This section explains how the quantitative econometrical research was conducted. Explaining how the relevant variables were selected, the models created, the size of the data material and the testing procedure that were conducted to the data sample and models.

2.1.1 Choosing Variables
The Efficient Market Hypothesis (EMH) states that share price reactions are assumed to be swift and that price is affected by all relevant information new to the market (Brealey et al, 2006). According to the EMH, it is therefore, unnecessary to try to determine the long-term effects of a press release. This thesis purpose is therefore to measure short-term price impact from news regarding results clinical trials. The dependent variable in all models was set to be the daily percentage change in price (%ΔPrice) for each pharmaceutical firm.
This thesis aim is not try to explain why each firm is priced in a certain way, rather what happens to prices after the market gets hold of new information, thus, relative price changes are to be seen a valid measure.

Broader market movements affect individual stocks and it is therefore important to filter out its impact on pricing. Four of the five firms in this sample are listed on the New York Stock Exchange\(^1\) (NYSE) (New York Stock Exchange, 2009). The S&P 500 is commonly used as an index for the American market and will be used as a proxy for all macroeconomic happenings in this sample. Since the price movements of the firms are measured on a daily basis, the daily percentage price change in the S&P500 index were used to filter out overall market movements and other information affecting the world economy.

The Dow Jones World Pharmaceutical index was included since pharmaceutical firms tend to have low market betas. This further filters out the effects of stock price movements related to other news primarily affecting the pharmaceutical sector that is not captured in the broader S&P500 index.

2.1.2 The Data Sample

The data sample used in this thesis includes an aggregate total of 27 years of daily data. The data set encompasses both time series data (the price and index movements over time) and cross sectional data (data from five different companies). A data set that is a mixture of these is called a panel data set. One of the main advantages of using a panel data set in relation to pure time series or cross sectional data is that it is possible to acquire a larger sample. Instead of estimating a model with data from only one pharmaceutical firm it is done with five, which fivefold the potential number of observations.

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\(^1\) Hoffman La-Roche is listed on SIX – The Swiss Stock Exchange.
The data set included time series for five of the world’s largest pharmaceutical firms, the firms and the respective length of the time series are illustrated in figure 1 below.

<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Time Series Length</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>AstraZeneca</td>
<td>124 Months</td>
<td>Jan 1997 – Apr 2009</td>
</tr>
<tr>
<td>GlaxoSmithKline</td>
<td>40 Months</td>
<td>Jan 2006 – Apr 2009</td>
</tr>
<tr>
<td>Hoffman La-Roche</td>
<td>76 Months</td>
<td>Jan 2003 – Apr 2009</td>
</tr>
<tr>
<td>Novartis</td>
<td>28 Months</td>
<td>Jan 2007 – Apr 2009</td>
</tr>
<tr>
<td>Pfizer</td>
<td>28 Months</td>
<td>Jan 2007 – Apr 2009</td>
</tr>
</tbody>
</table>

Figure 1: Data Sample

Since the press release archives available on the pharmaceutical firms’ websites differ, the time series of each pharmaceutical firm are of different length, making this an unbalanced panel data set. Since the author only intended to see the overall significance of the dummy variables, not separating them with regards to different firms, no separation dummies were created.

Missing or obviously erroneous values in the time series data were adjusted by means of linear extrapolation. The missing data was set to be the mean of the two surrounding values. This is a generally accepted method to deal with missing values in time series data (Greene, 2008).

2.1.3 Model Specification

Three models were made in order to answer the research questions. These three models are almost identical, however, they use different dummy variables in order to quantify the clinical trial results effect on either an aggregate level, or in detail.

The models were regressed by means of the Ordinary Least Square (OLS) method. Independent variables are classified as significant when the corresponding P-value is below 0.05, indicating that they are differentiated from zero with 95% certainty (Gujarati, 2003).
2.1.3.1 Model A
This model is used to analyze whether or not there are any overall price effects due to news regarding clinical test results. It uses two dummy variables; one if there is any positive news published, and one regarding the publication of negative news. Days in which there are no press releases mentioning clinical trial results are not coded with any dummy and are seen as the ‘base case’. The model is illustrated in figure 2.

\[ \% \Delta \text{Share Price} = \beta_0 + \beta_1 \% \Delta \text{S&P500 Index} + \beta_2 \% \Delta \text{DJ Pharmaceutical Index} + \beta_3 D_1 + \beta_4 D_2 \]

Where

\( D_1 = 1 \) if press release is positive, 0 otherwise (None or negative news)
\( D_2 = 1 \) if press release is negative, 0 otherwise (None or positive news)

Figure 2: Model A, Measuring the Overall Effect of Press Releases

The dummy variables significance determines if there is any price effect caused by either positive or negative information regardless of current research phase or area of therapy. The corresponding \( \beta \)-coefficient also measures the size of the price impact. It is assumed that successful trial results are to be having a positive \( \beta \)-coefficient whilst failing trials are to have a negative \( \beta \)-coefficient.

The \( \beta \)-coefficient for the S&P 500 index is showing the stocks beta value, however, the author has not set any hypothesis about its value or magnitude. The \( \beta \)-coefficient for the DJ Pharmaceutical index is assumed to be positive since news that are beneficial for other firms in the industry are most likely to be beneficial for all firms in the industry.

2.1.3.2 Model B
The dummy variables in Model B divide the findings from model A into greater detail. These variables show the price effects due to clinical trial results divided by area of therapy. It is possible that investors react to news differently depending on the area of therapy since the success rates differ or because some areas have better market potential than others. As in all models used, there are two dummy variables for each
press release, one for positive news and one for negative news. Trading days with no new press releases are not coded with a dummy variable and are to be interpreted as the ‘base case’. The model is illustrated in figure 3.

\[
\%\Delta \text{Share Price} = \beta_0 + \beta_1 \cdot \%\Delta \text{S&P500} + \beta_2 \cdot \%\Delta \text{DJ Pharmaceutical Index} + \beta_3 \cdot D_1 + \beta_4 \cdot D_2 + \beta_5 \cdot D_3 + \beta_6 \cdot D_4 + \beta_7 \cdot D_5 + \beta_8 \cdot D_6 + \beta_9 \cdot D_7 + \beta_{10} \cdot D_8 + \beta_{11} \cdot D_9 + \beta_{12} \cdot D_{10} + \beta_{13} \cdot D_{11} + \beta_{14} \cdot D_{12}
\]

Where

\(D_1 = 1\) if test results are positive (Oncology), 0 otherwise
\(D_2 = 1\) if test results are negative (Oncology), 0 otherwise
\(D_3 = 1\) if test results are positive (Cardiovascular/Gastrointestinal), 0 otherwise
\(D_4 = 1\) if test results are negative (Cardiovascular/Gastrointestinal), 0 otherwise
\(D_5 = 1\) if test results are positive (Central Nervous System), 0 otherwise
\(D_6 = 1\) if test results are negative (Central Nervous System), 0 otherwise
\(D_7 = 1\) if test results are positive (Anti-Infectives and Vaccines), 0 otherwise
\(D_8 = 1\) if test results are negative (Anti-Infectives and Vaccines), 0 otherwise
\(D_9 = 1\) if test results are positive (Arthritis and Pain), 0 otherwise
\(D_{10} = 1\) if test results are negative (Arthritis and Pain), 0 otherwise
\(D_{11} = 1\) if test results are positive (Respiratory), 0 otherwise
\(D_{12} = 1\) if test results are negative (Respiratory), 0 otherwise

Figure 3: Model B, Measuring Each Therapeutic Area’s Effect on Pricing

The dummy variables significance determines if there is any difference in the price effect due to the different areas of therapy regardless of phase. The corresponding \(\beta\)-coefficient also measures the size of the price impact. It is assumed that successful trial results are to be having positive \(\beta\)-coefficients whilst failing trials are to have negative \(\beta\)-coefficients.
The $\beta$-coefficient for the S&P 500 index is showing its beta value, however, the author has not set any hypothesis about its value or magnitude. The $\beta$-coefficient for the DJ Pharmaceutical index is assumed to be positive since news that are beneficial for other firms in the industry are most likely to be beneficial for all firms in the industry.

In Model B, some therapeutic areas have been bundled together to the same dummy variables such as cardiovascular and gastrointestinal drugs and anti-infectives and vaccines. This is due to the fact that there were too few observations in certain areas and that the model would use to have too many variables. The therapeutic areas where bundled together with similar areas of therapy. They were also bundled together since the author did not have adequate knowledge about the correct classification of certain diseases, which could have led to misclassifications that in turn could have altered the study’s results.

2.1.3.3 Model C
There is reason to believe that news regarding success or failure of Phase I or II compounds affect stock price less than Phase III results. This relates to the fact that the potential cash flow is both more probable and closer in time. This is measured in Model C by the dummy variables whose $\beta$-coefficients ought to have a higher value in absolute terms in later stages.

\[
\%\Delta \text{Share Price} = \beta_0 + \beta_1 \cdot \%\Delta S&P500 + \beta_2 \cdot \%\Delta \text{DJ Pharmaceutical Index} + \beta_3 \cdot D_1 \\
+ \beta_4 \cdot D_2 + \beta_5 \cdot D_3 + \beta_6 \cdot D_4 + \beta_7 \cdot D_5 + \beta_8 \cdot D_6
\]

Where

$D_1 = 1$ if test results are positive (Phase I), 0 otherwise

$D_2 = 1$ if test results are negative (Phase I), 0 otherwise

$D_3 = 1$ if test results are positive (Phase II), 0 otherwise

$D_4 = 1$ if test results are negative (Phase II), 0 otherwise

$D_5 = 1$ if test results are positive (Phase III), 0 otherwise

$D_6 = 1$ if test results are negative (Phase III), 0 otherwise

Figure 4: Model C, Measuring Each Phase Effect on Pricing
The dummy variables significance determines if there is any difference in the price effect due to differences in research phase. The corresponding $\beta$-coefficient also measures the size of the price impact. It is assumed that successful trial results are to be having positive $\beta$-coefficients whilst failing trials are to have negative $\beta$-coefficients.

The $\beta$-coefficient for the S&P 500 index is showing its beta value, however, the author has not set any hypothesis about its value or magnitude. The $\beta$-coefficient for the DJ Pharmaceutical index is assumed to be positive since news that are beneficial for other firms in the industry are most likely to be beneficial for all firms in the industry.

### 2.1.4 Data Gathering and Coding

All coding and regressions were made through the statistics package SPSS 17. The pharmaceutical firms price data and market indexes used in this thesis are gathered from the statistics database DataStream\(^2\). This data was regressed against coded press releases mentioning R&D results from five large, multinational pharmaceutical firms. The data was coded on a qualitative basis on whether or not the clinical trials had a positive or negative outcome.

The clinical trial results summaries were found on each pharmaceutical firms website, under their press release section. These summaries contain the main findings and statistical data, reporting if the study significantly met both its primary and secondary endpoints. News was coded as positive if they reached the study’s primary endpoint, or if that was not mentioned, if the drug passed on to later stage clinical trials. The trial was seen as negative if it resulted in the failure to meet its primary endpoint or if the project were terminated as a result of the study. The news was also coded with regards to the drugs area of therapy and phase in order to distinguish if there were any significant differences between those aspects.

\(^2\) Datastream is a statistics database supplied by Thomson Reuters, a worldwide recognized supplier of financial data.
2.1.5 Data Set Problems
When using econometrics it is of great importance to realize that each data set can have undesired properties that can bias the models output. (Gujarati, 2003). Panel data introduces more variability, more degrees of freedom and reduces biases in areas that normally bias estimation, such as collinearity. However, paneled data samples often incorporate problems with autocorrelation and heteroscedasticity. (Baltagi, 1997, Gujarati, 2003) The following subchapters briefly explain the possible biases incorporated in econometric models.

2.1.5.1 Multicollinearity
Multicollinearity refers to the problems that arise with highly or perfectly correlated explanatory variables. The main consequence of multicollinearity is that variances and covariance’s are larger than necessary, resulting in wider confidence intervals and less significant regressors. (Gujarati, 2003) The models were tested for multicollinearity via correlation analysis, explained in section 5.1.1 Multicollinearity.

2.1.5.2 Heteroscedasticity
The ordinary least square method assumes that the data set is homoscedastic, meaning that the variance is equal over time. Data material in which the variance is changing over time is called heteroscedastic data material. When regressing heteroscedastic data the OLS estimator is no longer efficient and has therefore less significant regressors than otherwise. (Gujarati, 2003) This data set has been tested for heteroscedasticity both with White’s General Heteroscedasticity Test and by a more informal graphical test. The outcome of these tests is presented in section 5.2 Heteroscedasticity & Autocorrelation.
2.1.5.3 Autocorrelation
Autocorrelation occurs when there is correlation between the error terms over time. This correlation results in that the OLS method for regressing data no longer is efficient. The estimator still is unbiased as well as consistent, however, the presence of autocorrelation results in broader confidence intervals and less significant regressors. (Gujarati, 2003) All models are to be tested for autocorrelation by means of the Durbin-Watson test. Lois (1989) claims that there is no need to test for autocorrelation in data material that is heteroscedastic, as these tests are erroneous.

2.1.5.4 Model Specification Errors
Specification errors are the most common source of inefficient or biased regression models. The problem that specification error creates depends on how the error has been made. The error could be that there are omitted variables from the ‘true’ equation, that there are superfluous regressors in the equation or that the model itself if wrongly specified or has the wrong functional form. (Gujarati, 2003) No tests for wrong functional form other errors are conducted on any of the models; however, the problems and possible biases related to errors in specification are discussed in section 5.3 Model Specification Errors.

2.2 Interview Procedure
Interviews were conducted with three equity research analysts at their respective office in Stockholm under the period of April-May 2009. The analysts interviewed where Morten Larsen, Mattias Häggblom and Marcus Bellander representing ABG Sundal Collier, Danske Bank Markets and D.Carnegie Investment Bank respectively. The analysts were selected at random form the major investment banks with offices in Stockholm. The interviews where semi-structured where the topics discussed were the pharmaceutical industry, firm and pipeline valuation. The analysts knew these topics in advance in order to prepare for the sessions. Notes were taken under the interviews, however no recordings were made. Before the start of each interview, the author asked for permission to refer to them by name in the publication of this thesis. The interview questions are displayed in Appendix 1 – Interview Questions.
2.3 Reliability and Validity
Reliability is a measure of whether this report could be duplicated by others, which subsequently comes to the same conclusions. Validity is a measure of the author’s capability to actually study what he or she is claiming that he or she is. (Björklund & Paulsson, 2003)

2.3.1 Reliability
This thesis has, as stated in 3. Research Method a two-fold research methodology. The interviews where conducted with leading security analysts in Stockholm based investment banks. However, one can never claim that data acquired through a conversation is fully reliable. In order to minimize what Jacobsen (2002) classifies as interviewer related effects and context related effects, personal interviews where conducted at their respective office during work hours. When being interviewed the interviewers appearance, body language and tone of voice can alter the way in which the person interviewed answers questions. However, face-to-face interviews are generally seen as the interview method that minimizes the risks of biases regarding interpretation, openness and trust (Jacobsen, 2002). The interviews were conducted at the respective analysts office to minimize the bias associated with interviewing a person in an unfamiliar location.

The analysts were only covering the Swedish/British pharmaceutical firm AstraZeneca and had none or little experience of valuating the remaining firms covered in this thesis, this could lead to a bias regarding how the market valuates the research pipeline in the other firms assessed in this thesis. However, since the equity research profession is exposed to tough competition from banks acting on a global scale the author doubts that analysts based in Sweden uses other a vastly different approach towards valuation than others. The risk of biasing the results as a consequence of my interview sample is seen as limited.
The reliability of quantitative empirical data could be considered to be the weak spot of this thesis. The reliability of the price data is high since most of the data is acquired from the internationally recognized database DataStream. However, the results of this thesis are largely determined by the coding of the press releases, which in turn is determined by the author’s interpretation of the information supplied by the various companies. The author has tried to make his coding procedure as transparent as possible under section 2.1.4 Data Gathering and Coding and has been cautious when interpreting the press releases. If the author could not get any opinion on whether the test results were positive or negative they were left un-coded in order not to over interpret or guess the markets interpretation of the trial results.

The information supplied by pharmaceutical firms about their research is not always unbiased. In fact, stock listed pharmaceutical firms has a clear interest in promoting their R&D success in order to increase the value of their equity and to signal to their owners that they are maximizing invested capital. When interpreting this data it is hard to neglect that erroneous classifications can be made. This can be illustrated by the fact that the sample was heavily weighted towards positive news (83,5 percent positive and 16,5 percent negative news). In fact, the world's largest pharmaceutical firm Novartis did not mention failure in any trials under the period April 2009 to January 2006, indicating that the industry is more interested in promoting success than failure. This limits the number of negative observations in the data sample and could potentially bias the markets reaction to different types of news.

2.3.2 Validity
In all types of empirical research it is of great importance to conduct the research in such a way that it is that the author is studying that he or she intends to study. When studying stock market behavior one is usually examining how the listed stocks pricing is affected by various happenings. This thesis studies the short-term price effects related to press releases and information regarding potential new products. Since this is measured with the change in share prices, one cannot neglect the fact that the price fluctuations can be due to other sources than this specific set of news. This thesis relies on the Efficient Market Hypothesis claiming that news affecting firm value is to be incorporated into pricing instantaneously (Brealey et al, 2006). However, Frazzini
(2006) has found that the stock market often underreacts to corporate news, which results in a post-announcement price drift. Which in turn can result in that there are larger share price impacts due to clinical trial results than measured in this thesis. One might claim that variables that captures port announcement drift in the model, however, that was seen as beyond the scope of this thesis.

As the number of observations increases the risk of coincidences biasing the significance of the model is decreasing. In order to filter out the effects of individual outliers, a large data has been gathered.

The data material gathered only included information from press releases, reading each compounds trial report could have increased the sample. However, the author did not have neither the time nor the expertise required to interpret these reports in a correct way. According to Larsen (2009) a significant amount of the clinical trial results are published at global conferences, which the author could not use in this study.
3. Frame of Reference
When valuating assets such as shares in pharmaceutical companies, there are three different approaches one might use. The first approach is the discounted cash flow valuation, which essentially relates the value of the firm as the present value of the firm’s future cash flows. The second is relative valuation, which sets the price of a firm in relation to the pricing of other similar firms with regards to certain ratios. At last, there is contingent claim valuation, which uses the characteristics of option pricing to estimate firm value. (Damodaran, 2006)

3.1 Discounted Cash Flow Valuation
Discounted Cash Flow valuation uses firm fundamentals to acquire the assets intrinsic value and are thus unaffected by the value of other traded stocks. Firm value is, as seen in figure 5, equal to the total stream of cash payments whose value is discounted by the investors required rate of return. (Damodaran, 2006)

The general model used in discounted cash flow valuation is illustrated below:

\[
\text{Firm Value} = \frac{E(CF_1)}{(1+r)} + \frac{E(CF_2)}{(1+r)^2} + \frac{E(CF_3)}{(1+r)^3} \ldots + \frac{E(CF_n)}{(1+r)^n}
\]

Where \( E(CF_t) \) = Expected cash flow in period \( t \)
\( r \) = Discount rate

Figure 5: The Discounted Cash Flow Model

3.1.1 Cash Flow Estimation
The cash flows that are discounted are those that are free to equity holders to withdraw from the firm, often called Free Cash Flow to Equity (FCFE) Discounted Cash Flow (DCF) valuation. (Damodaran, 2006) The cash flows that investors can claim, or, potentially can withdraw from the firm is defined as:

\[
\text{Free Cash Flow to Equity} = \text{Net income} - (\text{Capital expenditures} - \text{Depreciation})
\]
\[- \text{Change in noncash working capital} +
\]
\[(\text{New debt raised} - \text{Debt repayments})\]
When calculating these free cash flows it is of great importance to make as correct assumptions as possible about future growth. When the future outcome of a project is associated with a great deal of uncertainty it is recommended to use scenario analysis. Damodaran (2003) identifies four steps that needs to be taken in a scenario analysis:

1. Identify a number of scenarios that are most likely to occur.
2. Estimate the cash flow and value of each scenario.
3. Assign each scenario with a probability.
4. Report the output. Add the product of each scenarios value multiplied with the each scenarios assigned probability in order to acquire the expected value.

3.1.2 Estimating the Discount Rate

The required rate of return is a function of the level of risk that the investor takes on when investing (Brealey et al, 2008). Damodaran defines risk as “the likelihood that we will receive a return on an investment that is different from the return we expected to make”, thus, risk is a matter of uncertainty about the probability distribution of future outcomes (Damodaran, 2006, page 27).

The most frequently used model for estimating the cost of equity, and as a result the discount rate in FCFE-models, is the Capital Asset Pricing Model (CAPM). The model, created by Nobel laureate William Sharpe, assumes that the cost of equity is a linear function of the assets riskiness in relation to the market portfolio. (Brealey et al, 2008, The Nobel Price, 2009) The CAPM equation is defined as:

\[ r_e = r_f + \beta(r_m - r_f) \]

Where 
- \( r_e \) = Required return on equity
- \( r_f \) = Risk-free rate of return
- \( r_m \) = Return on the market portfolio
- \( \beta \) = Covariance between the stock and the market portfolio divided with the market portfolios variance.

Figure 6: Capital Asset Pricing Model
As figure 6 shows, the discount rate is a function of three components. The risk-free rate of return, which is determined by the short-term interest rate structure on treasury bills. The market risk premium, and the beta value. As the market portfolio yields the market risk premium, the beta value measures the firms systematic risk relation to that of the market. If a firm has a higher level of systematic risk than the market portfolio, it should have a higher required rate of return and should therefore have a higher discount rate. (Brealey et al, 2006)

3.2 Relative Valuation
Relative valuation has a fundamentally different approach than the DCF valuation technique. The DCF captures the assets intrinsic value by using the firm fundamentals such as the firm’s cash flow, growth and risk characteristics. Relative valuation on the other hand uses the observed value of similar assets in order to determine the firm’s value.

In order to valuate companies on a relative basis, there is a need to scale value-driving parameters such as profit, turnover and growth with regards to company turnover, market value and so forth. Some of multiples that are commonly used in relative valuation are the price to earnings ratio (P/E), price to sales ratio (P/S), price to book ratio (P/Book), enterprise value to EBIT ratio. (Damodaran, 2006)

According to Damodaran (2006), relative valuation can be seen as a four-step process:

1. Ensure that the multiple used for valuation has a consistent definition.
2. Find out the multiples distribution across the entire market and especially the same sector.
3. Analyze the multiple and understand its fundamentals and make sure you understand how changes in the business translate into changes in the multiple.
4. Find the ‘right firms’ to compare the firm with. It is also crucial to understand and control for the differences between individual companies.
In relation to DCF valuation, relative valuation is less time and resource consuming since it requires much less information and explicit assumptions to take into account. When working as an analyst, relative valuation also has the benefit of being easier to sell since it is both simpler and more intuitive to market to clients. It is also easier to defend since the assumptions made are not as explicit as those of the DCF and that the market sets the multiples of the comparing firms, which means that the individual analyst only needs to explain his or her deviation from the peer average. (Damodaran, 2006)

### 3.3 Contingent Claim Valuation

In relation to Discounted Cash Flow or Relative valuation, contingent claim valuation must be seen as the newest and most innovative way to valuate assets. The technique valuates assets that have option like characteristics with option valuation techniques such as Black and Scholes or binominal models. All option valuation techniques have one thing in common. They use the following variables in order to determine the assets value: the current price of the asset, the variance of the assets value, the strike price, the risk-free rate and time. (Hull, 2005)

Damodaran (2006) claims that pharmaceutical and biotech compounds in clinical trials is hard to valuate with both DCF and Relative valuation, however, the asset has option like characteristics and should consequently by valued as such. The technique does, in contrast to DCF or Relative valuation, perceive increased risk as positive. Risk is in DCF or Relative valuation seen as negative whilst option-pricing models see the potential upside and embrace risk. The contingent claim valuation techniques biggest limitation is that the inputs needed in the models are difficult to obtain or estimate, as with the case of drug development, the inputs needed could be impossible to estimate in a proper way. Since each patents needs to be valuated as separate options, it is also time consuming and easy to build in systematic errors. (Damodaran, 2006)

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3The explanation of these models is beyond the scope of this thesis. The author recommends “Options, Futures and Other Derivatives” by Hull (2005) for readers that would enjoy a more comprehensive explanation of option pricing models.
3.4 Prior Research

To the author’s best knowledge, no prior research has been carried out on this topic. The stock markets reaction to test results from clinical trials has not been studied in the past. However, studies have been conducted on stock market performance related to R&D expenditures. Scherer (2001) has pointed out that there is a significant correlation over time between R&D expenses and gross profits in pharmaceutical companies, which evidently shows that there is a connection between the budget for innovation and future profitability. Shortridge (2004) on the other hand found that there is no direct connection between share price and R&D expenses. Higher R&D expenses have a positive effect on share prices when the R&D expenses comes from successful manufacturers, meaning that research expenses from none-successful manufacturers has none or little value in the eyes of the investor. Danzon et al (2005) has also found that there is a negative correlation between the success rate of different therapeutic areas and the mean sales in that area of therapy. Which indicates that it is more risky to conduct research in areas of therapy that has low competition and/or high profitability.
4. The Economics of the Pharmaceutical Industry
This chapter introduces the reader to the pharmaceutical industry and explains the economics of a pharmaceutical company. It covers the industry’s pricing strategies and the drug development process.

4.1 An Introduction to the Pharmaceutical Market
The pharmaceutical industry is one of the most globalized industries of today. However, world’s leading pharmaceutical companies are based in a relatively small number of countries such as France, Germany, Japan, UK, USA, Sweden and Switzerland. Even though there are thousands of firms in health care, a large portion of the market is made up by what is called ‘big pharma’, large, global pharmaceutical firms. The market is often claimed to be highly concentrated, however, the ten largest pharmaceutical firms only have 44,1 percent and the twenty largest has 60,8 percent of the total pharmaceutical market. (Schweitzer, 2007) The market is usually divided into different drug families with regards to different areas of therapy for example, oncology, cardiovascular, central nervous system, gastrointestinal and anti-infectives. Competition within each subgroup, or within the treatment of each disease, usually holds a much higher concentration since firms often specialize within certain areas of research. (Kola & Landis, 2004, Schweitzer, 2007)

When discussing the health care market, one must make a clear distinction of two different kinds of medicine, chemical entities (small molecules) and biotechnology (large molecules). Biotechnology is defined as “Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use” (United Nations, 2002). Biotechnology is usually made out of proteins and created from live tissue. The molecules are usually larger in size than chemical entities, and therefore often referred to as large molecules. Most medicine is created through a chemical process, and the molecules are smaller in size and are therefore often called small molecules. (AstraZeneca, 2008) Big pharmaceutical firms often produce and market both types of products, however, biotechnology firms are usually smaller and more specialized than pharmaceutical firms (Hopewell, 2003).
4.2 Drug Discovery and Development
The creation of a new drug is a long-term investment. In most cases drug development projects take more than a decade before the substance is ready to be launched to the world market. Dickson & Gagnon (2004) has estimated that it takes between 3-20 years to develop a new drug, where the average is 8.5 years.

The research process can be divided into two major stages, the discovery phase and the development phase. In the discovery phase scientists are trying to identify a molecular entity that has the potential to change a desired biological process in order to cure a disease. When found, research is focused on optimizing this structure in order to obtain the molecular entity that has the most promising pharmaceutical value combined with the lowest biologically harmful properties. (Schweitzer, 2007)

If the substance is believed to have a reasonable chance of success, clinical trials are initiated (Schweitzer, 2007). In short, the full drug development process (for a US market launch) can be illustrated as in figure 7 below:

Figure 7: The Drug Development Process (Dickson & Gagnon, 2004)

---

4 The development process illustrated in figure 7 refers to a US market launch only. The development process is similar in other regions. However, the time frame and interventions used by regulatory agencies can differ. FDA refers to the American Food and Drug Administration, a governmental body that grants allowance to launch new compounds on the American market.
It is important to keep in mind that there is only a small fraction of the substances identified in the discovery phase (Non-clinical research) that makes it in to the clinical trials.

The first clinical stage is the Phase I trial were the drug is tested on healthy individuals in order to determine the safe dosage of the drug, side effects associated with high doses and the metabolic actions of the drug inside the human body. The trial is conducted on a small scale; the number of subjects often ranges from twenty to eighty. (Dickson & Gagnon, 2004, Food and Drug Administration: 2, 2009)

If the drug still is seen as promising it proceeds to Phase II testing. This scientific testing encompasses a larger sample study on what effect the drug has on individuals currently suffering from a disease. The study is used to determine if the drug has the claimed pharmaceutical effects and to determine the short-term side effects of the drug. This phase usually encompasses a couple of hundred patients, and the focus is usually to prove the drugs safety and to illustrate a proof-of-concept. (Dickson & Gagnon, 2004, Food and Drug Administration: 3, 2009) 60 percent of the substances put to clinical trials make it into Phase II (Kola & Landis, 2004).

Phase III studies gathers data from a large sample of individuals, focusing on proving the new drugs superior efficiency in comparison to both placebo and competing substances. This is the by far the largest study where the number of patients usually range from a couple of hundred to a couple of thousand. (Dickson & Gagnon, 2004, Food and Drug Administration: 4, 2009) Some 25 percent of substances put to clinical trials make it to Phase III (Kola & Landis, 2004).

After phase III the firm needs to file a New Drug Approval (NDA) to regulatory agencies in order to proceed with a market launch. Only 11 percent of the drugs put to clinical trials get approved. (Kola & Landis, 2004)

According to data based on ten large, multinational pharmaceutical firms under the period of 1991-2000, the cumulative success rate also varies drastically between different areas of therapy, which is illustrated in figure 8.
Pharmaceutical firms want to identify research failures in as early stages as possible in order not to ‘waste’ recourses on compounds that is not marketable. Phase III is, as a consequence of the large sample size, the most expensive phase in the drug development process and it is thus crucial to minimize failures at this late stage. When dividing Phase III failures into different areas of therapy it is clear that drugs treating cancer (oncology) and disorders in the Central Nervous System have a higher probability of failing than treatments for cardiovascular disorders or infectious diseases. This is illustrated in figure 9.
4.3 Pharmaceutical Pricing

Patents protect pharmaceutical innovations and are granted in order to create entry barriers that forbid competing firms to create similar products based on the same active compound. This barrier gives the pharmaceutical firm a significant amount of market power, which according to microeconomic theory gives the firm incentives to set prices according to the perceived value of the drug rather than its marginal costs. (Pindyck & Rubinfield, 2004, Scherer, 2004)

When setting the price of a compound there are a number of aspects that need to be incorporated in the analysis. If for example, the drug reduces the number of hospital visits or allows a patient to get back to work earlier, a part of the drugs value can be indentified as the loss in revenue for the firm/patient and the doctors wage costs that were to occur without the usage of the drug. Since wage levels differ among countries, the example shows that the optimal pricing strategy gives incentives towards geographical price discrimination. Other aspects that need to be considered are that the drug in some cases prolongs life, reduces pain and suffering, prohibit life long immobility or allows the patient to live a happier, more active life, which in turn needs to be valued. (Berndt & Seley, 2000, Scherer, 2004)

A large part of the global market for prescriptive medicine are financed by health insurances, which reduces the price sensitivity of the patient enabling pharmaceutical firms to charge higher prices than if the drugs were financed by the patients themselves. As an example, the United States market for prescriptive pharmaceuticals are experiencing amongst the highest price levels worldwide, which partly can be explained by the country’s high economic standards and that a large part of the health care system is financed with health insurances. (Berndt & Seley, 2000, Scherer, 2004)
The pharmaceutical industry has, as a consequence of their more value than cost-based pricing approach, higher margins than most of the other manufacturing industries. They are in a sense putting the price tag based on knowledge instead of the costs related to production and distribution of the drugs. However, Scherer (2004) refers to a study made by the U.S government claiming that the rate of return for pharmaceutical companies are only some two-three percent higher than what they perceive as a normal rate of return. This higher rate of return can in turn be explained by the high amount of technological risks in operations. (Scherer, 2004)

Once a products patent expires generic firms are allowed to duplicate the compound. As a consequence of the Waxman-Hatch Act, generic compounds are accepted without the requirement of clinical testing as long as they can prove to the Food and Drug Administration that the product is identical in efficiency, dosage and safety. This makes it harder for the research-based industry to retain high prices after patent expiration. (Dickson & Gagnon, 2004) Generics are less expensive than original substances since R&D accounts for the bulk of the costs related to drug development and not the production itself (Food & Drug Administration: 1, 2009). On average, the entrance of generic manufacturers lowers the market price within six months by 54 percent (Gabrowski & Vernon, 1996). As a consequence of the generic-friendly “Waxman-Hatch Act”, generic manufacturers market share has increased from 19 percent in 1984 to 50 percent in 2001 (Cantor et al, 2005).
5 Data Sample Evaluation and Method Discussion

In order to correctly interpret the output from the econometric modeling, a series of tests has been conducted to check for the data set problems explained in section 2.1.5 Data Set Problems.

5.1 Multicollinearity

Since the models used in this thesis only has two regressors that can correlate there is a need to test whether the S&P 500 and DJ Pharmaceutical index correlates enough to classify them as a source of multicollinearity. The pair-wise correlations between the different periods in which the clinical trial results are gathered are displayed in figure 10 below. As a rule of thumb multicollinearity is a serious problem if the pair-wise correlation is in excess of 0.8 (Gujarati, 2003).

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 1999 – Apr 2009</td>
<td>0.6075</td>
</tr>
<tr>
<td>Jan 2003 – Apr 2009</td>
<td>0.6863</td>
</tr>
<tr>
<td>Jan 2006 – Apr 2009</td>
<td>0.7205</td>
</tr>
<tr>
<td>Jan 2007 – Apr 2009</td>
<td>0.7388</td>
</tr>
</tbody>
</table>

Figure 10: Correlation Between the S&P 500 & DJ Pharmaceutical Index

As seen in figure 10 the correlation between the S&P500 and DJ Pharmaceutical index is quite high, however, they are not above what Gujarati (2003) claims to be the critical limit, where multicollinearity needs to be adjusted for. Ruling out one of the variables would cause a more severe specification bias which is discussed in section 3.1.3.4 Model Specification Errors. Combined with the fact that the correlation is lower than what is said to be the critical level, both indexes are kept in the model.

5.2 Heteroscedasticity and Autocorrelation

Both the Whites General Heteroscedasticity Test and the informal graph show that this data set clearly is heteroscedastic\(^5\), however, no adjustments has been made in order to correct this problem. The models increased standard error is disadvantageous for the results and therefore one might interpret the outcome of this study as a conservative or precautious approach. The significance of the model and its respective

\(^5\) The informal graphical test is attached Appendix 2 – Econometric Tests
regressors would be better if this problem were to be adjusted for. However, it is important to keep in mind that the OLS estimator is not the best linear unbiased estimator since it is not efficient. The author perceived the potential gain from correcting for heteroscedasticity as limited in relation to the amount of work needed to correct this problem. As seen in the chapter 6 Empirical Results, the corresponding P-values are so high that correcting the models for heteroscedasticity would not drastically change the outcome.

Autocorrelation cannot be detected if there is heteroscedasticity in the model (Lois, 1989). Since the data material is heteroscedastic, there is no need to test for autoregressive patterns. The model underrates the regressor’s significance if this data material were to have autoregressive patterns, which further strengthens this thesis conservative approach.

5.3 Model Specification Errors
The models used in this thesis are of simpler character and is most definitely subject to model specification errors. The models B and C contain insignificant regressors, which can be seen in sections 6.1.2 Measuring the Price Impact Between Different Areas of Therapy and 6.1.3 Measuring the Price Impact per Research Phase, making it clear that the model itself is not the ‘true’ model. Omitting relevant variables can be a serious problem since it could lead to inconsistent and biased estimates (Gujarati, 2003). However, the problem with bias and inconsistency tends to be minor when the omitted variables are not correlated with the regressors. The author believes that there is a great risk that the β-coefficients for the indexes are biased, but that it is highly unlikely that the press release dummies are highly correlated with important omitted variables. The risk of having severe model specification biases affecting the outcome of this thesis is seen as limited as no interpretation is made to the β-coefficients representing the two indexes.
6. Empirical Results

6.1 Measured Market Impact of R&D Related News

In total, this study encompassed a paneled data set of 6334 trading days or a total of 284 months. The sample outcome is summarized in Figure 11 below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Positive Observations</th>
<th>Negative Observations</th>
<th>Total Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Total</td>
<td>101</td>
<td>20</td>
<td>121</td>
</tr>
<tr>
<td>Phase III</td>
<td>62</td>
<td>15</td>
<td>77</td>
</tr>
<tr>
<td>Phase II</td>
<td>39</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td>Phase I</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Oncology</td>
<td>51</td>
<td>10</td>
<td>61</td>
</tr>
<tr>
<td>Cardiovascular/Gastrointestinal</td>
<td>24</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Anti-Infectives/Vaccines</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Arthritis and Pain</td>
<td>16</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Respiratory</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 11: Dummy Variable Summary

Trading days that included the publication of a press release (either positive or negative) accounts for 1.9 percent of the sample leaving 98.1 percent left without any dummy variable coding.

Positive press releases makes up 83.5 percent of the total press release sample and negative press releases accounts for 16.5 percent.

Phase III clinical trials accounts for 62.6 percent of the sample, phase II 36.6 percent and only one phase I trial was found in the sample. No negative Phase I releases was published in the data set.

---

6 Under a total of six trading days companies released more than one press release, they were coded as one observation but as separate observations in each sub category, thus 121 overall observations, 123 ‘phase observations’ a total of 127 observations per therapeutic area.
When dividing the press material with regards to therapeutic area, oncology trials is seen as the most common trials to publish (48.0 percent) followed by Cardiovascular and Gastrointestinal (25.2 percent) and Arthritis and Pain Management (13.4 percent). Press releases mentioning any of the three remaining areas of therapy accounts for a total of 13.4 percent of the sample.

6.1.1 Price Impact from News Related to Clinical Trial Results

Model A is used to test if the publication of clinical trial results has any significant share price effects, regardless of the trials phase or therapeutic area. The model specification is illustrated in 2.1.3.1 Model A.

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>A</td>
</tr>
</tbody>
</table>

The models significance, as could be seen in figure 12, is high. The F-value is extremely large and the corresponding p-value (Sig.) shows that the model as whole is highly significant. Thus, one can with great certainty say that at least one of the beta-coefficients is separated from zero.

<table>
<thead>
<tr>
<th>Coefficients(^7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model A: Overall News Impact</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
</tr>
<tr>
<td>% Change S&amp;P500</td>
</tr>
<tr>
<td>% Change DJ Pharma</td>
</tr>
<tr>
<td>Positive News (Overall)</td>
</tr>
<tr>
<td>Negative News (Overall)</td>
</tr>
</tbody>
</table>

\(^7\) Parameters that are in bold are statistically significant at a level of five percent.
The coefficients are all significant on a confidence level of five percent. The publication of a failed clinical trial results in an overall share price reduction of 0.76 percent whilst the publication of a successful clinical trial increases the share price 0.297 percent. This is in line with expectations. The results indicate that negative news in this sample affect share prices more in absolute terms than positive news.

6.1.2 Measuring the Price Impact Between Areas of Therapy

Model B is used to test if there are any differences in the price impact of press releases depending on the clinical trials area of therapy. The model specification is illustrated in 2.1.3.2 Model B.

<table>
<thead>
<tr>
<th>Model</th>
<th>Durbin-Watson</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2.152</td>
<td>0.333</td>
<td>0.332</td>
<td>225.336</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Figure 14: Model B Summary

The models significance, as could be seen in figure 14, is high. The F-value is extremely large and the corresponding p-value (Sig.) shows that the model as whole is highly significant. Thus, one can with great certainty say that at least one beta-coefficient is separated from zero.
<table>
<thead>
<tr>
<th>Model</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>.004</td>
<td>.018</td>
<td>.204</td>
<td>.838</td>
<td>-.032</td>
<td>.039</td>
</tr>
<tr>
<td>% Change S&amp;P500</td>
<td>-.108</td>
<td>.016</td>
<td>-6.882</td>
<td>.000</td>
<td>-.139</td>
<td>-.077</td>
</tr>
<tr>
<td>% Change DJ Parma</td>
<td>1.051</td>
<td>.023</td>
<td>45.466</td>
<td>.000</td>
<td>1.006</td>
<td>1.097</td>
</tr>
<tr>
<td>Positive (Oncology)</td>
<td>.407</td>
<td>.201</td>
<td>2.023</td>
<td>.043</td>
<td>.013</td>
<td>.802</td>
</tr>
<tr>
<td>Negative (Oncology)</td>
<td>-1.171</td>
<td>.453</td>
<td>-2.586</td>
<td>.010</td>
<td>-2.059</td>
<td>-2.283</td>
</tr>
<tr>
<td>Positive (Cardio/Gastro)</td>
<td>.324</td>
<td>.292</td>
<td>1.108</td>
<td>.268</td>
<td>-.249</td>
<td>.897</td>
</tr>
<tr>
<td>Negative (Cardio/Gastro)</td>
<td>-1.897</td>
<td>.550</td>
<td>-3.446</td>
<td>.001</td>
<td>-2.976</td>
<td>-2.818</td>
</tr>
<tr>
<td>Positive (CNS)</td>
<td>.093</td>
<td>.728</td>
<td>.127</td>
<td>.899</td>
<td>-1.335</td>
<td>1.520</td>
</tr>
<tr>
<td>Negative (CNS)</td>
<td>2.798</td>
<td>1.012</td>
<td>2.765</td>
<td>.006</td>
<td>.815</td>
<td>4.782</td>
</tr>
<tr>
<td>Positive (Anti-infective/Vaccines)</td>
<td>.657</td>
<td>.640</td>
<td>1.028</td>
<td>.304</td>
<td>-.596</td>
<td>1.911</td>
</tr>
<tr>
<td>Negative (Anti-infective/Vaccines)</td>
<td>.745</td>
<td>1.429</td>
<td>.521</td>
<td>.602</td>
<td>-2.057</td>
<td>3.547</td>
</tr>
<tr>
<td>Positive (Arthritis and Pain)</td>
<td>-.175</td>
<td>.358</td>
<td>-4.888</td>
<td>.626</td>
<td>-.877</td>
<td>.527</td>
</tr>
<tr>
<td>Negative (Arthritis and Pain)</td>
<td>2.244</td>
<td>1.532</td>
<td>1.465</td>
<td>.143</td>
<td>-.759</td>
<td>5.247</td>
</tr>
<tr>
<td>Positive (Respiratory)</td>
<td>.579</td>
<td>.715</td>
<td>.810</td>
<td>.418</td>
<td>-.822</td>
<td>1.981</td>
</tr>
<tr>
<td>Negative (Respiratory)</td>
<td>-2.654</td>
<td>1.430</td>
<td>-1.856</td>
<td>.064</td>
<td>-5.457</td>
<td>.150</td>
</tr>
</tbody>
</table>

Figure 15: Model B Coefficient Statistics

The dummy variables that correspond to news regarding oncology trials, both successful and failed, are significant at the five percent level. Positive results from an oncology trial increases the share price by 0.4 percent whilst a failure results in a 1.171 percent reduction in share price.

---

8 Parameters that are in bold are statistically significant at a level of five percent.
Negative news regarding cardiovascular or gastrointestinal trials reduces share price by 1,897 percent, whilst positive news has no significant effect on share price.

Failures in clinical trials on CNS compounds have a significantly positive effect on share price. All other press release information does not have significant effect on share price, however there is a tendency towards share price declines as a result of failures in clinical trials on respiratory compounds. Adjusting for heteroscedasticity and potential autocorrelation could potentially make this regressor significant, however, as made clear in section 5.1.2 Heteroscedasticity and Autocorrelation, no such adjustments has been made.

6.1.3 Measuring the Price Impact per Research Phase
Model C is used to test if there are any differences in the price impact of press releases depending on the phase in which the compound was tested. The model specification is illustrated in 2.1.3.3 Model C.

<table>
<thead>
<tr>
<th>Model</th>
<th>Durbin-Watson</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2,155</td>
<td>0,331</td>
<td>0,330</td>
<td>446,822</td>
<td>0,000</td>
</tr>
</tbody>
</table>

Figure 16: Model C Summary

The models significance, as could be seen in figure 16, is high. The F-value is extremely large and the corresponding p-value (Sig.) shows that the model as whole is highly significant. Thus, one can with great certainty say that at least one beta-coefficient is separated from zero.
<table>
<thead>
<tr>
<th>Coefficients(^9)</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
<th>95,0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>.003</td>
<td>.018</td>
<td>.181</td>
<td>.857</td>
<td>-0.032, 0.039</td>
</tr>
<tr>
<td>% Change S&amp;P500</td>
<td>-.106</td>
<td>.016</td>
<td>-6.730</td>
<td>.000</td>
<td>-1.137, -0.075</td>
</tr>
<tr>
<td>% Change DJ Pharma</td>
<td>1.052</td>
<td>.023</td>
<td>45.475</td>
<td>.000</td>
<td>1.006, 1.097</td>
</tr>
<tr>
<td>Positive Phase III</td>
<td>.423</td>
<td>.183</td>
<td>2.313</td>
<td>.021</td>
<td>0.065, 0.782</td>
</tr>
<tr>
<td>Negative Phase III</td>
<td>-1.249</td>
<td>.373</td>
<td>-3.352</td>
<td>.001</td>
<td>-1.980, -0.519</td>
</tr>
<tr>
<td>Positive Phase II</td>
<td>.108</td>
<td>.230</td>
<td>.470</td>
<td>.639</td>
<td>-.343, .559</td>
</tr>
<tr>
<td>Negative Phase II</td>
<td>.453</td>
<td>.588</td>
<td>.771</td>
<td>.441</td>
<td>-.699, 1.605</td>
</tr>
<tr>
<td>Positive Phase I</td>
<td>-.771</td>
<td>1.431</td>
<td>-.539</td>
<td>.590</td>
<td>-3.576, 2.034</td>
</tr>
</tbody>
</table>

Figure 17: Model C Coefficient Statistics

Positive news regarding clinical trials conducted in Phase III increases firm value by some 0.423 percent whilst negative news results in a 1.249 percent reduction in firm value. Both dummy variables are significant at the five percent level, whilst press releases in other phases does not significantly affect share price.

6.2 Security Analysts Views on Valuation
The analysts interviewed in this thesis had different backgrounds. Bellander had a background in economics, Larsen has a background as a biomedical analyst and Häggblom has studied both business administration and medicine. Thus, it is safe to say that the analysts covering health care stocks are a heterogenic group. Common for all analysts were that, out of all the firms used in this sample, they were only covering the British/Swedish pharmaceutical company AstraZeneca.

\(^9\) Parameters that are in bold are statistically significant at a level of five percent.
6.2.1 Analyst Views on Pharmaceutical Firm Valuation

All analysts use a mixture of DCF and Relative valuation when valuating pharmaceutical firms. The choice of valuation approach was directly linked towards the length of the analysis. The analysts interviewed in this thesis made a clear distinction between short-term and long-term value. The discounted cash flow states the more long-term value of the firm and Relative valuation is used as a more short-term prediction of the firm’s movement in relation to its peers.

The cash flow estimates in each analysts DCF valuation model are all structured in a way that all of the blockbuster drugs and most promising compounds in clinical trials are estimated separately.

The method used to set the appropriate discount rate to the DCF models varies between different analysts. All analysts use the basics of the CAPM, making a clear distinction between the risk-free rate of return, the market risk premium and the beta value. The beta value is however, based on different assumptions. Danske Markets sets the beta value according to a fixed length (24 month) historical covariance to the market portfolio (market index) (Häggblom, 2009). Carnegie sets the discount rate with regards to the analyst’s perception of the individual firms risk level, where they can choose low risk (β=0.8), normal risk (β=1) and high risk (β=1.2), and where therefore not using the stocks historical covariance to the market as proxy (Bellander, 2009).

When using relative valuation, analysts use a more qualitative approach. They compare key financial ratios, such as the price to earnings ratio, and use a qualitative discussion about the product portfolios remaining patent time, number of compounds in pipeline, growth potential and so forth as motivation for trading the stock at a discount or premium versus the rest of the pharmaceutical sector. A firm with substantial larger amount of substances in pipeline should, ceteris paribus, be traded at higher multiples than one with a smaller pipeline. (Bellander, 2009)
6.2.2 Analysts Views on Pipeline Valuation

All three of the interviewed analysts recognize the importance of research in order to generate strong future cash flows and to uphold the pricing power of the pharmaceutical companies. However, the analyst’s views on the pipeline’s impact on firm value and the level of detail required in the valuation models are dissimilar.

Analysts generally tend to set value on phase III compounds and recognize that some phase II substances can be of importance in pharmaceutical companies. However, Bellander at Carnegie claims that Phase I and II trials are of lesser importance since it is more difficult to estimate the market size and usage of the drug and since they also have a high rate of failure they are excluded in his valuation models. Its potential impact on cash flow, if launched, is also seen as limited in the near future and it is therefore not seen as important.

When estimating the impact prospect drugs has on future cash flows it is most common to use a risk adjusted Net Present Value (NPV) approach, where the drugs sales potential is estimated throughout its life cycle if it were to be launched, adjusted for the probability of a launch, and discounted into present value terms. This is illustrated in figure 18. All analysts in this thesis sample used this approach.

\[
Risk \text{ Adjusted } NPV = \frac{E(CF_1) \times p}{(1 + r)} + \frac{E(CF_2) \times p}{(1 + r)^2} + \ldots + \frac{E(CF_n) \times p}{(1 + r)^n}
\]

Where: 
- \( E(CF_t) = \) Expected cash flow in period \( t \)
- \( p = \) Probability of market launch
- \( r = \) Discount rate

Figure 18: Risk Adjusted Net Present Value

There are two ways in which analysts’ estimates cash flows in the risk adjusted NPV. One of the more in depth techniques to use when valuating then drugs expected cash flow is to analyze the whole life cycle of the drug, estimating the cash flow impact every year. This approach requires assumptions about market size, time to peak sales and expected patent expiry. An alternative way to estimate the drugs potential cash flow is to compare the drugs pharmaceutical ability to those of competing drugs in
order to estimate its relative success rate, basing the analysis on whether or not the analyst believes that the drug can be more successful than its predecessor or not. This requires that the drug candidate is to compete with other types of treatment for a particular or related disease.

Bellander claims that pharmaceutical companies generally have strong product portfolios, and that speculation in the research portfolio is both complicated and unnecessary, and does not add value to the analysis. He believes that it is more useful to focus on the current product portfolio. Bellander uses the risk adjusted NPV approach and assumes that all phase III compounds, regardless of therapeutic area has a fixed success rate of 70 percent. Morten Larsen, ABG Sundal Collier, on the other hand uses the risk adjusted NPV approach and employs a mixture of historical success rates within each compounds area of therapy and his own judgment when setting the probability of success. “Different compounds has both vastly different characteristics as well as market potential and it is therefore crucial to make a detailed estimate of each compound individually”. (Larsen, 2009) Mattias Häggblom, Danske Markets, stresses the importance of using a qualitative judgment and incorporates his own believes and experience when setting the success rates.

Bellander does not believe that the product pipelines is the main value driver in a pharmaceutical firm. In fact, he claims that the pipeline is of little importance and that an investor should be focusing on estimating the sales of the current product portfolio when valuating pharmaceutical firms.
They all claim that there is a significant difference between valuating larger pharmaceutical companies and smaller biotechnology firms. Smaller biotechnology firms do not often have a product portfolio and only a few risky compounds in clinical trials forcing the analysis towards determining the ‘correct’ value of the whole pipeline, as it is the firm’s greatest asset. It is not unusual that all compounds in clinical trials, regardless of phase, are valued in biotech. As a consequence of the larger amount of risk and lesser degree of diversification in their research portfolio, the value of biotech firms are more binary, if they succeed in turning promising compounds in to products they will probably generate strong cash flows, otherwise they will most certain go bankrupt. Häggblom usually uses a contingent claim approach when valuating these firms.
7 Analysis

7.1 Analysts Choice of Valuation Approach
The analysts’ uses a mixture of DCF and Relative valuation, whilst leaving the contingent claim approach to the valuation of small biotechnology firms. However, since all analysts use a mixture of both DCF and relative valuation one might conclude that there is not one theoretical approach that is clearly superior to another. They are used for different purposes, relative valuation is made to set short-term trading calls, which can be due to the fact that analyst are ‘protected’ by the rest of the markets valuation and needs only to defend their deviation from the assets current valuation. It is also easier to sell which is important as an analyst, especially when marketing shorter trading advice. The fact that analysts sees the DCF-model as the most important valuation technique could be due to that analysts are forced to publicize all assumptions explicitly and that the reader of research report easily can chose to accept or reject certain assumptions. These explicit assumptions make it easier for clients to benchmark the analyst’s competitors. This is more difficult using the more qualitative relative valuation technique where the assumptions are ‘hidden’ and it is thus easier to ‘sense-check’ analysts by means of the DCF valuation approach.

The complex contingent claim valuation model is not used by any of the interviewed analysts for valuating pharmaceutical firms. However, it is more common to use when valuating biotechnology firms, which could indicate that the option like pricing approach is most appreciated in high-risk firms that lives on the hope of succeeding launching compounds from a small pipeline with just a few substances in development. As biotechnology firms has a more binary value, the success of a compound results in tremendous share price appreciation, whilst a failure means bankruptcy, they are showing more option like characteristics than well diversified pharmaceutical firms.
7.2 Pipeline Valuation

7.2.1 Comparing Security Analysts Views on Pipeline to Theory

The pharmaceutical firms pipeline is valued mostly through a risk adjusted net present value approach where different analysts use different assumptions about the success rate in order to adjust the present value. This is very closely connected to the DCF framework used when estimating cash flows under uncertainty, where all analysts more or less used the four-step procedure introduced as explained in section 3.1.1 Cash Flow Estimation. The two scenarios are either a success in which the exploratory compound is launched to the world markets or that the project is a failure and therefore terminated before generating profits. These two scenarios are later assigned with probabilities, in which analyst’s uses different assumptions. The value of the compound is therefore the probability adjusted cash flow.

The scenarios are determined in two ways. Either based on a more thorough analysis or via comparison. Once again one can see that analysts uses a mixture between the DCF and Relative valuation approach. The more in depth method estimating sales over the drugs lifecycle requires more explicitly stated assumptions and can be more difficult to defend to investors, and shows the same characteristics as the DCF model. The relative valuation approach is once again a quicker method that is easier to defend. However, that is no saying to what is the best approach to use when estimating future cash flows of a potential new drug, clearly, no there is no consensus in the methodology used in the security analyst profession.

When setting the probabilities of success for individual compounds there is a close link between educational background and time spent on determining these probabilities. The two analysts that had a background in biomedicine were made more in depth analysis about the success rate, either by looking at historical success rates within each therapeutic area, or using their own judgment and experience.
The analyst that had background in economics did not believe that a high level of detail was worthwhile when valuating the pipeline and had thus a simpler way of determining its value. This once again indicates that there is no consensus in the security analyst profession and that the analyst own level of interest and/or knowledge heavily biases the analyst’s valuation models.

Contingent claim valuation, which theory stresses to be the best approach when valuating investigational new drugs, is not used at all when valuating ‘big pharma’s’ pipelines. This could be due to the difficulty to estimate the variables needed to use option based pricing models. It is, as an example, hard to estimate the degree of uncertainty (the volatility) of a new drug. As each compound needs to have their own individual set of variables, the aggregate assumptions that needs to be done leaves a lot of room for errors, as ‘Big Pharma’ has a great amount of compounds in clinical trials. As options are heavily sensitive to most input variables, the error made when valuating a large set of compounds could be overwhelming. As the pipeline is only one of several sources of value to these firms, option based pricing might bias the value of the pipeline, and thus biasing the analyst’s whole research report. The contingent claim model is perhaps better suited for valuating small biotechnology firms, where the pipeline is the main value driver, and where the pipeline usually contains only a few compounds, enabling the analyst to set the variables more thoroughly. Smaller firms with a less complicated mix between current sales and upcoming sales though hopefully Successful research allows the analyst to spend more time to thoroughly explain the valuation approach of the pipeline to their costumers.

Value was first given to compounds entering phase III. Some analysts also recognize the importance of valuating promising phase II compounds. The author believes that this is a sign of compromise, where in theory securities needs to be valuated by all actions that can have a impact on the firm’s net present value, however, as analysts have to prioritize their time in order to maximize their commission. Phase III compounds has, at least historically, had a greater probability of success, which lowers uncertainty to some extent. The potential cash flows from these compounds are also closer in time, which has a greater impact on the cash flows the next coming years than in early stage research. Phase I compounds has in theory only a minor
impact on the firm’s intrinsic value and analysts does not think that it is worthwhile to incorporate them into their analysis. This might imply that the value of the pharmaceutical industry’s pipeline could be understated since analysts do not incorporate the full potential in the pipeline into the valuation models.

7.2.2 Comparing Analyst Views on Pipeline Valuation to Market Reactions
As the market clearly reacts to clinical trial results, security analysts are correct in recognizing the pipelines value. However, as the results from the econometric models shows, the only phase in which the market assigns value is the third and last stage of clinical trials. Phase II trial results does not have a significant impact on firm value. Two of the interviewed analysts assigned value to some of the most promising Phase II compounds but not all of them, whist one analyst did not assign any value to compounds in Phase II. Analyst valuation models are therefore inline with the markets reactions to these trials.

Model B also shows that only successful oncology trials affects firm value. As each analyst assigned value to pipeline projects individually not taking the area of therapy in to consideration, one might see that there is a discrepancy between market reactions and analyst valuation models. Oncology, or cancer treatment, could be one of the most lucrative areas in which to business (Bellander, 2009). If a drug prolongs a patient’s life, it is likely that patents have low price sensitivity, which makes it likely that the pharmaceutical firm chooses a high price strategy in order to maximize profit. As research in this field could be highly profitable and in combination with the therapeutic areas high rate of failure, the market can, if clinical trials are positive, expect a large impact on future cash flows and are therefore able to purchase shares that are higher priced. However, even though analysts do not explicitly take the area of therapy into account, their cash flow estimates of each individual drug does as they compare revenues from the drugs predecessors. It might be so that analysts should focus more on oncology trials and less on other areas of therapy as the market clearly does not assign the same weight to other trial results.
### 7.2.3 Comparing Theory Regarding Pipeline Valuation to Market Reactions

The empiric results show that there is an overall connection between the publications of results from a clinical trials and firm value. This is completely inline with finance theory. The fact that the model shows significance on a daily data set shows that pricing quickly adapts to new information. Research in pharmaceutical firms makes up the foundation on which upcoming sales are to be based upon and according to the DCF valuation technique it should impact firm value. The fact that there is an overall pricing effect, due to both positive as well as negative news is therefore inline with common firm valuation techniques.

However, only clinical trial results from investigational compounds in oncology, cardiovascular/gastrointestinal and CNS is significantly affecting firm value. It is plausible that failing trials for respiratory drugs could affect value, if the data material where to be corrected for heteroscedasticity and autocorrelation as the corresponding P-value was 0,067. The fact that negative news regarding CNS trials has a positive effect on share price is a surprising finding, however, it could be due to the limited amount of observations. Since there are only two observations it is fully possible that there has been other occurrences (not captured by the S&P500 or DJ Pharma index) that resulted in increasing share prices.
8. Conclusions

How Does Security Analysts Valuate Pharmaceutical Companies and Their Research Pipelines?

Analysts use a mixture of Discounted Cash Flow valuation and relative valuation. The choice of methodology relates to the time frame of the valuation. When setting a shorter term value, relative valuation is usually the focus whereas the Discounted Cash Flow model is their statement of the perceived value in the long-term. When using relative valuation they usually have a more qualitative discussion about the firm’s position in relation to competition with regards to growth, patent time left on the product portfolio, pipeline potential and so forth. The Discounted Cash Flow valuation models of all analysts incorporate explicit estimates of success rates, time to peak sales and market potential of all Phase III compounds and some of the most interesting Phase II compounds. However, the analysts used vastly different assumptions off the success rate.

The econometric models shows that news regarding results from Phase III clinical trials has a significant impact on firm value. This implies that either the analysts are correct when applying value to these compounds or that the analysts views on valuation is significantly affecting share price performance. However, the author sees the first explanation as most plausible.

In conclusion, security analysts uses the same toolbox when valuating pharmaceutical firms, however, the assumptions behind each analysis differs drastically. All analysts recognize that the pharmaceutical industry’s pipeline is of importance but disagree on its relative importance. Some analysts’ uses clinical trial results and historical data to make advanced models about pipeline value whilst others doubt that the pipeline is an important value driver and uses simpler models.
Is There Any Discrepancy Between Analyst Valuation Techniques and Financial Theory?

Yes, there are some discrepancies. Financial theory often recommends contingent claim valuation models when valuating assets such as R&D pipelines in pharmaceutical companies. Analysts do not use this valuation technique, and instead uses DCF or relative valuation, this could be due to the complexity of using two different valuation techniques when valuating large pharmaceutical firms or the complexity of estimating the input needed for option pricing.

Even if all analysts recognize the difference between risk-free rate of return and market return and beta when setting an appropriate discount rate in their DCF-models not all analysts sets the beta value according to the security’s covariance to the market portfolio.

Does Press Releases or Other News Regarding Results From Clinical Trials Affect Firm Value?

Yes, they affect firm value. However, different news affects firm value differently. The study proves that the market only reacts to phase III clinical trial results and neglects most of the results published in earlier trials.

Does Press Releases or Other News Regarding Different Areas of Therapy Affect Firm Value Differently?

Yes, they affect firm value differently. This study proves that clinical trial results for most areas of therapy do not affect firm value. The therapeutic areas affecting firm value were news regarding both the success and failures of oncology trials, failed trials regarding gastrointestinal or cardiovascular compounds and failed trials regarding substances treating disorders in the central nervous system.
8.1 Suggestions for Further Research

This thesis has determined that there is a significant link between clinical trial results and pharmaceutical firm value. Interestingly enough, failures seem to have a greater absolute share price impact than succeeding trials. The author has not tried to explain this remarkable behavior. Most financial theory suggests that investors are rational in their expectations and that they are quickly and accurately able to change expectations if they have biased expectations. Positive and negative news should therefore be having the same absolute impact on share pricing, why isn’t it so? Why do only certain areas of therapy affect firm value? Are the findings of this thesis applicable to smaller pharmaceutical firms? As analysts claim that they valuate the biotechnology sector differently, does clinical trial results affect that sector differently? Could the results of this study be improved if the data sample were to be enlarged? The author would like to encourage the finance society to examine the exciting realm of pharmaeconomics, as the empirical ground in this area is clearly lacking.
References


http://nobelprize.org/nobel_prizes/lists/all/


Appendix 1 – Interview Questions

Introduction
Brief presentation of myself and the aim of the thesis.
Confidentiality, asking for permission to quote the analyst in this thesis, and asking whether or not the analyst wants to read a transcription of the interview.

The Respondent
Can you give me a brief presentation about yourself?
What is your background?
How did you end up as a security analyst?
What companies do you cover?
Are you covering the stocks yourself or do you work as a team?
If so, how large is your team?
What recommendation structure does your firm have? (e.g. Conviction Buy, Buy, Hold, Sell)

Pharmaceutical Valuation
What kind of framework (DCF, Relative Valuation, Contingent Claim) do you use when valuating companies?
How do you valuate Pharmaceutical firms?
Is there any difference between smaller pharmaceutical firms and ‘big pharma’?
What are the main value drivers in these firms?
How do you estimate cash flow growth?
What key financial ratios do you use when comparing a firm to its peers?
How do you choose the required rate of return?
How do you estimate \( \beta \)?
Is there any value attached towards a well-diversified product portfolio?

Pipeline valuation
How do you valuate the product pipeline?
Which compounds are attached with value?
Is there any difference with regards to the compounds area of therapy?
How do you estimate a compounds success rate?
How do you estimate the market potential for a drug in development?
Is there any value attached towards having a well-diversified research portfolio?

Other
What problems is the pharmaceutical industry facing today?
Are generic manufacturers a bigger threat today?
Is different geographical markets differently priced?
Are firms in biotechnology valued differently?
How do you interpret and analyze press releases regarding results from clinical trials?
Appendix 2 – Econometric Tests

Informal Graphical Heteroscedasticity Test

As seen in the figure, residuals are fanned out both to the left and to the right of the middle. The data material is clearly heteroscedastic.