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MOVING THROUGH THE CLINICAL PIPELINE

An event study on Biotech companies' stock prices when shifting clinical trial phases

Author
Lukas Björklund

Supervisor
Anders Vilhelmsson

SCHOOL OF ECONOMICS AND MANAGEMENT
Lund University

Abstract

Biotech companies on the stock market follow a rigorous clinical process for their product development. The implications of this for investors is an alternative approach to stock valuation that incorporates the uncertainty to the potential future cash flows will be realized. The 3- step clinical process prior to regulatory approval each increase the probability of having drug candidates approved.

As Biotech companies announce clinical results, implying they will move on to subsequent clinical phases, stock prices should according to the Efficient Market Hypothesis react instantly and completely in parity to the stock being fairly valued. This thesis evaluated the Cumulative Abnormal Stock Returns for Biotech stocks around a 20- day period prior and following the announcements. The method used for this event study was a statistical Z-test to determine if the event period reported any statistically significant Abnormal Returns. Theories assessed in this study was Efficient Market Hypothesis and Discounted Cash Flow modeling for security valuation. Additionally, previous literature covering Post Earnings Announcement Drift, Risk-Adjusted Net Present Value for biotech valuation as well as News trading were also assessed in the light of EMH.

The results showed that there was no statistical significance to prove Cumulative Abnormal Returns during the event window observed. Furthermore, average stock prices increased in line with the increased probability of receiving market approval at later clinical stages. Although not statistically significant, the results indicated tendencies for News Trading strategies to hold.

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1 Introduction

1.1 Background

Research and Development (R&D) within the pharmaceutical and biotechnology sector fills an important role concerning public health. It is a driver of innovation leading to higher output of medical products, resulting in more treatments and higher quality substances reaching the market. Eventually, this results in improvements of public health and quality of life. From an investment standpoint, successfully developed treatments, medicines and other clinical products are associated with patent protection and price-inelastic demand which results in high profit margins (Toptal, n.d).

Products in this sector that are developed for clinical applications are required to complete a series of preclinical and clinical trials prior to receiving regulatory approval for launching their products to the market. In average, the process from initiation of clinical trials to product launch could take approximately seven to ten years (FASS, 2017). The majority of clinical trials globally are performed for products developed by large pharmaceutical companies, colloquially named as "Big Pharma", with multiple product verticals and diverse product portfolios (FASS, 2017). Big Pharma fund their R&D operations through allocating a share of their revenue on R&D. Along with "Big Pharma" are companies, often smaller, whose entire operations are focused on developing new treatments, drugs and medical devices for clinical applications. Companies in this sector are typically referred to as "Biotech" and "Biopharma", where the primary difference from "Big Pharma" is the specialization on R&D instead of also being responsible for distribution and marketing, which is the case for the pharmaceutical companies. This implies that the investors behind this type of biotech companies are at the mercy of the development of the clinical trials. Biotechnology in a defining sense refers to developing commercial products from living organisms, as opposed to pharmaceutical companies' products that generally have a chemical base. The products developed by Biotechnological companies can have a wide variety of applications, although the majority is for medical and agricultural applications (Investopedia, 2018). As a simplification in this thesis, "Biotech" will refer to companies that have product candidates in clinical trials, and will therefore not distinguish between whether the product candidate is derived from living organisms or not.

As a general valuation principle for investors, the current value of an asset, for instance a share of equity in a publicly traded company, is said to be the discounted value of all future cash flows (Corporate Finance Institute, n.d). In more practical terms, valuation methods of stocks often adhere to projected earnings, assets, and cash flows utilizing DCF-valuation metrics, earnings multiples, price/book ratio etc (Corporate Finance Institute, n.d). The lion shares of research show that stock prices in this type of assets fluctuate with the underlying companies' expected earnings over time (AAII, n.d). For companies that only have products in clinical trials, there is a high level of uncertainty if future cash flow will ever be realized, as they are closely tied to the success of the clinical trials. This implies a different valuation approach of biotech companies' R&D pipelines (Toptal, n.d).

1.2 Problem discussion

As most types of fundamentally inclined investment analysis methods take current or shortly forecasted earnings into account in the valuation process, determining a value of a company in early clinical trials becomes more complex. In the perspective of investors, news around clinical trials tend to have a significant influence on the stock prices of large companies in the Biopharmaceutical sector. (Hwang, 2013).

Regardless of company size in the pharmaceutical and Biotechnological space, investing in R&D is associated with risks for which the impact on future profitability is high (Hwang, 2013). Therefore, the outcomes of clinical trials are important events for firms operating in the Pharmaceutical and Biotech industry. For larger pharmaceutical corporations with diverse product pipelines, the news releases of clinical data are important economic events to which significant abnormal returns are achieved following the announcement. Further, negative abnormal returns following negative clinical trial news were larger than the respective abnormal returns for positive clinical news (Hwang, 2013).

Clinical trial announcements cause stock prices to change around the date of the news announcements, trending towards the direction of the nature of the clinical trial announcements during a period of 60 days before the announcement (Rothenstein et. al., 2011). A reason for this could be the incidence of insider trading, implying some investors act on information not yet released to the public, also referred to as Material Non Public Information (MNPI)(Rothenstein et. al. 2011). The study was limited to phase III oncology companies and found abnormal returns, both positive and negative, during the time period leading up to the news announcement, which depended on the outcome of the respective clinical trial announcement.

Two of the major shortcomings with event studies is that the price impact of the effect being observed is relatively small in an environment where many types of news can influence the stock price (macroeconomic data, politics, etc) which makes it hard to measure precisely (Investopedia 2019e). The other problem is that the event may already be anticipated and therefore only part of the event will be reflected in the stock price movement. Making an event study on small biotech companies overcomes both of these problems. As results of clinical trials for small biotech companies are binary events in the nature of “make or break”, the effect on stock prices should be large. Furthermore, given that most product candidates do not make it to market launch, implying that any positive news from clinical trials are unexpected. Furthermore, biotech companies tend to have low correlation between them, and as a group historically have had a low correlation with market-wide stock indexes (Candriam 2017). This implies that market-wide news affects biotech companies to a lower extent than the financial markets as a whole.

1.3 Purpose

The purpose of this report is to study the cumulative abnormal stock returns of publicly traded biotech companies in clinical trials around the announcements regarding clinical results of product candidates as well as initiations of new studies.

1.4 Disposition

This paper is divided into three parts, where the first part describes the details of the clinical development process as well as some theories and previous literature on how financial markets react when they encounter new information. Additionally, a valuation method on Biotech companies is presented. The second part of the paper presents the process of which the study has been conducted, including data collection and screening criteria for companies included. The third part contains results followed by a discussion tying to theories and previous literature.

1.5 Development of Clinical Products

1.5.1 Clinical process

The drug discovery process in general holds the following phases:

Drug discovery phase: At this stage, computer databases are used to find chemical compounds that could have an altering effect on the target diseases. As an indication, approximately 1 on 10000 tested compounds at this stage will eventually reach the market (Medicilon, 2016).

*Preclinical stage:*At this stage, potential drug candidates that have been identified in the previous screening process to have altering effects on the target are assessed. This normally involves testing the substances in animals, where the activity and toxicity (effect on the target disease and potential harm to the cell) of the substance is studied and presented to relevant medical products authorities. At the end of this phase, an application is filed to the applicable medical products authority, which is the Food and Drug Administration in the United States and the Swedish Medical Products Agency in Sweden.

Clinical Phase I: During the first clinical phase, the safety of the product is assessed. The product candidate is at this stage injected in a small number of volunteering healthy humans, who are carefully monitored after taking a single dose of the drug candidate. Some of the participants are injected with a placebo substance. Before advancing to the following phase, the candidate is injected multiple times during a sequential time period, where the healthy volunteers are monitored for further side effects not identified earlier in this phase. Approximately 70 % of drugs tested in phase I move on to the next phase (FDA).

Clinical Phase II: At this clinical stage, the substances are tested for their effectiveness to alter the symptoms of the target disease. To achieve this, a somewhat larger group is used in order to assess the substances' effect on the symptoms, as well as confirming dosage for the larger-scale phase III study. Can be divided into early (phase IIA) and late (phase IIB) stages. Approximately 33 % of drugs tested in phase II move on to phase III (FDA).

Clinical Phase III: Will only commence if the results from phase II are positive enough to motivate continued studies. In this stage, the product candidate is compared to a placebo substance or an already approved substance for the same type of disease. These tests are double-blind, meaning neither the medical professionals nor the patients know which substance they receive. The scale of the studies in this size in general involve 300-3000 patients. Approximately 25% of drugs tested in this phase eventually reach the market.

Final application to medical product authorities: if the product candidate shows a statistically significant difference compared to a placebo substance or previously approved substance, the company will file a final application to the applicable medical products agency. In this application, the clinical results along with safety, effect and quality are documented and presented.

The probabilities of reaching market launch for products once they have reached the respective clinical phases are presented below, which is an average across diseases. The proportion of products reaching the market for cancer and Alzheimer is lower than for the numbers presented below while hematology and infectious diseases have significantly higher probabilities of reaching approval from phase I, 26,1 % and 19,1 %, respectively (BIO, 2016).

Phase I: Approximately **70 %** of studies move on to Phase II
Phase II: Approximately **33 %** of studies move on to Phase III
Phase III: Approximately **25 %** of studies move on to applying for regulatory approval
FDA approval: Approximately **85 %** of applications to FDA are approved (BIO, 2016).

This produces the following probabilities of receiving authority approval once the drug candidate reaches each respective clinical phase:

Phase I: **5 %**
Phase II: **7 %**
Phase III: **21 %**

1.5.2 Corporate strategies

As developing product candidates through a process with clinical trials is a process spanning over multiple years requiring extensive financing, the companies in this study have different strategies. For most of them, they aim to remain specialized on drug development after product launches and therefore outsource the production and distribution in collaboration with larger pharmaceutical companies, and receive royalty payments and patent protection for doing so (Investopedia, 2019a). In other cases, they partner with larger pharmaceutical companies during earlier stages of the development, namely phase II or III as a measure to reduce the financial risk of the clinical study (GEN, 2018). In this setup, the larger pharmaceutical companies arrange conditional cash payouts in case clinical results are successful, although before final authority approval. Another alternative is acquisition of either the product patent or the entire company in order to be integrated to the larger pharmaceutical companies' R&D pipelines. Cooperation between companies can also be based on securing the supply of future substances in combination with technological exchanges between the companies. This consolidation trend with higher

levels of mergers and acquisitions is primarily based on cost pressure and economies of scope (FASS, 2017), (Investopedia, 2018).

The price premium pharmaceutical companies pay when making public offers for Biotech companies are rewarding for investors. Since 2013, the average premium was in the range between 60-120 % compared to the average share price during the 30 days prior to the deal announcement.

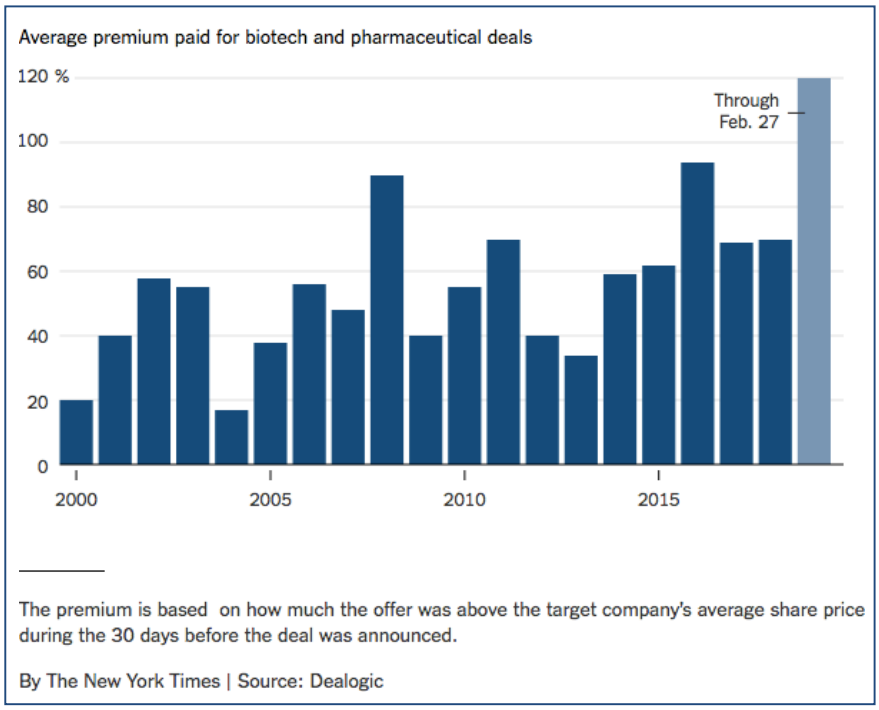


Figure 1: Average premium paid for biotech and pharmaceutical deals. Source: Dealogic (2019)

1.6 Theory

1.6.1 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) is a concept that was initially studied in the United States around the 1950s, and have since been highlighted in academic research around financial markets (Investopedia 2019c). In short, the theory states that stock prices reflect all available information to the market at a given point in time, which implies consistent risk-adjusted excess returns are impossible (Investopedia 2019c). EMH can be categorized as weak, semi-strong and strong. The strong form of the EMH argues for all public and private information being accounted for in the stock price, while the semi-strong and weak form only account for public and historic information, respectively (Investopedia 2019e).

An elaboration of a theory consistent with EMH was presented in 1965 by Eugene Fama's "Random walks in Stock-Market Prices", where the efficiency of the market is further explained. Fama defines efficient markets consisting of "large numbers of rational profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants" (Fama, 1965, p.3-4) . Further, as the competition between the participants leads to the stock price already being

a fair estimate of the intrinsic value of the underlying stock. As disagreement between market participants regarding the intrinsic value of the underlying stock, causing the "random walk" in the stock price, as these discrepancies are not systematic in an efficient market (Fama, 1965). As new information reaches the market, the competition between the market participants will on average cause the full effect of the new information being directly reflected in the stock price (Fama, 1965). However, Fama further states that stock prices both will over adjust as well often as under adjust for the respective effect of the event, causing the random walk to continue as new information reaches the market (Fama, 1965). The implication of this theory for investors is that using technical analysis to time the market will in the long run prove to not create any higher returns than buying and holding securities over longer periods of time. (Fama, 1965). EMH further argues that stock picking cannot outperform the market returns, and the only way for investors to generate higher returns is to undertake riskier investments. (Investopedia 2019c)

Although the EMH have been a central theme around academic studies around financial markets since its initial proposition, consensus have yet to be found. Studies reveal empirical evidence aligned with EMH as well as against it. According to an article published by CNBC, 85 % of active funds are trailing the S&P500 index in a ten-year period and 92% in a 15-year period, being an empirical argument against stock picking to the benefit of passive investments through indexing (CNBC, 2019).

1.6.2 Discounted Cash Flow (DCF)

Discounted Cash Flow modelling is used as an absolute method of valuation of securities based on the discounted value of all future cash flows. There are three key components in DCF-valuation: Discount rate, Cash flows and Growth for future cash flows (Damodaran, 2000).

Discount rates are determined by the cost of equity and the cost of debt, composing the Weighted Average Cost of Capital (WACC). Cost of equity relates to the returns investors require in order to invest in the firm, which can be derived through calculating with a risk-return or dividend growth model, among others. Cost of debt concerns the interest the firm has to pay for borrowing, which is determined by the general interest rate level, premium accounting for default risk and the tax rate for the firm. WACC accounts for the capital structure and the relative weight between the equity and debt in the firm. (Damodaran, 2000)

Further, cash flow estimations are made through identifying the firm's current earnings and accounting for how much the firm has invested for future growth. Simplified, these calculations can be performed as the following:

Revenues
(–) Operating expenses
(–) Tax payments
(–) Interest payments
= Net Income
(–) Capital Expenditures
(+) Depreciation & Amortization
(+) Adjusting for non-cash items
= Free Cash Flow to Equity

Further, taxes and interest payments are deducted in order to calculate the net income available to shareholders. Adjustment for non-cash items are attributable to changes in net working capital (inventory, accounts receivable, accounts payable) and items in Net Income that do not represent cash flows such as depreciation of goodwill and amortization. (Damodaran, 2000)

There are multiple levels of rigidity to which the DCF-model qualifies cash flows. In its strictest form, cash dividends to shareholders are the ultimate cash flow to equity holders. However, the majority of companies tend to hold cash to finance investments as well as for stability in case the firm meets fluctuations in demand. Adhering to this strictest form of actual cash flows will therefore likely result in companies being undervalued. Similarly, only taking potential dividend into account might inversely overvalue the firm (Damodaran, 2000).

As cash flow estimations are made for both the near future (1-3 years from now), an estimation period (4-10 years from now) and assuming the firm will continue its operations forever, a perpetual growth estimate, an aggregated estimate of the future cash flows to equity (shareholders) is derived. With the discount rate (WACC), the value of these cash flows are derived to a present value today (Damodaran, 2000).

$$DCF = \sum \frac{CF_n}{(1+r)^n}$$

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} \dots \frac{CF_n}{(1+r)^n}$$

CF_n = Cash Flow at year n, determined by Free Cash Flow to Equity
r = Discount rate, determined by WACC

1.7 Previous literature

1.7.1 Post Earnings Announcement Drift

Post Earnings Announcement Drift (PEAD) is a phenomenon evaluated by Ball and Brown in their 1968 paper "An empirical evaluation of accounting income numbers", where the price changes of individual stocks were studied following their published earnings announcements. The empirical results of their paper, which in subsequent literature have been named PEAD, demonstrates that stocks following their earnings announcements tend to trend into the direction of the earnings surprise in relation to the expectation of the market, which holds for a limited period of time following the earnings announcement (Ball & Brown, 19689. This anomaly stands in contrast to the Efficient Market Hypothesis, which states that markets react to new information immediately, and therefore adjusts the price of the underlying stocks directly according to new earnings information announced (Fama 1965).

Another study conducted by Bernard and Thomas highlights that explanations for PEAD can be divided into two categories: delayed price response for the new information and Capital Asset Pricing Model (CAPM) being incomplete or misestimated (Bernard & Thomas, 1989).

Capital Asset Pricing Model (CAPM) describes the relationship between systematic risk and expected return for investors. In brief, it models the returns investors should expect given its risk (Corporate Finance Institute). Bernard and Thomas argues for CAPM being incomplete or misestimated as a possible explanation for PEAD. This could relate to one of the shortcomings with CAPM; measuring stocks' risks through volatility, even though volatility is not equally risky in both directions, and therefore does not follow a normal distribution (Investopedia 2019b).

The arguments Bernard and Thomas highlight behind the delayed price response are based on the notion that transaction costs could impede a complete and immediate response to the new information reaching the market (Bernard & Thomas 1989). Another possibility is that investors with biased views make decisions of the basis of the new information reaching the market before the full earnings forecasts and outlooks are revised by analysts, and a complete and unbiased view of the stock is reflected in the market price (Bernard & Thomas 1989).

1.7.2 A valuation method for Biotech: Risk-Adjusted Net Present Value

As most biotech companies are yet to make revenues, investors need to understand how Biotech Pipeline valuation differs from profitable firms. Primarily, the lack of tangible revenues, a different product development process and binary clinical data outcomes are the major differences for biotech companies compared to conventional profitable firms (Toptal, n.d). A recommended valuation methodology is using Risk-Adjusted NPV (Net Present Value), which adjusts for the probability of developing a successful drug, as well as adjusting for other influencing factors such as partnerships. For calculations of scenarios, a Bayesian approach where a success rate is measured and continuously adjusted based on new evidence regarding the clinical development. (Toptal, n.d)

In more detail, cash flow projections with a similar methodology in the DCF-model in 1.6.2 are performed, accounting for patent length, pricing, size of target market and assumption of market share for the product candidate. An alternative to Bayesian probability is using a significantly higher discount rate to account for the risk associated with the investment. The probability-weighted cash flows are added together, creating the aggregate NPV for the product candidate, which can be expanded into entire pipeline portfolios. (Toptal,n.d)

Below is a simplified formula for determining the Net Present Value of a biotech company according to the risk-adjusted NPV.

$$NPV = P * \sum \frac{CF_n}{(1+r)^n}$$

CF_n = Cash Flow at year n, determined by Free Cash Flow to Equity
r = Discount rate, determined by WACC
P = probability of successful product launch

The probability of a successful product launch can be further clarified using Bayesian probability, shown below.

$$P = p(A) * p(B|A) * p(C|B) * p(D|C)$$

A= Phase I success
B= Phase II success
C= Phase III success
D= FDA regulatory approval

The variable P therefore is the product of conditional probabilities of having successful clinical data throughout the clinical phases. The variable P in the formula can also be removed from the formula and integrated in an increased discount rate, which would account for the uncertainty of the future cash flows to the firm.

1.7.3 News Trading - "Buy on rumors, sell on news"

Trading around news announcements is a strategy used by investors to profit from the increased volatility around a particular news announcement (Brunnermeier, 2001). This could be caused by information leakage or by investors being positioned in the market for specific outcomes ahead of important announcements (GDP, inflation, interest rates, product launches, earnings announcements). In theory, the strategy is based on leveraging a short-lived private information advantage. In practice, this could be manifested through institutional investors receiving information from sell-side analysts before their recommendation changes are made public (Brunnermeier, 2001). Another aspect of this adage is that stock markets are forward-looking, as investors buy and value assets based on the anticipation on future cash flows. On an aggregated level, this explains how the stock market tends to be a leading indicator of the economy as a whole as well as for individual underlying companies (Torssell, 2016). As investors exit their positions in the market should the news announcements be aligned with or below expectations, a subsequent stock price plunge after news perceived as positive might be explained through the news selling strategy (Lightspeed, 2017).

Selling on news around changed analyst recommendations is a strategy used by active institutional investors, a 2017 study by Pamela Moulton revealed. Active institutional investors included in the study did in aggregate purchase shares in the four days prior to analyst upgrades, and sold off during the day of the announcement (Moulton, 2017). During the first trading day after the analyst upgrade, active institutional investors returned to purchasing shares. For analyst downgrades, the process was inversed, with active institutional investors net selling in the four trading days prior to the downgrade, and subsequently buying during the day of the downgrade announcement (Moulton, 2017). Moulton illustrates active institutional investors' behavior around analyst recommendation changes in figures 2-3 below (Moulton, 2017).

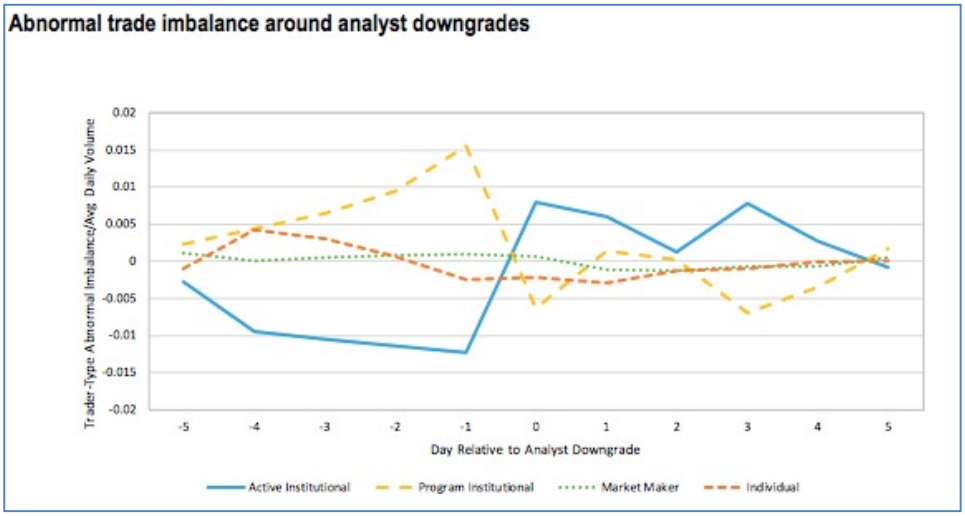


Figure 2: Abnormal trade imbalance around analyst downgrades (Moulton)

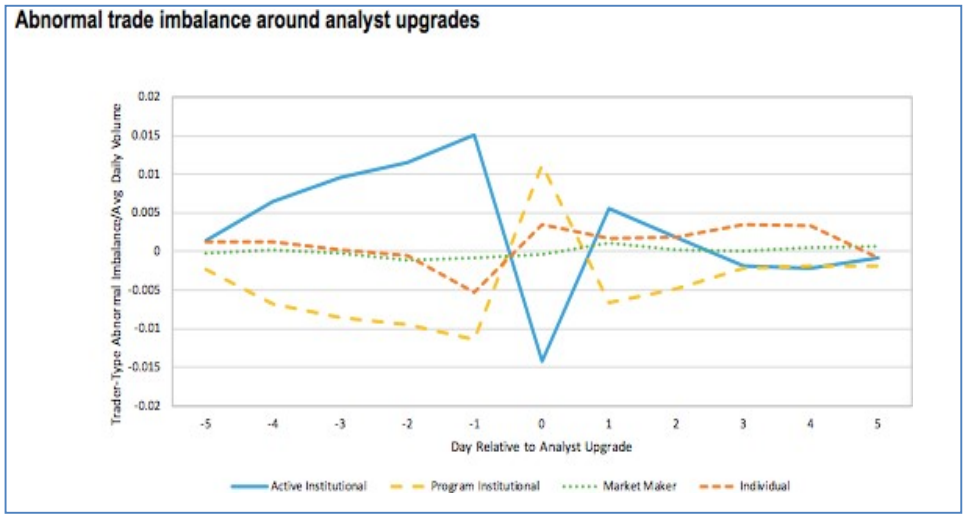


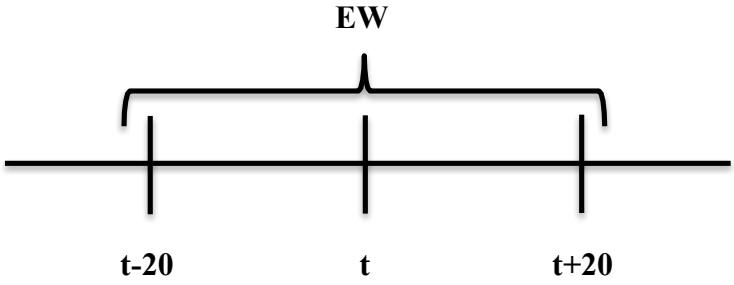
Figure 3: Abnormal trade imbalance around analyst upgrades (Moulton)

2 Method

2.1 Event study

This paper will perform an event study consisting of 53 events where in total 27 publicly traded Swedish biotech companies have moved from one clinical phase to another in their research. As some of the companies in the sample do not announce the results of their respective clinical trials in conjunct with announcements that new clinical trials in the following phase will be initiated, the event study both takes the endings and starting points of clinical phases into consideration. For instance, the companies might decide to follow up a certain study with another in the same clinical phase before receiving approval to continue the clinical trials in the subsequent clinical phase. In addition, some of the clinical trials in phase one and two are merged into one larger study, which are normally referred to as phase I/II, which implies that the actual transition between these phases are not clearly identified. In these situations, the event is treated as one conjoint clinical phase.

For each particular event in this study, 41 daily stock closing prices are observed for every company, creating the $t \pm 20$ event window (EW) where the event day is denoted by t.



Starting a new phase is treated strictly as positive information, while ending a phase is interpreted as positive if results indicate that studies in the subsequent phase will further be conducted, alternatively if a product launch will take place. In the case of discontinuation of the clinical program, the interpretation is negative.

The daily stock returns are calculated through the logarithm of the ratio of the stock price compared to the preceding day. The sum of all daily stock returns (R) thereafter composes the Cumulative Return (CR) for the event period.

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) * 100$$

$$CR = \sum R$$

R = stock return on day t (%)
P_t = stock price at day t
CR= cumulative daily stock return

2.1.1 Market model for estimated returns

The returns of the event window are thereafter compared to an estimated market return, which is supposed to illustrate the return of the stock during the event period had there been no news changing the fundamentals of the underlying companies. For this estimate, Beta-values between the given stock and the OMX Stockholm Health Care index for the preceding 250 trading days are calculated using the formula below.

$$\beta_a = \frac{Covar\ (a, b)}{Var\ (b)}$$

a = stock
b = index
Covar = covariance
Var = variance

Some companies in the sample has less than 250 trading days prior to their respective event periods, and will therefore have Beta-values measured for the longest period possible prior to the event period.

The Cumulative Returns during the event period will thereafter be compared to the respective returns of the estimated returns using the market model, which creates the Cumulative Abnormal return for the period, illustrated in the formula below.

$$R_{it} = \alpha + \beta_i R_{mt} + \varepsilon_{it}$$

$$E(R_{it)} = \alpha + \beta_i R_{mt}$$

$$AR_{it} = R_{it} - (\alpha + \beta_i R_{mt)} = \varepsilon_{it}$$

$$CAR_{it} = \sum R_{it} - (\alpha + \beta_i R_{mt)} = \sum \varepsilon_{it}$$

R_{it} = Return of stock **i** during the time period **t**
$E(R_{it})$= Expected return of R_{it}
AR_{it} = Abnormal return of stock **i** during time period **t**
R_{mt}= Market return

The rationale behind the market model is that the abnormal returns of securities can be calculated using the Beta-value and the returns of the market, where a comparable stock index can be used.

For the context of this study, the returns of OMX Stockholm Health Care index will be utilized as the comparable stock index for which R_{mt} will be retrieved. Furthermore, the same index has been used for calculations of Beta-values $\beta_{[}$.

2.1.2 Statistical testing for Cumulative Abnormal Returns

A method of measuring the statistical significance of the Cumulative Abnormal Returns is through a Z-test. As the abnormal returns in the context of the market model can be interpreted as residuals with a standard normal distribution, N(0,1). This implies that θ in the equation below also should follow the standard normal distribution.

$$\theta = \frac{\overline{AR_t}}{\sqrt{var\ (\overline{AR}_t)}}$$

$\overline{\overline{AR}}_t$ = Sample Average abnormal return

$var\ (\overline{\overline{AR}}_t)$ = residual variance from the market model

The Z-test following the standard normal distribution assumption will determine the statistical significance to the abnormal returns in the results.

2.2 Selection criteria for data

2.2.1 Companies

The selection criteria for the companies in the study are participation in clinical trials for the development their product pipeline. Further, another contingency is that they should have no or low levels of revenue, no consistent profitability and being dependent on the development of these clinical trials for their future survival and profitability. The companies should also have been going through a transition of clinical phases as public companies. Companies producing medical devices do in some cases follow a less rigorous clinical trial process, for which this type of companies also have been deselected. Companies with wide pipeline portfolios spanning across clinical phases along with products launched have also been deselected.

2.2.2 Events

The qualification criteria for the events are in the case of publishing of clinical results that they conclude the current clinical phase for that specific project. Qualifying events for initiations of new clinical phases could either be announced in separate press releases ahead of their starts or in conjunct with announcements of clinical data results in the preceding phases. The dates for the event used is the first trading day that the financial markets are aware of further studies being conducted.

2.3 Data

Initially, the companies have been selected through a sector screening for “Healthcare” and “Biotech” at Borsdata.se, followed by a screening on the companies’ financials in order to confirm they align with the selection criteria presented above. Thereafter, the clinical trial history

of each individual company is assessed, and key dates for starts and endings of clinical trials are identified using the companies' regulatory press releases.

Price data used has been downloaded from Compustat and Borsdata.se, in the cases where Compustat lacks information, the data has been retrieved from Borsdata.se.

2.4 Delimitations

The larger pharmaceutical companies conduct a substantial part of the current clinical trials, and as they are not included in this event study, a limitation of this paper is how the financial markets react to the clinical development of their product pipelines. In the study conducted by Hwang (2013), the effect on the stock market price around the clinical news announcements is still substantial for the large pharmaceutical companies (Hwang, 2013). The reason for this limitation is that larger pharmaceutical companies are more complex in terms of their clinical portfolio and revenue streams. Further, they are for the most part already profitable and can therefore fund their research and development with the cash flow from their operations, and are therefore not in the same position as companies who are strictly funded from capital raised from the stock market. The large pharmaceutical companies also tend to launch new products through a Merger & Acquisition strategy of clinical portfolios, for which they are not strictly at the mercy of their own clinical development as the companies highlighted in this paper. In addition, some companies

Another delimitation is the number of samples, which due to the nature of events along with strict screening criteria, was not higher. As a measure to increase the validity of the study in this context would be to increase the number of events included along with the geographical scope of the study. As every single event required manual handling through finding and confirming dates of clinical news announcements, the capacity for the context of this study was not higher.

Additionally, as some of the companies included in the event study have a short history on the public markets, their track record during different types of climates in the financial markets are limited, which implies a risk of the Beta-values utilized in the estimation of their returns being affected by large price changes during individual trading days. Furthermore, this could affect the aggregated results of the study.

Another delimitation is the uncertainty of when the markets are provided with information from the clinical trials. Although the companies are required to present clinical results as part of regulation, the markets might already have access to that information. To measure if this occurs regularly, the 20 trading days prior to the announcement will also be individually assessed.

2.5 Hypothesis

The hypothesis in this paper is that the stock price movement to the clinical trial news are instant and complete during the first few trading days following the news announcement. The reasoning for this hypothesis is the binary nature of the clinical data announcements, where investors have few other components to measure the value of the company than clinical data. This hypothesis

aligns with the Efficient Market Hypothesis and Risk Weighted Discounted Cash Flow model referenced in section 1.7.2. News on clinical data confirming continued studies should according to the Risk Weighted DCF, all else being equal, increase the probability of product launch and therefore the value of the company.

The null-hypothesis for the statistical test of the Cumulative Abnormal Returns is that the returns in the sample are equal to the expected returns.

H_0: $CAR_\tau = 0$
H_a: $CAR_\tau > 0$

3 Results & Discussion

3.1 Descriptive statistics

3.1.1 Entire sample

For the companies in the sample, the daily returns were added in order to derive the returns for the Event Window (EW). Standard deviation for the event window was also calculated, which provided the following average result for all of the events in the study.

Return EW (%)	**3,348**
Return day t to t+20 (%)	**0,872**
Return day t-20 to t (%)	**2,476**
Standard deviation (Volatility) EW	**28,94**

Table 1: Stock returns during the event window (EW)

The positive return of 3,35 % is to an extent of 74% realized during the 20 trading days prior to the news announcements, while only 26% of the remainder stock price upswing is realized during the 20 trading days following the announcement.

As for measuring the average cumulative abnormal returns (CAR) for the entire sample, where the returns presented above are compared to a market weighted method of estimating the stock returns using beta values of the previous 250 trading days following the OMX Stockholm Health Care index.

CAR EW (%)	**2,711**
CAR day t to t+20 (%)	**0,218**
CAR day t-20 to t (%)	**2,493**
Expected return EW OMX Health care (%)	**0,649**
Expected return day t to t+20 (%)	**0,666**

Expected return t-20 to t (%)	**-0,017**
Average Beta with OMX Health Care	**0,19**
Average Beta with OMXSPI	**0,17**

Table 2: Cumulative Abnormal Return

The table demonstrates that the cumulative abnormal return for the sample also is positive, showing a 2,7% positive return for the event window. For the case of CAR, 92 % of the CAR was realized in the trading days prior to the announcement while 8 % were realized in the 20 trading days following the announcement.

The average Beta-value of 0,19 implies that on average the stock prices in the sample move 0,19 % for every 1 % in the same direction as the OMX Stockholm Health Care index. Furthermore, the average Beta-value between the companies in the sample and OMXSPI (widest general OMX Stockholm index) was 0,17.

As the events observed both included announcements of starts as well as results (endings) of clinical phases, a comparison between the events have been conducted.

3.1.2 Comparing types of events

	CAR (%)	Actual return (%)
EW	0,44	1,41
Day t to t+20	1,83	2,18
Variance EW	537,05	460,26
Standard deviation EW	23,17	21,45

Table 3: Stock returns sorted for clinical phases started

As the table above indicates, the Cumulative Abnormal Return during the event window is close to 0. Furthermore, the volatility during the event period indicated by the standard deviation of 23,17. which implies that the results are not statistically different from 0 at the 5 % confidence level (p=0,93).

	CAR (%)	Actual return (%)
EW	6,05	6,38
Day t to t+20	-0,77	0,03
Variance EW	581,89	583,76
Standard deviation EW	24,12	24,16

Table 4: Stock returns for clinical phases ended

CAR for the event window was 6,05 % with a standard deviation of 24,12 %, indicating the returns from the companies in the sample during the event window were not significantly

different from 0 at a 5 % significance level (p=0,23). Both for CAR and actual returns, more than 99% of the returns during the event window are realized during the trading period prior to the clinical data announcement.

3.1.3 Comparing clinical phases

	CAR (%)	Actual return (%)
EW	1,52	2,56
Day t to t+20	-1,20	0,46
Variance EW	560,85	563,65
Standard deviation EW	23,68	23,74

Table 5: Stock returns for phase I events

For announcements in phase I, the CAR was 1,52%, which was not significant at the 5% significance level (p=0,79).

	CAR (%)	Actual return (%)
EW	1,40	2,05
Day t to t+20	2,76	2,81
Variance EW	585,42	498,80
Standard deviation EW	24,20	22,33

Table 6: Stock returns for phase II events

For announcements in phase II, the CAR was 1,40%, which was not significant at the 5% significance level (p=0,77).

	CAR (%)	Actual return (%)
EW	9,37	9,50
Day t to t+20	-0,78	-1,18
Variance EW	519,53	502,40
Standard deviation EW	22,79	22,41

Table 7: Stock returns for phase III events

For announcements in phase III, the CAR was 9,37%, which was not significant at the 5% significance level (p=0,23).

3.1.4 Comparing the timelines of the news announcements

The following graphs illustrate the average cumulative returns distributed throughout the event window, as an indication to how the news announcements around the clinical trials are received by the stock markets.

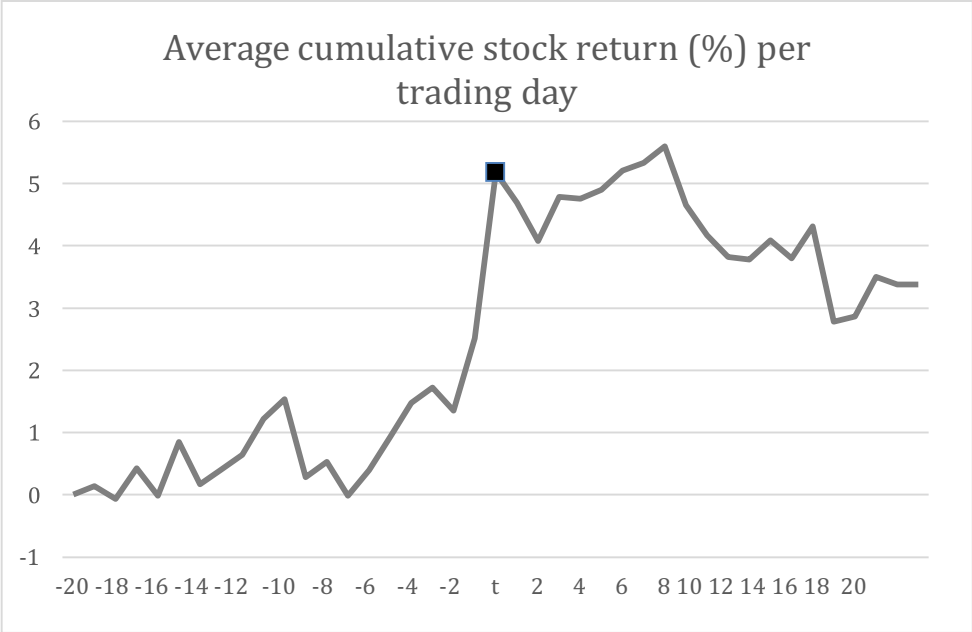


Figure 2: Average cumulative stock return (%), entire sample

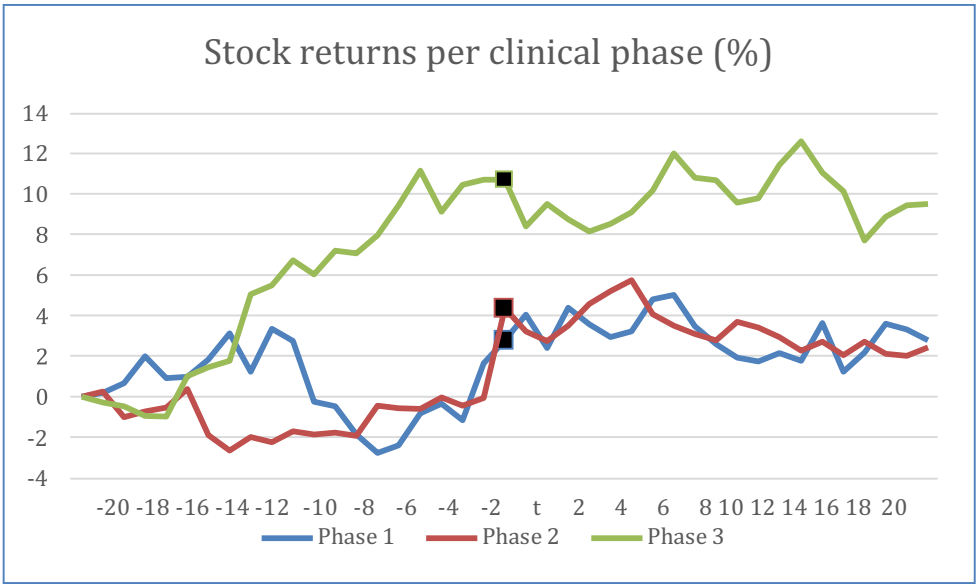


Figure 3: Stock returns per clinical phase

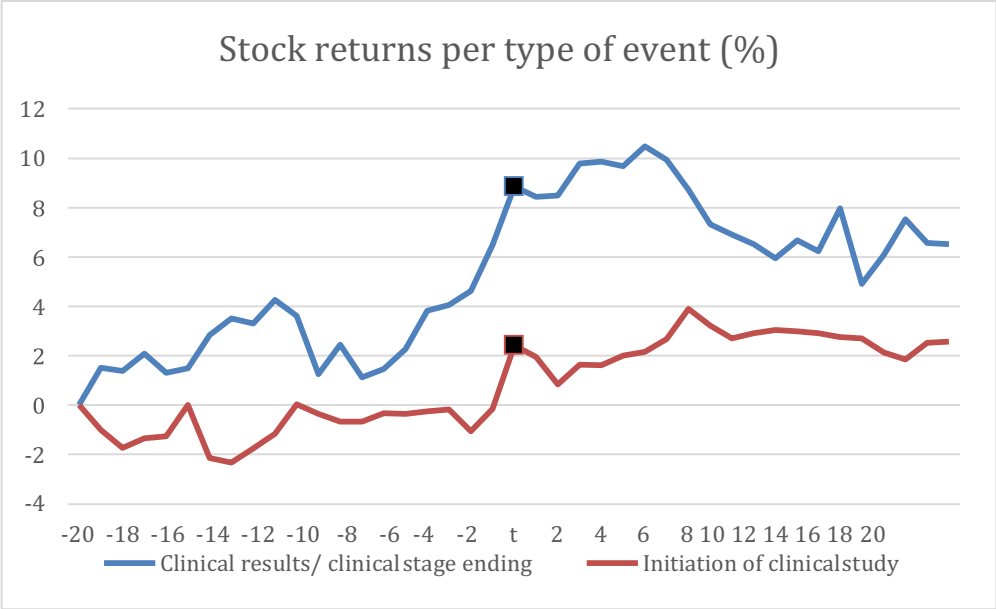


Figure 4: Stock returns sorted for type of event

3.1.5 Comparison based on stock market return on day t

The following graphs illustrate the stock price movements based on the initial stock market return on the day of the clinical news announcement, denoted as day t

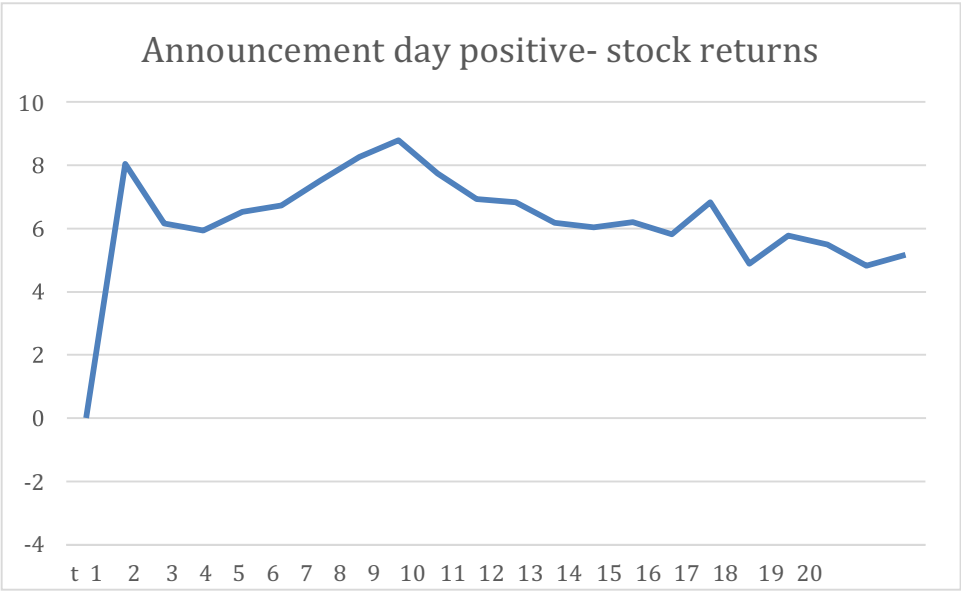


Figure 5: Stock returns given positive returns on announcement day

CAR day t to t+20 (%)	4,8
Return EW (%)	5,16
Standard deviation day t to t+20 (%)	7,83

Table 8: Stock returns given positive returns on announcement day

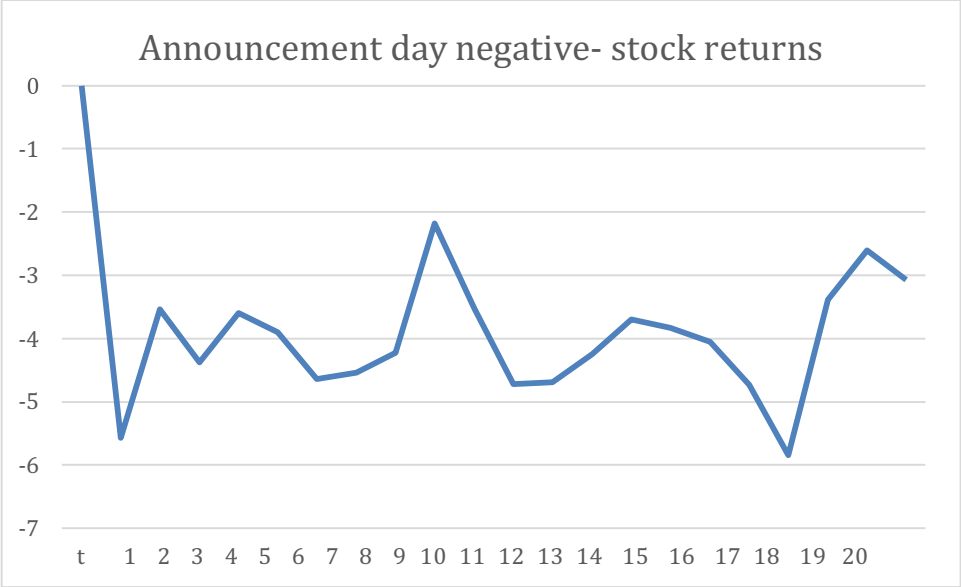


Figure 6: Stock returns given negative returns on announcement day

CAR day t to t+20 (%)	-3,43
Return EW (%)	-3,07
Standrad deviation day t to t+20 (%)	5,5

Table 9: Stock returns given negative returns on announcement day

3.1.6 Z-test test on the statistical significance of the Cumulative Abnormal Return

The result of the Z-test used to measure the statistical significance of the Cumulative Abnormal Returns as described in 2.1.2 provided the following inputs:

$\overline{AR_t}$	**2,22**
$var(\overline{AR_t})$	**10,20**
Z-value θ	**0,69**
One Sided Z-critical, α=0,95	**1,65**

P-value θ	**0,76**

Table 10: Z-test for statistical significance of the Abnormal Return

As the Z-value of θ is smaller than the critical Z-value at 95 % significance level, one cannot reject the null-hypothesis of CAR=0.

3.2 Analysis & Discussion

The purpose of this event study is to measure abnormal returns throughout the period of clinical transitions, with the hypothesis that market reactions should be instant and complete. This implies that for the hypothesis to hold, stock returns would be realized during the few trading days following the event. As the results above illustrate, the cumulative abnormal returns (CAR) from the day of announcement (day t) and the 20 following days are only a minor part of the CAR for the entire event window. This implies that the 20-day period prior to the clinical trial announcement accounts for 74 % of the CAR throughout the event window for the entire sample average.

The statistical test on the significance of the Cumulative Abnormal Returns concludes that the null-hypothesis of CAR=0 was not rejected. The implications of these results are that for the events studied, we cannot conclude with statistical significance that clinical announcements of changing clinical phases create abnormal stock returns during the event window of t ± 20 trading days. The results are consistent with previous findings on the strong form of the Efficient Market Hypothesis, which states that all public and private information already is priced into the stock price. Furthermore, when separating the events that had positive and negative stock price reactions during the announcement day, immediate price movements could be observed during the first trading day following the announcement, which aligns with the theoretical rationale of EMH. This is illustrated in figures 6 and 7.

The results of the study revealed that for the event window measured, there was no occurrence of Post Earnings Announcement Drift (PEAD), neither for the sample nor when sorting for announcement day stock returns. Events where the stock price surged during the announcement day trended negatively after the peak reached during the first day of trading following the announcement. For events where the returns on the announcement day were negative, the opposite occurred.

The results are consistent with the News Trading strategy, noting that when measuring for the entire sample, stock prices surged during the days preceding the announcement and dropped during the first days following it, illustrated in figures 3,4 and 5. This is consistent with the findings of Brunnermeier (2011), who claims that investors leveraging private information during a short period of time or being positioned speculatively for an outcome of a future event as a reason behind the News Trading strategy (Brunnermeier). Furthermore, the results could be explained by the findings of Moulton (2011), who found that active institutional investors were found to be purchasing shares during the days leading up to analyst upgrades, and selling on the day of the upgrade. The opposite was found with analyst downgrades (see figures 2 and 3). For the context of this study, this would imply that investors bought the stock in the 20 days prior to

the announcement day based on private information or speculative positioning, and used the announcement day to exit the position and take the profits.

Risk-weighted New Present Value as valuation method for biotech stocks would suggest the stock price should increase as clinical data is announced, due to an increased probability of a successful market launch. In this context, the Cumulative Abnormal Returns for the Event Window were aligned with the probabilities of reaching the market from the respective clinical phases. For the events concerning clinical phase I and II, the CAR was 1.52 % and 1.4 %, respectively. As the probability of reaching the market on average increases with 2 % in phase II compared with phase I, the results are in line with a reasonable theoretical estimation, all else being equal. CAR for phase III was 9.37 %, which is 5 percentage points below a theoretical estimation based on the 14 % probability increase of reaching the market once the clinical trial is in phase III, all else being equal.

The key takeaways of the findings in this study for investors are the complexity that come with investing in Biotech stocks around clinical data announcements, as there were no statistically significant findings of abnormal returns or other anomalies to the EMH. However, a statistically insignificant observation that was found was the fact that both for the entire sample and for the separate sample categories was that the stock prices tended to increase during the 20 days preceding the announcements. For investors, seeing a price surge in Biotech stocks could therefore be an indication of investors positioning for clinical news. This is in practice complicated for investors to execute, and could therefore be seen as a complementary approach to other valuation methods when making investment decisions in Biotech.

The larges average stock price movements were observed in news announcements concerning clinical phase III, which although also being statistically insignificant, could be imply a larger probability of being acquired by a large pharmaceutical company or increasing the number of partnerships, which all else being equal should cause the stock price to rise. Furthermore, in a portfolio perspective, investing in individual Biotech stocks is associated with high risks, given that the volatility is higher than the stock market as a whole. Biotech stocks do however have both have low correlations with the rest of the stock market as well as within the sector. For investors interested in the Biotech sector, portfolio risk could be lowered through diversifying across the Biotech sector through the low correlation between the stocks in the portfolio.

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