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Do Market Characteristics Impact Abnormal Returns in Insider Trading?

An event study of abnormal returns following announcements of CEO transactions on OMX Stockholm Large Cap and Nasdaq First North Growth Market

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Abstract

In this study we compare short-term abnormal returns associated with announcements of CEO transactions on OMX Stockholm Large Cap and Nasdaq First North Growth Market. Our final dataset contains 537 CEO transactions on OMX Stockholm Large Cap and 710 CEO transactions on Nasdaq First North Growth Market between 2019 and 2023. We conduct an event study and apply the market model to examine the cumulative average abnormal returns related to insider trading. Our results establish that CEO trading generates abnormal returns on Nasdaq First North Growth Market to a larger extent than on OMX Stockholm Large Cap. We find that acquisitions and disposals result in different market reactions on Nasdaq First North Growth Market, revealing that the signalling value is dependent on the transaction type. In addition, we find that there is a significant difference between how the markets react to CEO transactions for all but one event window. Results indicate that differences in abnormal returns can be attributed to market characteristics. We suggest that the characteristics of Nasdaq First North Growth Market translates into stronger market reactions. Lastly, we find that the market model is sufficient in explaining variation of abnormal returns when comparing it to the Fama-French Three-Factor model.

Keywords: Event study, Insider trading, Cumulative average abnormal returns, Nasdaq First North Growth Market, OMX Stockholm Large Cap

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1. Introduction

1.1 Background

Humans have an inherent tendency to conform to the actions of others. This is particularly true when they perceive others as more informed about a given situation. Financial markets represent a setting where this tendency becomes particularly relevant. Seyhun (1986) establishes that there is an informational hierarchy between those working at a firm and external investors. As a result of insiders' informational advantage, they are able to make more informed trading decisions than external investors, creating a situation of information asymmetry. External investors are aware that the other party, the insider, has access to more, and higher quality information, than they do. From this perspective, studying whether the market interprets announcements of insider transactions as signals of future stock performance becomes valuable. Investigating market reactions provides insights into how new information influences investor behaviour, and its consequent implications for understanding market efficiency. Seyhun (1986) states that the position of the insider affects abnormal returns. Specifically, findings reveal that executives generate larger abnormal returns than other insiders. This stems from executives' relation to critical aspects of the firm's operations such as decision-making, financial planning, and short- and long-term strategies.

Insider trading is regulated by state authorities to prevent market abuse and unlawful trading. We limit our focus to transactions that comply with these regulations, that is, legal insider trading. Despite not trading on price-sensitive information, insiders still have in-depth knowledge, and insider trading has consequently been a longstanding topic of controversy. Some discuss the fairness of insiders outperforming the market. In contrast, others view insider trading as a source of information to utilise in their own investment strategies. The true informational value of an insider transaction has been thoroughly analysed by researchers as they have been meaning to establish the existence, or non-existence, of abnormal returns. This discourse reflects the broader discussion on market efficiency. Beating the market is the goal of active investors. Passive investors, on the other hand, view such efforts as fruitless. The lengthy discussion on active versus passive trading, and the question on whether it is possible to outperform the market, has economists divided. According to the Efficient Market Hypothesis (EMH) there is no possibility of generating abnormal returns. This is as all information, public or private, is reflected in market prices (Fama, 1970). Conflicting their conclusions, many researchers find that insiders are able to generate abnormal returns (Jaffe,

1974; Seyhun, 1986; Hillier et al., 2015). Abnormal returns following the announcement of an insider transaction would indicate that all information is not reflected into stock prices.

Previous research examines the informational value associated with different types of transactions. Intuitively, acquiring a stock conveys a belief in strong future performance, while disposals might communicate an apprehension of diminishing returns. Lakonishok & Lee (2001) and Connelly et al. (2011) conclude that insider acquisitions are valuable as signals of future stock performance. Contrary to intuition, Lakonishok & Lee (2001) and (Tamersoy et al. 2014) find that disposals are not indicative of stock performance. Key studies, such as Seyhun (1986) and Lakonishok & Lee (2001), identifies firm size as a factor that influences abnormal returns associated with insider trading. Their findings suggest that executives in small firms are able to predict future performance with higher accuracy due to their comprehensive grasp of the company.

The presence of information asymmetry in insider trading increases the risk of adverse selection. Adverse selection describes how less informed investors are disadvantaged by insiders acting on their exclusive information. Akerlof (1970) illustrates how asymmetric information can result in market inefficiencies when it causes disadvantaged parties to abstain from market participation. To counteract this imbalance, regulations on insider trading and reporting mechanisms have a crucial role in increasing transparency. The function of regulations can be understood through signalling, an economic theory defined by Spence (1973). Signalling describes how informed parties can reduce information asymmetry by revealing their intention and information to uninformed parties. Analysing the impact of information asymmetry on market reactions requires an understanding of the differences between financial markets.

Financial instruments are traded across a range of markets, each defined by different factors such as geography and market capitalisation. Markets differ in regulatory intensity and degree of analyst coverage; distinct characteristics that can influence the degree of information asymmetry and pricing efficiency. This positions certain market segments as particularly interesting in the context of insider trading, as some characteristics may amplify the signalling value of transactions. An example of a highly regulated and mature market is OMX Stockholm Large Cap (Stockholm Large Cap). In contrast, Nasdaq First North Growth Market (First North) lists companies aspiring to access the main market. While each company on Stockholm Large

Cap has a market capitalisation exceeding one billion euro (Nasdaq, 2024a), First North has no market capitalisation threshold, making it accessible for small and growing companies. The market is classified as a Multilateral Trading Facility (MTF) and has more flexible listing requirements than main market exchanges. This simplifies entry to capital markets, allowing firms to raise funds and increase their visibility (Nasdaq, 2024b). While growth markets provide unique opportunities and flexibility, these advantages are integrated with increased risks (Nasdaq, 2023).

1.2 Purpose and Research Question

The purpose of our study is to investigate whether short-term abnormal returns following the announcement of a CEO transaction are significantly different between Swedish companies traded on First North and Stockholm Large Cap. These markets represent contrasting environments, differing mainly in firm size, regulatory intensity, and analyst coverage. First North, as a growth market, features smaller, more volatile companies, and the market operates under more flexible regulations. In contrast, Stockholm Large Cap lists Sweden's largest and most mature companies, subject to stricter regulations and greater analyst coverage. The distinct differences between First North and Stockholm Large Cap offers an interesting basis for comparing how market characteristics impact abnormal returns generated from insider trading. Our study focuses on CEO transactions, as previous research demonstrates that top positions are associated with larger abnormal returns (Hillier et al., 2015; Tamersoy et al., 2014). Furthermore, Degryse et al. (2014) and Hillier et al. (2015) emphasise that increased regulation most heavily affects the behaviour of top executives. Given that the regulatory environment is one of the key differentiating factors between the markets in our study, focusing on CEOs provides the most constructive insights. The objective of this study is threefold. We first examine the existence of abnormal returns related to CEO trading. Then, we identify whether there is a difference in abnormal returns based on transaction type. Through this question, we aim to deepen our understanding of the informational value of CEO trades. This builds on the conclusions by, among others, Lakonishok & Lee (2001) and Degryse et al. (2014), stating that acquisitions are more informative than disposals, especially for small firms. Lastly, we examine if there are differences in abnormal returns when comparing First North and Stockholm Large Cap.

1.2.1 Contribution

Our study contributes to previous literature by offering a comparative analysis of two contrasting markets. While earlier research in the Swedish context predominantly focuses on more regulated main markets, we address this gap by incorporating the rather unexplored environment of First North. The market characteristics of First North, such as smaller firms, higher volatility, less stringent regulations, and lower analyst coverage, creates an environment that is prone to information asymmetry. These factors can increase insiders' ability to generate abnormal returns, according to findings by Frankel & Li (2004). Hence, by studying a growth market, and by comparing it with a main market, our study contributes with insights into how market characteristics, and information asymmetry, impact market reactions to insider trading.

1.3 Sample and Findings

Our study focuses on announcements of CEO transactions in Swedish companies traded on Stockholm Large Cap and First North between 2019 and 2023. While Sweden is subject to EU regulations on insider trading, there are additional domestic reporting requirements. To construct a sample of transactions that are subject to unitary regulations, a geographical limitation is made to Swedish companies. We restrict our focus to acquisitions and disposals of shares made directly by the insider. The methodology is an event study, applying the market model based on the procedures outlined by MacKinlay (1997). We identify abnormal returns on First North for most event windows. On Stockholm Large Cap this cannot be determined to the same extent. Furthermore, we find that the informational value of a transaction is different between acquisitions and disposals on First North. We find support for the conclusion that there are differences in abnormal returns between the markets. These results indicate that differences can be ascribed to market characteristics. To assess the appropriateness of the market model, we incorporate the Fama-French Three-Factor (FF3) model. We find that the FF3 model contributes with limited explanatory value, indicating that the market model is sufficient in explaining variability of abnormal returns.

1.4 Disposition

This study is organised into nine sections, each briefly outlined below to offer an overview of the report. Section 2 contains a literature review, namely an explanation of previous literature

and research. This section also introduces our hypotheses. Section 3 outlines the methodology. In this section we define event windows, the estimation window, and the models used to study our hypotheses. We also discuss limitations of our method, and the statistical tests that are performed. In section 4, we present methods of data collection and filtering, together with our final dataset. Section 5 contains the empirical results. Section 6 offers a discussion based on the results presented in section 5. Section 7 contains the conclusions to our study. This section also contains the limitations and contributions of our study, as well as suggestions for future research. Section 8 lists the references and electronic sources. Section 9 contains the appendix.

2. Theory and Literature Review

2.1 Efficient Market Hypothesis

According to the EMH, financial analysis and active trading strategies are considered futile, since it is not possible to beat the market by generating abnormal returns. This is as the price of a stock, at any time, reflects all available information (Fama, 1970). Fama (1970) further defines three different forms of market efficiency. The first is a weak form that considers stock prices to reflect historical information. In the weak form there is no possibility of outperforming the market based on historical data. The second form is a semi-strong form that considers all historical and publicly available information to be reflected in market prices (Fama, 1970). For insider transactions, the announcement day is when information is made public, and thus when it is reflected in market prices according to the semi-strong form. According to the semi-strong form insiders can outperform the market by acting on in-depth information. Thirdly, Fama (1970) defines a strong form of market efficiency, asserting that prices reflect all private, public, current, and future information. Under the strong form, all information is reflected in market prices, rendering a person's individual information irrelevant. If the strong form of market efficiency holds true, no abnormal returns should be identified as the result of insider trading.

One of the common arguments active investors use to dispute the EMH is the existence of arbitrage opportunities using one-factor models such as the capital asset pricing model (CAPM). Arbitrage is often justified by referencing the outperformance of small- and growth stocks. Findings that reveal size- and value premiums consequently add complexity to the discussion on market efficiency. These premiums are supported by research; Banz (1981) identifies a size premium that is unexplained by the CAPM beta. Furthermore, Rosenberg et al.

(1985) reveals a value premium identifying that high book-to-market stocks (value stocks) outperformed those with a low book-to-market ratio (growth stocks). Fama & French (1992) rejects the notion of an inefficient market, and instead redefines the premiums as proxies for additional, systematic, risk. Dimson et al. (2017) reasons that the value premium is a result of the companies' pronounced risk of financial distress. Size premiums are attributed to the risks associated with historical poor earnings of small firms (Fama & French, 1992). Through the FF3 model, Fama & French (1993) develop a multi-factor model that analyses stock returns through three different risk factors: market risk, size, and book-to-market ratio. Combination of the three factors is found to account for common variation in stock returns.

2.2 Information Asymmetry

There is a certain level of information asymmetry between insiders and external investors regarding a company's operations, objectives, and future prospects. Insiders have access to non-public and material information, while external investors rely solely on public information such as disclosures and market reports. When one party in a transaction possesses more, and higher quality, information than the other, it can create noteworthy challenges. Especially when such information could be used to improve decision making. The asymmetry creates an imbalance in decision-making processes as one party gains an unfair advantage. As a result, the informed party can act in ways to exploit the less informed, a process Akerlof (1970) defines as adverse selection. If external investors feel disadvantaged by the information gap, they might deem the investment environment unattractive and decide not to engage in the market. As market participants are driven out, the result becomes a less efficient market and ultimately a market disintegration (Akerlof, 1970).

2.2.1 Signalling

Signalling is considered a solution to the problems associated with adverse selection. Signalling is the process when the more informed party takes deliberate actions to credibly disclose private information. Information asymmetry arises from the costs incurred by reliably disclosing private information. These signalling costs play a crucial role in determining a signals' credibility and effectiveness as they determine whether or not external investors perceive the signal as reliable (Spence, 1973). In the context of insider trading, Connelly et al. (2011) describes the signalling process as follows: insiders have in-depth information about their

company, positive, negative, or neutral. They act as signallers and choose how, and if, they communicate this information. Insider trading can impact market reactions as the transactions contain information that is not reflected in stock prices (Jaffe, 1974). Signalling focuses on the conscious communication of positive information. As the signal receiver, the external investors lack insight into the company's operations. Subsequently they analyse signals to make more informed decisions. Ultimately, signalling benefits both parties, and is a way for insiders to influence external investors' decisions to invest in the company. Insiders benefit from investors acquiring shares in the company, and investors profit from acquiring shares in companies that signal sound future performance (Connelly et al., 2011). Signals such as prompt and transparent disclosure of trades and satisfactory adherence to insider trading regulations are essential to reduce the adverse effects of information asymmetry on market efficiency. These signals promote transparency, and market integrity, as they allow external investors to make more informed decisions.

2.3 Insider Trading and Abnormal Returns

Insider trading has been subject to academic interest for decades, as researchers have been seeking to identify if and how insiders generate abnormal returns. Jaffe (1974) concludes that insiders possess information that allows them to predict future stock performance and generate abnormal returns during a short-term period; up to 8 months after the trading event. Seyhun (1986) confirms this notion and highlights that the magnitude of abnormal returns depends on several factors, such as firm size and identity of the insider. Research on insider trading thus challenges the strong form of market efficiency, indicating that market prices do not fully reflect all information (Fama, 1970). Despite insiders not acting on private information, Degryse et al. (2014) attributes abnormal returns generated from insider trading to in-depth knowledge of company prospects. The authors conduct an event study on the Dutch market between 2002 and 2008, and their findings reveal that acquisitions by executives are followed by abnormal returns of up to 2%. The results imply that both insiders, and outsiders who mirror them, can earn abnormal returns. This aligns more closely with the semi-strong form of market efficiency, as defined by Fama (1970).

2.3.1 Insider Trading Legislation

Insider trading by persons discharging managerial responsibilities and individuals closely associated to them has been regulated by the pan-European Market Abuse Regulation (MAR) since 2016. These regulations replaced the Market Abuse Directive (MAD) from 2003 (EUR-Lex, 2014). MAR is a regulatory framework that prevents illegal insider trading and market abuse by individuals that possess private and/or price sensitive information. Amongst other things, MAR defines the regulations for securities traded on MTFs, as these were not regulated to the same extent under MAD. Additionally, the timespan for reporting insider transactions was shortened to three days (EUR-Lex, 2014). Currently, all insider trading in Swedish companies must be reported to Finansinspektionen within three business days of the transaction occurring. The day a transaction is announced is when information is released to the market. The trend of an increasingly strict regulatory environment could be argued to limit insiders' ability to generate abnormal returns, subsequently reducing the informational value of an insider transaction. If insider transactions did not provide meaningful insights into a company's financial health or future performance, their role as signals would diminish.

2.3.2 Firm Size and Abnormal Returns

A common assumption is that insider transactions in smaller companies yield larger abnormal returns than transactions in larger firms. This can be partly attributed to the relationship between firm size and analyst coverage, as Bhushan (1989) identifies that smaller firms are normally subject to less coverage. Frankel & Li (2004) highlights the importance of analyst coverage in insider trading. They state that increased coverage reduces the profitability of insider trades through its moderating effect on information asymmetry. The authors refer to Elliott et al. (1984), who suggest that limited analyst coverage in smaller firms could result in market prices being less reflective of available information; enabling insiders to capitalise on their in-depth information. On a similar note, Seyhun (1986) identifies a negative relationship between abnormal returns and firm size, suggesting that insiders in smaller firms generate larger abnormal returns. Lakonishok & Lee (2001) reinforce this theory by demonstrating that small companies exhibit more price inefficiencies than large companies, providing insiders with an informational advantage. Jeng et al. (2003) evaluates the impact of firm size, analysing U.S. insider transactions between 1975 and 1996. Their results reveal that insider acquisitions in small firms generate significant abnormal returns, while disposals do not. Degryse et al. (2014) support previous conclusions as they find that executives in small firms earn larger abnormal

returns than those in large firms within 30 trading days after an acquisition. The study concludes that disposals in small firms have a less pronounced effect on share prices, indicating that disposals carry less informative value than acquisitions. The lower informational value is attributed to disposals being driven by other factors than knowledge of the firm's future performance, as discussed in the following section.

2.3.3 Transaction Type and Abnormal Returns

Previous literature has investigated whether abnormal returns vary depending on the transaction type. Lakonishok & Lee (2001) and Jeng et al. (2003) conclude that insider acquisitions generate abnormal returns and that they are more valuable than disposals as signals of future stock performance. Acquisitions serve as a way for investors to communicate positive signals to the market by increasing their ownership in the company and their skin in the game (Connelly et al., 2011). Furthermore, an acquisition can be deemed to create stronger incentive compatibility between the insider and the external investor. Tamersoy et al. (2014) find that disposals are not necessarily a signal that a stock is overvalued. They suggest that disposals are often related to liquidity or diversification. A study on the Swedish market by Kallunki et al. (2009) finds that investors with less diversified portfolios are more likely to take part in disposals, further supporting diversification as a motive for disposals. Similarly to external investors, Kallunki et al. (2009) finds that insiders are subject to the disposition effect, a systemic behavioural bias that points out the tendency to hold on to stocks that have lost value and sell those that have risen in value. This strengthens the impression that disposals are not necessarily a signal of poor performance.

2.3.4 Insider Position and Abnormal Returns

Research by Tamersoy et al. (2014) identifies that CEOs have a more volatile trading behaviour than other insiders. Analysing U.S. data from 1986 to 2012, the authors state that this behavioural trend was evident in the years leading up to the 2008 financial crisis. This indicates that CEOs have access to more valuable information than insiders with a less comprehensive grasp of operations. Degryse et al. (2014) detects that trades by executives have the largest effect and ascribes this to their informational advantage. Although in-depth information is not the foundation of every transaction, it is interpreted as such by the market. Hillier et al. (2015) finds that executives earn superior returns through insider trading and attributes this to their

expertise and skills, rather than access to information. Degryse et al. (2014) further integrates the impact of an insider's position with theories on transaction type and firm size. Their findings show that disposals by CEOs in small firms do not predict poor future performance to the same extent as disposals from other insiders; or disposals made in larger firms in the study. As we focus on firms in different markets our results are likely to depend on an interconnectedness of factors discussed in section 2.3, as suggested by Degryse et al. (2014).

2.3.5 Market Regulation and Abnormal Returns

Previous research also focuses on how market regulations impact insider trading. By controlling for individual characteristics, Hillier et al. (2015) find that trading behaviour amongst top management is hampered by increased regulatory scrutiny and the attention associated with the position. Degryse et al. (2014) find that the implementation of MAD reduced the informational content of insider disposals, demonstrated by less negative market reactions. Disposals made during the period prior to MAD resulted in 1.11% lower abnormal returns, than trades made after, indicating that strict regulation reduces the informational value of disposals. Frankel & Li (2004) demonstrate that an environment characterised by informative financial statements and robust analyst coverage diminishes the profitability of insider transactions. This supports the theory that a combination of regulatory measures and market transparency limits the ability of insiders to capitalise on in-depth information, enhancing overall market efficiency.

2.4 Hypotheses

Our study focuses on whether short-term abnormal returns following the announcement of a CEO transaction are significantly different between Swedish companies traded on First North and Stockholm Large Cap. We assess three hypotheses that contribute to the understanding of our research question.

Firstly, we investigate if each market, on its own, generates short-term cumulative average abnormal returns (CAARs). Consistent with earlier research such as Jaffe (1974), Seyhun (1986), Lakonishok & Lee (2001) and Degryse et al. (2014), we expect to find that insiders earn abnormal returns on both markets. Accordingly, we expect to be able to reject the null hypothesis across markets. Our first hypothesis is as follows:

$H1_0$: There are no short-term cumulative average abnormal returns following announcements of CEO transactions.
$H1_1$: There are short-term cumulative average abnormal returns following announcements of CEO transactions.

As the existence or non-existence of abnormal returns is established, we examine transaction type to develop our understanding of insider trading as signals to the market. Studies conducted by, among others, Lakonishok & Lee (2001) and Jeng et al. (2003) find that informational value is higher for acquisitions than disposals. Connelly et al. (2011) defines acquisitions as a positive signal of firm quality. Furthermore, Jeng et al. (2003) and Degryse et al. (2014) find the informational value of acquisitions to be stronger for small firms. Based on these findings we expect that First North will display larger differences between acquisitions and disposals. We expect to be able to reject the null hypothesis, on both markets, and conclude that abnormal returns are not identical for acquisitions and disposals. This leads us to the formulation of our second hypothesis:

$H2_0$: The cumulative average abnormal returns following announcements of CEO transactions are equal for acquisitions and disposals.
$H2_1$: The cumulative average abnormal returns following announcements of CEO transactions are not equal for acquisitions and disposals.

First North is subject to limited analyst coverage and operates under less stringent regulations than main market exchanges. In contrast, Stockholm Large Cap is bound by strict regulatory standards, and the listed companies are carefully covered by analysts, authorities, and the public eye. Frankel & Li (2004) argue that increased analyst coverage reduces information asymmetry, thereby limiting abnormal returns associated with insider trades. On a similar note, Hillier et al. (2015) find that increased regulatory scrutiny primarily hampers the trading behaviour of executives. This suggests that First North presents an advantageous environment for CEOs to capitalise on their in-depth information. Combining these findings with the conclusions of Seyhun (1986), Lakonishok & Lee (2001), and Degryse et al. (2014) that state firm size as a determinant of abnormal returns, we expect to find that short-term abnormal returns are significantly different when comparing First North to Stockholm Large Cap. The third hypothesis is studied in two parts, one comparing acquisitions, and one comparing disposals. The third hypothesis is designed as follows:

$H3_0$: The cumulative average abnormal returns on First North are equal to those on Stockholm Large Cap following announcements of CEO transactions.
$H3_1$: The cumulative average abnormal returns on First North are not equal to those on the Stockholm Large Cap following announcements of CEO transactions.

3. Methodology

This section presents the quantitative method that is used to calculate CAARs and to test our hypotheses. Additionally, we address the limitations to our methodology and offer an evaluation of its constraints.

3.1 Event Study

To examine our research question and provide conclusions to our hypotheses we conduct an event study based on the procedures outlined by MacKinlay (1997). We determine the effects of an economic event, in this case a CEO transaction announcement, on the return of a stock. Conducting an event study allows us to compare pre-event, event, and post-event returns. We study market reaction by comparing stock returns from two time periods, an event window and an estimation window. The event window refers to the period around the event, and the estimation window includes time prior to the event and represents the non-affected state of the market (MacKinlay, 1997).

3.1.1 Event Window

Event windows track fluctuations in stock returns as new information is incorporated into market prices. The duration of this process varies depending on the degree of market efficiency (Fama, 1970). In this study, we use [-5;5], [-3;3] and [0;1] as event windows. Multiple windows are utilised to understand the duration of impact and the informational value of an insider transaction announcement. Event windows are kept short to limit influence of non-announcement related factors that affect stock returns. The actual event date is defined as the day a transaction is announced, and not the day it takes place. This is as the announcement communicates information publicly. According to MacKinlay (1997) an event generates immediate reflection into market prices. In cases when insider transactions are disclosed on a non-trading day the following trading day is set as the event day (MacKinlay, 1997). When determining event windows, it is of relevance to include days before the announcement, as

information may have been acquired beforehand (MacKinlay, 1997). Therefore, we choose to include the [-5;5] and [-3;3] as pre- and post-event windows. Since transactions must be registered within a maximum of three days after they occur, the [-3;3] event window accounts for market reactions within the three-day registration period. To study market reactions over a slightly longer timeframe, we use the [-5;5] event window. The extended event window captures two days before the maximum three-day registration period, accounting for the probability that external investors have responded to information leakages.

3.1.2 Estimation Window

The expected return of a stock is predicted during an estimation window. Expected return is defined as the return under regular market conditions, as if no insider transaction had taken place. In accordance with the recommendations of MacKinlay (1997), the estimation window encompasses 120 trading days. The returns during event windows should not influence estimation of expected return (MacKinlay, 1997). Thus, we make sure that event- and estimation windows do not overlap. Expected return is used in the calculation of abnormal returns.

3.2 Abnormal Returns

3.2.1 Market Model

In order to calculate abnormal returns, we apply the market model, a widely used model for estimating abnormal returns in event studies (MacKinlay, 1997). The market model assumes a linear relationship between individual stock returns and market return. First, we establish a stock's expected return using two separate indices that represent the markets in our study. Next, we calculate abnormal returns associated with the announcement of an insider transaction. Abnormal return is calculated as the difference between a security's actual return and its expected return.

Market Model

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it}$$

Where:

r_{it}: Return for firm *i* in time period *t*.

α_i: Alpha coefficient for stock *i*.

β_i: Beta coefficient for stock *i*.

r_{mt}: Return of the market in time period *t*.

ε_{it}: Residual; the mean disturbance term for firm *i* in time period *t*, with variance $\sigma^2_{\varepsilon i}$. Expected mean disturbance is zero.

We estimate the market model parameters, alpha (α) and beta (β) through an ordinary least squares (OLS) regression that regresses the actual return of each stock against the market index over the estimation window. Beta is consequently based on historical return and measures the risk of a stock relative to the market index.

3.2.2 Fama-French Three-Factor Model

The market model is a one-factor model. MacKinlay (1997) argues that multi-factor models provide limited explanatory value for event studies. However, MacKinlay (1997) states an exception to this conclusion. This is when sample firms share a common characteristic, for example, concentration in one market capitalisation group. To account for the potential explanatory differences between one- and multi-factor models we include the FF3 model in our study. Inclusion of FF3 as a multi-factor model is relevant for our analysis as First North predominantly consists of smaller, high-growth firms, while Stockholm Large Cap features larger firms. Inclusion is further supported by Fama & French (1993), arguing for the appropriateness of the FF3 model in event studies. They consider it superior to one-factor models as the model reduces variability by capturing relevant firm-specific components. FF3 allows us to consider two additional factors, size and value, when estimating the expected returns used for calculating CAARs. The first factor is SMB, which captures the excess returns of small-cap over large-cap firms. Secondly, HML reflects the excess returns of value stocks over growth stocks. The model is used to test hypothesis 1 and 3. Based on the acknowledged benefits of multi-factor models for samples with similar characteristics, we expect the FF3 model to explain variation of abnormal returns. We expect this contribution to be most pronounced on First North as the market is composed of small, growing firms. While the market

model acts as our primary model when testing our three hypotheses and discussing our results, the FF3 model is used as a complementary model to assess the suitability of the market model. The comparison provides a more comprehensive understanding of abnormal returns. If results using the FF3 model are significant to a larger extent than those using the market model, it indicates that inclusion of SMB and HML explains variance of abnormal returns. In contrast, little difference in significance indicates that the market model sufficiently accounts for relevant risks. The formula is defined as follows:

Fama-French Three-Factor Model

$$E(r_{it}) = r_f + \beta_1(r_{mt} - r_f) + \beta_2(SMB) + \beta_1(HML) + \varepsilon_{it}$$

Where:

$E(r_{it})$*:* Expected return for firm *i* in time period *t.*

r_f: Risk-free rate.

$r_{mt} - r_f$: Market risk premium.

SMB (Small Minus Big): Historic excess returns of small-cap firms over large-cap firms.

HML (High Minus Low): Historic excess returns of value stocks (high book-to-market ratio) over growth stocks (low book-to-market ratio).

β: Beta coefficients determined via linear regression.

ε_{it}: Residual; the mean disturbance term for firm *i* in time period *t*, with variance $\sigma^2_{\varepsilon i}$. Expected mean disturbance is zero.

3.2.3 Calculation of Cumulative Average Abnormal Returns

Abnormal return (AR) is calculated by subtracting the expected return from the actual return. When the difference is positive, it indicates that actual return exceeded expectations. A negative abnormal return implies that actual return was below the expected level. AR quantifies the immediate, daily reaction of a single security to an event.

Abnormal Return (AR)

$$AR_{it} = r_{it} - (\alpha_i + \beta_i r_{mt})$$

Where:

AR_{it}: Abnormal return for firm *i* in time period *t.*

r_{it}: Return for firm *i* in time period *t.*

α_i: Alpha coefficient for stock *i.*

β_i: Beta coefficients for stock *i.*

r_{mt}: Return of the market in time period *t.*

$\alpha_i + \beta_i r_{mt}$: Expected stock return for firm *i* in time period *t.*

Daily abnormal returns are averaged across all securities in the sample to calculate average abnormal return (AAR). This provides a measure of the aggregated market reaction on each day within the event window. In the formula below, *N* represents the number of insider transactions:

Average Abnormal Return (AAR)

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it}$$

Cumulative abnormal return (CAR) is the sum of ARs for a single security over the entire event window. In contrast to AAR, which captures daily reactions, CAR quantifies the cumulative effect of an event on a single security between time t_1 and t_2, offering a broader perspective of its performance over time. The formula is defined as follows:

Cumulative Abnormal Return (CAR)

$$CAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it}$$

Lastly, by averaging the CARs across all securities in our sample, we obtain cumulative average abnormal return. While CAR reflects the cumulative impact of an event on a single security, CAAR aggregates the effects across all observed insider transactions. This allows us to analyse the market reaction during the event windows and identify trends within our sample. CAAR is calculated as:

Cumulative Average Abnormal Return (CAAR)

$$CAAR(t_1, t_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_{t_1,t_2}$$

Hypothesis tests are considered statistically significant if the null hypothesis can be rejected at a 5% significance level. Our hypotheses are defined as follows:

$H1_0$: There are no short-term cumulative average abnormal returns following announcements of CEO transactions.
$H1_1$: There are short-term cumulative average abnormal returns following announcements of CEO transactions.
$H1_0$: $CAAR = 0$
$H1_1$: $CAAR \neq 0$

$H2_0$: The cumulative average abnormal returns following announcements of CEO transactions are equal for acquisitions and disposals.
$H2_1$: The cumulative average abnormal returns following announcements of CEO transactions are not equal for acquisitions and disposals.
$H2_0$: $CAAR_{\text{Acquisitions}} = CAAR_{\text{Disposals}}$
$H2_1$: $CAAR_{\text{Acquisitions}} \neq CAAR_{\text{Disposals}}$

$H3_0$: The cumulative average abnormal returns on First North are equal to those on Stockholm Large Cap following announcements of CEO transactions.
$H3_1$: The cumulative average abnormal returns on First North are not equal to those on the Stockholm Large Cap following announcements of CEO transactions.
$H3_0$: $CAAR_{\text{FN acquisitions}} = CAAR_{\text{SLC acquisitions}}$
$H3_1$: $CAAR_{\text{FN acquisitions}} \neq CAAR_{\text{SLC acquisitions}}$

$H3_0$: $CAAR_{\text{FN disposals}} = CAAR_{\text{SLC disposals}}$
$H3_1$: $CAAR_{\text{FN disposals}} \neq CAAR_{\text{SLC disposals}}$

3.3 Limitations of Event Study

MacKinlay (1997) recognises that there are trade-offs between long and short event windows. Longer event windows reflect more information and thus risk capturing unrelated events, potentially reducing accuracy of results. However, selecting a short event window risks excluding relevant information, such as information leakages (MacKinlay, 1997). The strict regulations on insider trading and the requirement of timely reporting reduces the likelihood of information leaking in advance of the announcement date. We find that this limits the need to extend event windows significantly before and after the event day. We see that the [-5;5] window offers a reasonable balance, keeping the effectiveness of short event windows while accounting for factors such as information leakages. Furthermore, the use of a [-5;5] event window is supported by research, as exemplified by Lakonishok & Lee (2001).

As the aim of our study is to investigate if market characteristics influence the generation of abnormal returns, we acknowledge a limitation to the methodology. Our study analyses differences between Stockholm Large Cap and First North, chosen based on their distinct market characteristics such as regulatory environment, firm size, and analyst coverage. The market model does not isolate the effect of specific factors, instead the market beta collectively captures systematic risk associated with each market. As a result, we cannot distinguish which specific market characteristics influence the generation of abnormal returns. Any observed between Stockholm Large Cap and First North should be interpreted as the combined effect of broader market characteristics. By including the FF3 model we can address some of these limitations. The FF3 model allows for an assessment of how well market beta, as estimated in the market model, captures systematic risk factors. A comparison between models sheds light on whether incorporation of risks related to size and market-to-book ratios explain more of the variation in abnormal returns.

3.4 Statistical Tests and Robustness Checks

When evaluating methods for significance tests in event studies, Brown & Warner (1985) highlights that daily stock return data tends to deviate from normality. Building on this, Kolari & Pynnonen (2011) examine the effectiveness and limitations of parametric and non-parametric tests in event studies, with a particular focus on abnormal returns. They reference Brown & Warner (1985) and emphasise that the non-normality of daily return data reduces the power of

parametric tests, such as the t-test, which assume normality and independence across samples. To ensure validity of our results, we use the Jarque-Bera test to identify whether our observed AARs and CAARs deviate from normality. If data exhibits a normal distribution, we employ the parametric t-test. If the test indicates a non-normal distribution, we instead utilise the Wilcoxon Signed-Rank test as a non-parametric method. This test evaluates the significance of CAARs by determining whether their mean differs significantly from zero, without assuming normality (Newbold et al., 2020). The test is performed when testing the two markets separately.

When we compare independent samples, such as acquisitions and disposals, or First North and Stockholm large Cap, we use the Wilcoxon Rank-Sum test if the abnormal returns follow a non-normal distribution. This test is suitable as our samples contain more than ten observations and tests two independent samples (Newbold et al., 2020). We apply the test to determine whether CAARs are significantly different between markets when comparing their reaction to acquisitions and disposals respectively.

4. Data Collection

4.1 Market and Stock Returns

Our study focuses on insider transactions between the 1st of January 2019 to the 31st of December 2023. As mentioned in section 3.1.2, event- and estimation windows should not overlap. We consequently retrieve data that extends 125 days before the first event, and 5 days after the last event. Stock return data for all companies listed on Stockholm Large Cap and First North is retrieved from Compustat.

Expected returns are calculated using appropriate market indices. OMX Stockholm Large Cap Gross Index (OMXSLCGI) is used for Stockholm Large Cap, and First North - All Share (FIRSTNORTHSEK) is used for 3First North. Market return data is retrieved from Nasdaq.

4.2 Fama-French Three-Factors

The FF3s are retrieved from the Kenneth French Website. We utilise the dataset titled *Fama/French European 3 Factors [Daily]* (French, 2024). We use the European factors as a

proxy since unique FF3s for the Swedish market are not available. The European dataset includes 16 countries, all EU-members except Norway, Switzerland, and England. The SMB and HML factors are applied directly from the European dataset while the market risk premium is recalculated using the same market indices as for the market model.

4.3 Insider Transactions

Finansinspektionen holds a PDMR Transactions Register that registers all insider transactions in Swedish companies exceeding 5,000 euro during any calendar year. We use this threshold as the minimum value for transactions analysed in this study. The study is limited to transactions announced between the 1st of January 2019 and the 31st of December 2023.

Table 1 reports details regarding the filtration of insider transactions. The original dataset from Finansinspektionen includes 90,088 transactions. The first stage entails sorting data to only include Swedish companies on First North and Stockholm Large Cap. Thereafter we filter the dataset to only include current transactions made by the insider themselves. We make further filtration to only include share transactions. Moreover, we exclude amendments and transactions made as part of a share option programme. We also limit the dataset to only include acquisitions and disposals. Furthermore, we limit the dataset to only include CEOs. We classify insiders that have multiple roles, for example CEO and Board Member, as the highest hierarchical role. Thereafter, we aggregate transactions made on the same day, by the same legal person, and exclude aggregated transactions amounting to zero. Lastly, we exclude transactions without market data for the entire estimation period. This eliminates recently listed companies, more heavily impacting the number of transactions on First North. Our final dataset consists of 710 CEO transactions on First North, 661 acquisitions and 49 disposals. On Stockholm Large Cap there are 537 CEO transactions, 469 acquisitions and 68 disposals. Our datasets contain a sufficient number of observations to perform a valid statistical analysis.

4.4 Filtered Dataset

Table 1. Description of filtration for final dataset

Panel A. Data filtration - Stockholm Large Cap	
Filtration Stages	**Number of Transactions**
Transactions made 2019-2023	90,088
Less transactions made outside Stockholm Large Cap	7,214
Less non-current transactions	6,861
Less transactions that are not made directly by the insider	4,846
Less instrument types other than shares	4,825
Less amendments or links to share option programmes	3,997
Less transactions other than acquisitions and disposals	3,935
Less clustering for transactions made on the same day	3,125
Less transactions made by other insiders than CEOs	542
Less transactions without data for the estimation window	537

Panel B. Data filtration - First North	
Filtration Stages	**Number of Transactions**
Transactions made 2019-2023	90,088
Less transactions made outside First North	8,927
Less non-current transactions	8,534
Less transactions that are not made directly by the insider	5,586
Less instrument types other than shares	5,509
Less amendments or links to share option programmes	5,172
Less transactions other than acquisitions and disposals	5,113
Less clustering for transactions made on the same day	2,827
Less transactions made by other insiders than CEOs	790
Less transactions without data for the estimation window	710

The dataset contains more acquisitions than disposals, as quantified in table 2. Moreover, we identify that there are more transactions made in the latter half of our timespan. This might be attributed to the use of the current list of companies on each market. This excludes companies traded under different ISIN codes in the beginning of the period and companies that were listed in the beginning of the period but have since been delisted.

Table 2. Number of transactions for each year

Panel A. Transactions - Stockholm Large Cap						
	2019	**2020**	**2021**	**2022**	**2023**	**Total**
Acquisitions	50	77	87	129	126	469
Disposals	6	14	19	12	17	68

Panel B. Transactions - First North						
	2019	**2020**	**2021**	**2022**	**2023**	**Total**
Acquisitions	65	87	118	211	180	661
Disposals	8	17	11	9	4	49

4.5 Limitations of Dataset

A limitation of our dataset is the inconsistency in insider categorisation across companies. In the PDMR transactions register, insiders register their transactions without subsequent review by the Financial Supervisory Authority (Finansinspektionen, 2024). This introduces variation in role titles across the dataset. For instance, a CEO in one company may be categorised as an "Executive Director" or "Manager", while in another company, a "Manager" might be a person with limited insider knowledge. We acknowledge that this potentially introduces undesired variability into our results.

Another limitation to note when interpreting our results is the risk of misrepresentation in transaction type data. Our sample contains a much higher number of acquisitions than disposals. Consequently, the low number of disposals could impact the reliability of results, as they may be heavily influenced by individual firms. This limits our ability to draw robust conclusions on the informational value of disposals and reduces the comparability between acquisition and disposals.

Due to the lack of Swedish data, the factors SMB and HML are calculated using European data. Griffin (2002) argues that domestic factors are more suitable than global factors due to country specific risks. We recognise that Swedish factors would be more appropriate but deem European data to be an adequate proxy.

An additional factor to consider is that the studied period was subject to substantial market fluctuations due to external factors such as COVID-19. This impacts the generalisability of our results over time. We acknowledge that companies studied in this report experienced varying levels of impact, as the financial downturns of COVID-19 hit small companies harder than it did large companies (Hurley et al., 2021).

5. Results

5.1 Descriptive Data Statistics

This section presents descriptive statistics of abnormal returns. Table 3 panel A displays results on Stockholm Large Cap. The standard deviation is relatively consistent for acquisitions and disposals. Contrary to our previous beliefs, the results demonstrate a negative mean for acquisitions during the two longer event windows. The [0;1] event window displays a positive mean. This event window also demonstrates the largest negative mean for disposals.

Table 3 panel B presents descriptive statistics for First North. First North displays higher maximums and lower minimums than Stockholm Large Cap across all event windows. This is consistent for acquisitions and disposals. We find particularly large negative values for acquisitions on First North. As we study our dataset, we conclude that there are two acquisitions that are considerably more negative than the remaining observations, suggesting potential outliers. Despite their magnitude we include all extreme values in the dataset. This is as we do not identify errors in their calculation or underlying causes that justify their elimination. We consequently reason that these observations contain valuable data despite their deviations. First North demonstrates positive means for acquisitions to a larger extent than Stockholm Large Cap. Additionally, First North exhibits larger standard deviation for all events, regardless of transaction type. The largest negative result is identified as the minimum for acquisitions during the [0;1] event window.

Table 3. Descriptive statistics of abnormal returns

Panel A. Descriptive statistics AR - Stockholm Large Cap					
	Minimum	**Mean**	**Median**	**Standard Deviation**	**Maximum**
Acquisitions					
[-5;5]	-3.4891	-0.0829	-0.0423	0.8276	3.1702
[-3;3]	-6.0195	-0.1364	-0.1416	1.1240	3.7054
[0;1]	-7.6054	0.0284	0.0890	2.1438	8.8263
Disposals					
[-5;5]	-6.0719	-0.3446	-0.0892	1.3278	1.2676
[-3;3]	-9.3686	-0.2825	-0.0770	1.3104	1.2929
[0;1]	-4.5728	-0.6397	-0.6156	1.3596	2.2043

Panel B. Descriptive statistics AR - First North					
	Minimum	**Mean**	**Median**	**Standard Deviation**	**Maximum**
Acquisitions					
[-5;5]	-97.1066	-0.0831	0.0476	5.0448	12.2984
[-3;3]	-97.3782	0.0153	0.1344	5.2036	17.2008
[0;1]	-116.8404	0.4439	0.5437	6.9409	51.8217
Disposals					
[-5;5]	-6.6601	-0.6139	-0.5914	1.6837	2.3033
[-3;3]	-10.4009	-0.8473	-0.5672	2.5901	4.1969
[0;1]	-19.9192	-1.9823	-1.9699	4.4298	7.2462

Note: Results are displayed in percentages.

5.2 Hypothesis Tests

Following section contains the results of our empirical analysis, aligning with the structure presented in section 3.

5.2.1 Average Abnormal Returns

To ensure validity, we apply the Jarque-Bera test to identify if the AARs exhibit deviations from normality. The p-value from the Jarque-Bera-test is $2.2e^{-16}$ for both markets. Consequently, we reject the null hypothesis that the data is normally distributed. To account for non-normality, we apply the non-parametric Wilcoxon Signed-Rank test when analysing significance of abnormal returns (Newbold et al., 2020).

A summary of AARs on Stockholm Large Cap is displayed in table 4. AAR accounts for the aggregated market reaction on each day within our 5-day event window. The results demonstrate significant AAR for acquisitions during day -2 and -1. The corresponding days for disposals are day 0, 1, and 5. Aligning with expectations, abnormal returns are consistently

positive after the announcement of an acquisition. However, the results are not significant at the 5% level. All significant results for disposals display negative AAR, aligning with expectations. The results reveal that acquisitions are significant to a lower degree than disposals, contrasting our prior beliefs.

Table 4. Significance of average abnormal returns on Stockholm Large Cap

Panel A. AAR - acquisitions			**Panel B.** AAR - disposals		
Event Day	**AAR**	**p-value**	**Event Day**	**AAR**	**p-value**
-5	0.0380	0.2443	-5	-0.1591	0.5678
-4	-0.3091	0.1358	-4	0.4805	0.0810
-3	0.0134	0.6873	-3	0.0128	0.2947
-2	-0.4470	0.0053**	-2	0.1103	0.6980
-1	-0.8478	0.0000***	-1	-0.2158	0.4766
0	-0.1314	0.8760	0	-0.6654	0.0488*
1	0.1881	0.1474	1	-0.6139	0.0312*
2	0.2469	0.0725	2	0.0338	0.9197
3	0.0227	0.9622	3	-1.0706	0.8955
4	0.2566	0.1871	4	-0.8177	0.5971
5	0.0582	0.0751	5	-1.3167	0.0434*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: AARs are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

Corresponding results for First North are displayed in table 5. Results show significant AAR for day -4 and 0 for acquisitions, and day 1 and 5 for disposals. Contrary to Stockholm Large Cap, we do not identify consistent positive abnormal returns after an announcement of an acquisition, however, these results remain insignificant at the 5% level. The day of announcement displays significant positive AAR, aligning with expectations. Both significant results for disposals reveal negative AARs.

Table 5. Significance of average abnormal returns on First North

Panel A. AAR - acquisitions			**Panel B.** AAR - disposals		
Event Day	**AAR**	**p-value**	**Event Day**	**AAR**	**p-value**
-5	-0.2541	0.0884	-5	0.6928	0.2405
-4	-0.5698	0.0037**	-4	0.4597	0.7277
-3	-0.1140	0.1462	-3	-1.5376	0.0536
-2	0.1367	0.8223	-2	0.1917	0.2610
-1	-0.3608	0.1523	-1	-0.2252	0.3396
0	0.8877	0.0000***	0	-1.2769	0.1183
1	0.0002	0.7242	1	-2.6877	0.0060**
2	-0.0964	0.6069	2	0.1792	0.5573
3	-0.3461	0.4865	3	-0.5497	0.6401
4	-0.0574	0.7102	4	0.2125	0.9208
5	-0.1396	0.1755	5	-2.2116	0.0025**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: AARs are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

5.2.2 Cumulative Abnormal Returns

Table 6 presents descriptive statistics for CARs on Stockholm Large Cap and First North respectively. CAR is the sum of abnormal returns during the event window. On Stockholm Large Cap we identify that there are negative reactions to the announcement of a disposal across all event windows. Although acquisitions display positive reaction during the [0;1] event window, the results indicate that acquisitions do not yield positive returns over longer event windows. Standard deviation decreases with shorter event windows, indicating that the immediate effect is more consistent while longer event windows capture varied market reactions. These results demonstrate the largest negative value for disposals, and the largest positive value for acquisitions.

Descriptive statistics for First North are displayed in panel B. Acquisitions exhibit positive mean CARs over the two shorter event windows, while disposals are constantly negative. Results present a wide range of market reactions, wider than on Stockholm Large Cap, as identified by the minimum and maximum values. This reveals that some acquisitions have large negative abnormal returns. The previously identified extreme values for acquisitions become amplified when abnormal returns are cumulated. The standard deviation is consistently larger for acquisitions, suggesting a less uniform interpretation.

Table 6. Descriptive statistics of cumulative abnormal returns

Panel A. Descriptive statistics CAR - Stockholm Large Cap

	Minimum	Mean	Median	Standard Deviation	Maximum
Acquisitions					
[-5;5]	-38.3805	-0.9115	-0.4657	9.1034	34.8718
[-3;3]	-42.1362	-0.9551	-0.9915	7.8682	25.9381
[0;1]	-15.2109	0.0567	0.1780	4.2875	17.6525
Disposals					
[-5;5]	-66.7914	-3.7903	-0.9812	14.6062	13.9436
[-3;3]	-65.5801	-1.9774	-0.5387	9.1726	9.0503
[0;1]	-9.1456	-1.2794	-1.2311	2.7191	4.4085

Panel B. Descriptive statistics CAR - First North

	Minimum	Mean	Median	Standard Deviation	Maximum
Acquisitions					
[-5;5]	-1068.1722	-0.9137	0.5232	55.4932	135.2829
[-3;3]	-681.6475	0.1072	0.9406	36.4251	120.4058
[0;1]	-233.6807	0.8879	1.0875	13.8818	103.6433
Disposals					
[-5;5]	-73.2608	-6.7527	-6.5045	18.5211	25.3366
[-3;3]	-72.8061	-5.9061	-3.9701	18.1307	29.3786
[0;1]	-39.8384	-3.9646	-3.9398	8.8595	14.4923

Note: Results are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

5.2.3 Cumulative Average Abnormal Returns

We test for normality of CAARs using the Jarque-Bera test. We obtain a p-value of $2.2e^{-16}$ for both markets and conclude that CAARs follow a non-normal distribution. Therefore, we apply the Wilcoxon Signed-Rank test. Table 7 displays the CAARs on Stockholm Large Cap. Results are significant during the [-3;3] event window for acquisitions, and during the [0;1] event window for disposals. The negative CAAR for acquisitions contradicts expectations. The only positive CAAR is identified for acquisitions during the [0;1] event window. This result is not significant at a 5% level. The first hypothesis cannot be rejected across all event windows for Stockholm Large Cap.

$H1_0$: $CAAR = 0$

$H1_1$: $CAAR \neq 0$

Table 7. Cumulative average abnormal returns on Stockholm Large Cap

Panel A. CAAR - acquisitions			**Panel B.** CAAR - disposals		
Event	**CAAR**	**p-value**	**Event**	**CAAR**	**p-value**
[-5;5]	-0.9115	0.0502	[-5;5]	-3.7904	0.1061
[-3;3]	-0.9551	0.0072**	[-3;3]	-1.9774	0.0749
[0;1]	0.0567	0.5807	[0;1]	-1.2794	0.0005***

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

The CAARs on First North are displayed in table 8. The results display significant results for all event windows except [-5;5] for acquisitions. CAARs for significant acquisitions are consistently positive, while all CAARs for disposals are negative. The lowest CAAR is identified during the [-5;5] event window for both transaction types. The results with the highest significance occur during the shortest event window. We reject the first hypothesis for all event windows on First North except [-5;5] for acquisitions.

$H1_0$: $CAAR = 0$

$H1_1$: $CAAR \neq 0$

Table 8. Cumulative average abnormal returns on First North

Panel A. CAAR - acquisitions			**Panel B.** CAAR - disposals		
Event	**CAAR**	**p-value**	**Event**	**CAAR**	**p-value**
[-5;5]	-0.9137	0.0608	[-5;5]	-6.7527	0.0210**
[-3;3]	0.1072	0.0020**	[-3;3]	-5.9061	0.0122**
[0;1]	0.8879	0.0000***	[0;1]	-3.9646	0.0009***

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

Table 9 displays a statistical comparison between the abnormal returns following an acquisition and a disposal on Stockholm Large Cap and First North respectively. As data follows a non-normal distribution, we use the Wilcoxon Rank-Sum test to test the significance between two independent samples. Results reveal that there is not a significant difference between the reactions to acquisitions and disposals for the [-3;3] and [-5;5] event windows on Stockholm Large Cap. Consequently, we can only reject the null hypothesis for the [0;1] event window. In contrast, findings show significant differences between transaction types across all event windows on First North. Hypothesis 2 can be rejected across all event windows on First North.

$H2_0$: $CAAR_{\text{Acquisitions}} = CAAR_{\text{Disposals}}$

$H2_1$: $CAAR_{\text{Acquisitions}} \neq CAAR_{\text{Disposals}}$

Table 9. Cumulative average abnormal returns comparing acquisitions and disposals

Panel A. CAAR Stockholm Large Cap - acquisitions and disposals			
Event	**Acquisitions CAAR**	**Disposals CAAR**	**p-value**
[-5;5]	-0.9115	-3.7904	0.4921
[-3;3]	-0.9551	-1.9774	0.7535
[0;1]	0.0567	-1.2794	0.0021**

Panel B. CAAR First North - acquisitions and disposals			
Event	**Acquisitions CAAR**	**Disposals CAAR**	**p-value**
[-5;5]	-0.9137	-6.7527	0.0038**
[-3;3]	0.1072	-5.9061	0.0007***
[0;1]	0.8879	-3.9646	0.0000***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Rank-Sum test.

Table 10 presents a statistical comparison between CAARs on Stockholm Large Cap and First North. We apply the Wilcoxon Rank-Sum test. Results demonstrate that First North and Stockholm Large Cap exhibit significantly different reactions to both acquisitions and disposals. The sole event window in which a significant difference cannot be established is the [-5;5] event window for disposals. CAARs on First North are associated with larger positive values for acquisitions and larger negative values for disposals. The null hypothesis for acquisitions is rejected across all event windows. The null hypothesis for disposals is rejected for all event windows except [-5;5].

$H3_0$: $CAAR_{\text{FN acquisitions}} = CAAR_{\text{SLC acquisitions}}$

$H3_1$: $CAAR_{\text{FN acquisitions}} \neq CAAR_{\text{SLC acquisitions}}$

$H3_0$: $CAAR_{\text{FN disposals}} = CAAR_{\text{SLC disposals}}$

$H3_1$: $CAAR_{\text{FN disposals}} \neq CAAR_{\text{SLC disposals}}$

Table 10. Cumulative average abnormal returns comparing transaction type across markets

Panel A. CAAR Stockholm Large Cap and First North - acquisitions

Event	Stockholm Large Cap	First North	p-value
[-5;5]	-0.9115	-0.9137	0.0153*
[-3;3]	-0.9551	0.1072	0.0000***
[0;1]	0.0567	0.8879	0.0003***

Panel B. CAAR Stockholm Large Cap and First North - disposals

Event	Stockholm Large Cap	First North	p-value
[-5;5]	-3.7904	-6.7527	0.1026
[-3;3]	-1.9774	-5.9061	0.0360*
[0;1]	-1.2794	-3.9646	0.0164*

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Rank-Sum test.

5.2.4 Cumulative Average Abnormal Returns, Fama-French Three-Factor Model

Table 11 and 12 display the CAARs using the FF3 model. The Jarque-Bera test p-value is $2.2e^{-16}$ for both markets and thus we reject the null hypothesis that CAARs follow a normal distribution. We apply the Wilcoxon Signed-Rank test. Results on Stockholm Large Cap are significant during the [-3;3] and [-5;5] window for acquisitions, and the [0;1] event window for disposals. Aligning with the CAARs calculated using the market model (table 7), the only positive result for acquisitions is observed during the [0;1] event window. However, this result is not statistically significant. The identified CAARs for disposals are negative across all event windows. Using the FF3 model, we cannot reject the null hypothesis on Stockholm Large Cap across all event windows. We consequently do not find consistent support that cumulative average abnormal returns exist.

$H1_0$: $CAAR = 0$

$H1_1$: $CAAR \neq 0$

Table 11. FF3 cumulative average abnormal returns on Stockholm Large Cap

Panel A. CAAR - acquisitions

Event	CAAR	p-value
[-5;5]	-1.3009	0.0027**
[-3;3]	-1.1609	0.0010**
[0;1]	0.0305	0.6090

Panel B. CAAR - disposals

Event	CAAR	p-value
[-5;5]	-3.7195	0.1417
[-3;3]	-1.7715	0.1920
[0;1]	-1.2178	0.0005***

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Ranked-Sign test.

Results for First North are displayed in table 12. The market demonstrates significant abnormal returns across all event windows for both transaction types, except the [-5;5] event window for acquisitions. This pattern aligns with the results observed when using the market model (table 8). In contrast to the market model results, the only positive CAAR for acquisitions is observed during the [0;1] event window. Disposals display consistently negative CAARs across all event windows. For First North, we can reject the null hypothesis for all event windows except the [-5;5] event window for acquisitions.

$H1_0$: $CAAR = 0$

$H1_1$: $CAAR \neq 0$

Table 12. FF3 cumulative average abnormal returns on First North

Panel A. CAAR - acquisitions			**Panel B.** CAAR - disposals		
Event	**CAAR**	**p-value**	**Event**	**CAAR**	**p-value**
[-5;5]	-1.3200	0.1889	[-5;5]	-6.4667	0.0144*
[-3;3]	-0.6311	0.0159*	[-3;3]	-5.5579	0.0059**
[0;1]	0.8778	0.0000***	[0;1]	-3.8992	0.0012**

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Signed-Rank test.

Table 13 presents a statistical comparison between CAARs on Stockholm Large Cap and First North. Consistent with the analysis performed using the market model, the Wilcoxon Rank-Sum test is applied to determine if there is a significant difference between the two markets. Results for acquisitions show significant differences across all event windows. This allows us to reject the third null hypothesis for acquisitions. Disposals, on the other hand, do not exhibit significant difference during the [-5;5] event window. The null hypothesis is rejected for all event windows except [-5;5] for disposals.

$H3_0$: $CAAR_{\text{FN acquisitions}} = CAAR_{\text{SLC acquisitions}}$

$H3_1$: $CAAR_{\text{FN acquisitions}} \neq CAAR_{\text{SLC acquisitions}}$

$H3_0$: $CAAR_{\text{FN disposals}} = CAAR_{\text{SLC disposals}}$

$H3_1$: $CAAR_{\text{FN disposals}} \neq CAAR_{\text{SLC disposals}}$

Table 13. FF3 cumulative average abnormal return comparing transaction type across market

Panel A. CAAR Stockholm Large Cap and First North - acquisitions

Event	Stockholm Large Cap	First North	p-value
[-5;5]	-1.3009	-1.3200	0.0064**
[-3;3]	-1.1609	-0.6311	0.0002***
[0;1]	0.0305	0.8778	0.0005***

Panel B. CAAR Stockholm Large Cap and First North - disposals

Event	Stockholm Large Cap	First North	p-value
[-5;5]	-3.7195	-6.4667	0.0528
[-3;3]	-1.7715	-5.5579	0.0064**
[0;1]	-1.2178	-3.8992	0.0126*

* p < 0.05, ** p < 0.01, *** p < 0.001

Note: CAARs are displayed in percentages, the p-value is derived from a Wilcoxon Rank-Sum test.

5.3 Summary of Results

Table 14. Hypotheses summary

	Stockholm Large Cap	First North
Hypothesis 1		
$H1_0$: $CAAR = 0$	Rejection for some windows	Rejection for some windows
$H1_1$: $CAAR \neq 0$		
Hypothesis 1, FF3		
$H1_0$: $CAAR = 0$	Rejection for some windows	Rejection for some windows
$H1_1$: $CAAR \neq 0$		
Hypothesis 2		
$H2_0$: $CAAR_{\text{Acquisitions}} = CAAR_{\text{Disposals}}$	Rejection for some windows	Reject H0
$H2_1$: $CAAR_{\text{Acquisitions}} \neq CAAR_{\text{Disposals}}$		
	Stockholm Large Cap and First North	
Hypothesis 3		
$H3_0$: $CAAR_{\text{FN acquisitions}} = CAAR_{\text{SLC acquisitions}}$	Reject H0	
$H3_1$: $CAAR_{\text{FN acquisitions}} \neq CAAR_{\text{SLC acquisitions}}$		
$H3_0$: $CAAR_{\text{FN disposals}} = CAAR_{\text{SLC disposals}}$	Rejection for some windows	
$H3_1$: $CAAR_{\text{FN disposals}} \neq CAAR_{\text{SLC disposals}}$		
Hypothesis 3, FF3		
$H3_0$: $CAAR_{\text{FN acquisitions}} = CAAR_{\text{SLC acquisitions}}$	Reject H0	
$H3_1$: $CAAR_{\text{FN acquisitions}} \neq CAAR_{\text{SLC acquisitions}}$		
$H3_0$: $CAAR_{\text{FN disposals}} = CAAR_{\text{SLC disposals}}$	Rejection for some windows	
$H3_1$: $CAAR_{\text{FN disposals}} \neq CAAR_{\text{SLC disposals}}$		

6. Discussion

In this section we discuss our results within the context of previous literature and theory. We identify areas where results align and differ with expectations and analyse theory that supports these findings. To examine the potential differences between markets we first examine CAARs on each market. We establish significant CAARs on First North for all but one event window. On Stockholm Large Cap results do not display significant CAARs to the same extent. Results further indicate that CEO trading generates stronger reactions on First North than on Stockholm Large Cap. We further assess if CAARs are different based on transaction type. The results on First North show consistent differences across event windows. Stockholm Large Cap does not reveal a significant difference in the longest event window. Lastly, we compare the markets. Our findings reveal that the markets react differently to insider trading, except during the longest event window for disposals. Moreover, we examine the suitability of the market model, incorporating the FF3 model to account for size and value factors. The overall consistency in results suggests that the market model is sufficient in its risk estimation.

Initial calculations of ARs, AARs, and CARs are conducted in accordance with the methodology outlined in section 3. Acquisitions display both negative and positive means. This implies that there is not a uniform interpretation of acquisitions. The negative means for acquisitions are unanticipated given previous research such as Connelly et al. (2011) and Lakonishok & Lee (2001) referencing acquisitions as positive signals. Nonetheless our results indicate that disposals are followed by a larger negative reaction. The results on First North show large negative minimums compared to Stockholm Large Cap. This is expected given the volatile nature of the market. The identified extreme values for acquisitions do however introduce the risk of individual firms heavily impacting results. This impact potentially skews the mean towards lower values for all acquisitions. The descriptive statistics further show differences between markets. This can be an indication that market characteristics do have an impact on the abnormal returns associated with insider trading. We examine these potential differences through our three hypotheses, each analysing CAARs from different perspectives.

6.1 Existence of Cumulative Average Abnormal Returns

Our first hypothesis examines whether there are short-term cumulative average abnormal returns following announcements of CEO transactions. While the markets demonstrate varied

levels of significant results, neither market provides sufficient evidence to reject the null hypothesis across all event windows. As a result, we cannot determine that CAARs are consistently different from zero. Our results consequently contrast earlier research, such as Jaffe (1974) and Seyhun (1986), who identify that insiders do earn abnormal returns. First North displays significant abnormal returns to a larger extent than Stockholm Large Cap. This indicates that the market characteristics on First North contributes to the generation of abnormal returns.

We identify significant results during two event windows on Stockholm Large Cap; [-3;3] for acquisitions and [0;1] for disposals. Both significant results show negative CAARs. Noteworthy, the CAAR for acquisitions of -0.96% contradict expectations as previous research conclude acquisitions to be a positive signal (Lakonishok & Lee, 2001). The absence of significant CAARs across Stockholm Large Cap shows that CEOs are not able to outperform the market based on in-depth information, as argued by Fama (1970) in the strong form of market efficiency. This indicates that the market is efficient to a high degree. The lack of significant CAARs can also be explained by Hillier et al. (2015) who argue that situations with strong corporate governance practices reduces the likelihood of top executives trading on their in-depth information. This is furthered by the increased probability of inspection associated with executive positions. Stockholm Large Cap is highly regulated and aligning with Hillier et al. (2015) this suggests that the signalling value of insider transactions diminishes. Consequently, this reduces the generation of abnormal returns, as observed in our results. Furthermore, factors such as high analyst coverage associated with the firms on Stockholm Large Cap might reduce CAARs generated by CEO transactions, aligned with ideas presented by Frankel & Li (2004).

On First North, we observe significant CAARs for all event windows except [-5;5] for acquisitions. Additionally, significant CAARs are positive for acquisitions and negative for disposals. The established existence of CAARs on First North, for all except one event window, aligns with our expectations of amplified reactions to insider trading on more volatile growth markets. Our findings can be explained by Frankel & Li (2004) and Degryse et al. (2014), who identify that factors such as reduced analyst coverage and less stringent regulations increase information asymmetry. These characteristics are prominent on First North. As we identify abnormal returns, our findings support the notion that there is an information asymmetry on the market, resulting in strong signalling value of CEO transactions. Moreover, our results align

with previous research such as Lakonishok & Lee (2001) and Seyhun (1986) who suggest that insiders in small firms are better positioned to predict stock price movements. Our findings on First North contradicts the strong firm of the EMH, arguing that all information should already be incorporated into stock prices (Fama, 1970). Instead, findings align more closely with the semi-strong form, as discussed in section 2.

The significance of CAARs when utilising FF3- and the market model are similar. On Stockholm Large Cap the main difference is the FF3 model's identification of significant CAARs during the [-5;5] event window for acquisitions. This implies that the FF3 model provides a marginally stronger explanation for the variance in abnormal returns. On First North the main difference is that FF3 shows a negative CAAR for acquisitions during the [-3;3] event window while the CAAR using the market model was positive. An inconsistency of the calculated CAARs is expected given that the FF3 model incorporates two additional betas in its calculation of expected returns. The overall similarity of results indicates that the market model is sufficient, and that the FF3 as a multi-factor model adds limited explanatory value. Our findings contradict previous expectations that the FF3 model would explain variation of abnormal returns on First North to a greater extent. However, the limited gains of a multi-factor model align with the argument by MacKinlay (1997) regarding the suitability of the market model in event studies; despite samples sharing a common characteristic. The appropriateness can be attributed to the market beta as an adequate representation of risk. Based on the conclusions made by Griffin (2002), the lack of explanatory value could also be attributed to using the European FF3s as a Swedish proxy, omitting country-specific factors.

6.2 Cumulative Average Abnormal Returns, Transaction Type Comparison

The second hypothesis investigates if abnormal returns are different based on the transaction type. The results on Stockholm Large Cap do not support that CAARs are different for acquisitions and disposals, except during the [0;1] event window. On the contrary, we can reject the null hypothesis at a 5% significance level across all event windows on First North, revealing that CAARs are consistently different between transaction types. These findings support our expectation that market characteristics matter in how insider transaction types are interpreted.

On Stockholm Large Cap, the only significant difference is observed for the [0;1] event window. This indicates that the market reaction differs between transaction types immediately

after the announcement, but that this difference is not pronounced over time. Recalling the CAARs on Stockholm Large Cap in table 7, we observe significant negative reactions during the [-3;3] event window for acquisitions and the [0;1] event window for disposals. As we do not identify consistent existence of CAARs, nor find support that transaction types result in different reactions, we are not able to conclude that one transaction type is more informative. This contrasts previous research such as Lakonishok & Lee (2001) and Jeng et al. (2003) who ascribe different informational value to acquisitions and disposals. However, these studies find this difference to be more prominent for small firms. We propose that market characteristics such as firm size, stability, regulatory environment, and analyst coverage likely contribute to efficient market pricing on Stockholm Large Cap. We further argue that this efficiency reduces the difference in informational value between transaction types.

In contrast, the results on First North show that CAARs differ between transaction types across all event windows. Based on previous research, such as Degryse et al. (2014) and Frankel & Li (2004), our findings support the idea that insider transactions are stronger signals in cases where information asymmetry is greater. We argue that characteristics such as firm size, risk, more flexible regulations, and reduced analyst coverage enhances the difference in informational value between transaction types. Our findings suggest that disposals convey stronger signals to the market. This is as we find that the magnitude of positive CAARs for acquisitions is small. Disposals, on the other hand, generate larger negative CAARs across all event windows. To exemplify, the most positive acquisition CAAR is 0.89%, while the most negative disposal CAAR is -6.75%. These findings contrast earlier research, such as Jeng et al. (2003) and Degryse et al. (2014). Their studies demonstrate that acquisitions generate significant abnormal returns in small firms while disposals do not. Based on the limitations of our dataset, discussed in section 4.4, these results should be interpreted with caution due to the much smaller sample size of disposals. This imbalance may limit comparability between transaction types and increase the risk that individual transactions heavily impact results.

6.3 Cumulative Average Abnormal Returns, Market Comparison

Based on our third hypothesis we are able draw conclusions on how the abnormal returns differ between Stockholm Large Cap and First North. The results reveal a significant difference between markets' reaction to the announcement of an acquisition. For disposals, we observe significant differences in all event windows except [-5;5].

The market reactions on First North are stronger for both acquisitions and disposals compared to Stockholm Large Cap, the only exception being acquisitions during the [-5;5] event window. The [0;1] event window for acquisitions on First North displays significant abnormal returns of 0.89%, while the corresponding result on Stockholm Large Cap is not significantly different from zero. In the same event window First North has a -3.96% CAAR for disposals, with the corresponding CAAR for Stockholm Large Cap being -1.28%. In addition, we find that acquisitions exhibit larger positive CAARs for First North during the two shorter event windows. This aligns with previous research stating that acquisitions are more informative signals in small firms than in large firms (Degryse et al. 2014). Contradicting this conclusion, and our identified trend, First North displays a larger negative CAAR during the [-5;5] event window. Additionally, the identified CAARs for this event window are notably similar between markets, despite their significant difference. Stockholm Large Cap displays a CAAR of -0.9115%, compared to -0.9137% on First North. This atypical finding can possibly be attributed to the large negative values that have been identified for acquisitions on First North. Based on the absence of significant difference between disposals for the [-5;5] event window, we conclude that the variations in market reaction are confined to the immediate period following an event. Overall, the results suggest that First North displays greater reactions to insider trading announcements in the short term, regardless of transaction type. For Stockholm Large Cap, CEO transactions generate weaker and more consistent levels of CAARs, reflecting its more regulated and efficient nature.

We compare the results using the market model, displayed in table 10, to those using the FF3 model, displayed in table 13. The difference in significance is limited, and the two models allow for rejection of the null hypothesis across the same event windows. The FF3 model contributes with slight explanatory value reflected by the absolute p-values. This indicates that SMB and HML do explain variation of abnormal returns to a certain extent. The overall consistency between models indicates that the market model is comprehensive in its estimation of systematic risk factors.

The findings displayed in table 10 and 13 reinforces the arguments made regarding hypothesis 1 and 2. Our results support the perception that market characteristics do impact abnormal returns and the notion that Stockholm Large Cap and First North react differently to announcements of CEO transactions.

7. Conclusion

This study investigates whether short-term abnormal returns following the announcements of CEO transactions are significantly different for Swedish companies traded on Stockholm Large Cap compared to First North. These markets provide an interesting setting for comparison, highlighted by differences in firm size, regulatory environment, and analyst coverage. We identify that earlier research, particularly in the Swedish context, primarily focuses on more regulated main markets. Our study contributes to bridging this gap by incorporating the rather unexplored environment of First North. To gain an understanding of the differences in abnormal returns, and the influence of market characteristics, we compare market reactions to CEO transactions made in Swedish companies between 2019 and 2023.

Previous research, such as Jaffe (1974) and Seyhun (1986), finds that insider trading generates abnormal returns. We find abnormal returns on First North except during the longest event window for acquisitions. The results for Stockholm Large Cap do not show the same level of consistency. Our results do not demonstrate conclusive evidence that insider trading generates abnormal returns across markets and event windows, contrasting earlier research. In addition, we find clear differences in abnormal returns between the markets. This indicates that the abnormal returns associated with a CEO transaction must be ascribed to other factors than solely the position as an insider. Our findings support the notion that market characteristics, such as information asymmetry and firm size, represent these factors; and that they are deciding factors in the signalling value of insider trading.

The broader trend of our results reveal that disposals tend to carry stronger signals to the market than acquisitions, contrasting our expectations and previous research (Jeng et al., 2003; Degryse et al., 2014). This conclusion is supported by specific findings such as the larger negative returns for disposals compared to the positive returns for acquisitions on First North. In addition, all significant CAARs on Stockholm Large Cap are negative. We can state that there is a significant difference between CAARs on First North and Stockholm Large Cap for all event windows except one. This difference further highlights the impact of market characteristics and information asymmetry. While our study contributes with suggestive results, we are not able to draw undisputed conclusions on the specific characteristics that drive this impact. We argue that our study contributes to an enhanced understanding of how market

characteristics influence abnormal returns associated with insider trading. This paves the way for future discussion regarding which characteristics are most material.

Further contribution is made by examining the suitability of the market model as a one-factor model, as discussed by Fama & French (1993) and MacKinlay (1997). The limited difference between CAARs using the different models indicate that the market model is sufficient when compared to a multi-factor model. This suggests that the market beta is an appropriate estimation of risk. Our findings consequently support the conclusions by MacKinlay (1997) on the adequacy of one-factor models in event studies.

We acknowledge that the limited dataset for disposals reduces the robustness of our conclusions. We do however argue that the analysis of transaction type remains valuable in its contribution to the understanding of our research question. Furthermore, we recognise that the presence of large negative observations for acquisitions on First North likely reduces the magnitude of positive CAARs. Nonetheless, we consider the inclusion of extreme values to be valid as no errors are identified. It is worth noting that the market model does not isolate the effect of specific market characteristics on the generation of abnormal returns. The differences between Stockholm Large Cap and First North should be interpreted as the combined effect of broader market characteristics.

In terms of future research, we see that a more controlled examination of abnormal returns would offer constructive insights. Building on the limitations of our study, applying a model that accounts for separate market-level factors would enable more precise identification of the specific characteristics that influence abnormal returns. Expanding on our conclusions regarding the impact of market regulation, future studies could determine whether similar effects are evident based on specific company characteristics. Are there, for example, differences in abnormal returns for companies with a clear adherence to Corporate Social Responsibility, compared to those categorised as sin-stocks. This comparison would allow for a deeper examination of the differences that arise from both legislative regulatory environments and standards that are self-imposed by companies based on moral or rules of conduct.

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9. Appendix

9.1 AI-Disclosure

The only AI tool that has been used in this thesis is ChatGPT 4o. ChatGPT's primary contribution was its assistance in improving and troubleshooting the R code used to generate results, as recommended by faculty. To a lesser extent AI was used for refining text, helping us identify, and correct, potential grammatical mistakes, as well as minimise repetitive phrasing.

AI tools has contributed to the quality of this study by enhancing grammar and readability. Moreover, the guidance AI provided in the development of our code streamlined the process. This allowed us to spend more time on the analysis and overall refinement of our text.

We acknowledge that there are multiple risks to account for when utilising AI. The most prominent risks include its biases and lack of critical thinking, the risk of overlooking errors, and the likelihood of AI generating false information. We took several measures to mitigate these risks. To ensure that each methodical step in the code was understood and proper, the suggested methods were cross-examined with methods used in previous research. As AI does not provide sources for any information it produces, AI was not used to write any original text. AI tools were instead only used to improve language in excerpts that were originally written by us.

Utilising AI tools has been a valuable learning experience. The process has clearly shown us the strengths and limitations of AI. The clear confirmation bias that AI resorts to when facing challenges and/or suggestive prompts can result in misleading conclusions. Our experiences with AI have highlighted how important human critical thinking is in evaluating information and critically assessing sources.