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ABNORMAL RETURNS AT LOCKUP EXPIRATION

An Emperical Assessment of Nordic IPOs

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ABSTRACT

The purpose of this thesis is to examine whether abnormal stock returns occur when lockup agreements of Nordic IPOs expire. Furthermore, our objective is also to assess potential ex ante cross-sectional predictors that may impact such abnormal returns. We have structured our cross-sectional hypotheses according to three overall classifications of characteristics, namely 1) lockup characteristics, 2) IPO characteristics, and 3) lockup period characteristics. When performing an event study on a sample of 141 Nordic IPOs that have taken place from 2009 to 2017, we find significant evidence of abnormally negative price reactions at lockup expiration. Specifically, our event study shows that Nordic IPOs on average experience a significantly negative cumulative abnormal return of -1.1% surrounding lockup expiration. This bears the highly noteworthy and focal implication of invalidating the semi-strong form of the efficient market hypothesis. With this finding, we contribute to the existing field of research by (to our knowledge) being one of the first European studies to observe significant evidence of abnormally negative stock returns when lockup agreements expire. We furthermore provide a thorough analysis and discussion that discredits any exploitative opportunities of risky arbitrage, as the magnitude of the average cumulative abnormal return does not surpass concurrent transaction costs. In addition, when conducting a cross-sectional analysis of ex ante explanatory variables, we find evidence of three statistically and economically significant characteristics. Here, our results suggest that more negative abnormal returns will on average transpire when 1) a greater percentage of shares are subject to lockup relative to the overall free float, 2) stock prices show high levels of volatility leading up to lockup expiration, and 3) consecutively positive price ramps are observed prior to lockup expiration. We attribute our findings to the underlying implications of the downward-sloping demand curve and distortive effects that stem from information asymmetry and overconfident and contrarian investor beliefs.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

1 Introduction

In November 2017, TCM Group A/S[1] (TCM) launched an initial public offering (IPO) on the NASDAQ OMX Copenhagen. The IPO prospectus for TCM included a lockup agreement[2] between the underwriters and selected existing shareholders of the issuing firm, where the existing shareholders contractually agree not to sell a certain percentage of their holdings for a pre-specified period after the IPO. This period is known as the lockup period, whereas the date on which the agreement expires is referred to as the lockup expiration date[3]. Once lockup agreements expire, pre-IPO shareholders (*e.g. shareholding executives, other shareholding employees, private equity (PE) firms, venture capitalists (VC), institutional shareholders*) are free to sell their shares to the public in accordance with insider trading regulations (Patel, 2018).

The IPO process of TCM was led by Carnegie Investment Bank and Danske Bank who functioned as Joint Global Coordinators. Sebastian Hougaard – managing director at Carnegie Investment Bank – emphasizes that a typical lockup agreement "*is a way of communicating to the market that […] we are holding the selling shareholders of firms with an unproven track record to their promises from the IPO*" (Hougaard, 2018, p. 3). This is exemplified in the prospectus for TCM, which addresses two lockup agreements that restrict the selling shareholder (IK Investment Partners[4]) and shareholding managers and members of the board of directors for 180 and 360 calendar days, respectively. A management-restrictive lockup generally reassures the market that restricted executives will continue their efforts in accordance with firm's best interests (Field and Hanka, 2001), whereas lockups for PE and VC firms indicate that they will neither attempt to cash-out immediately after the IPO nor in advance of impending bad news (Ofek and Richardson, 2000). Hence, as argued by Sebastian Hougaard, such lockup agreements "*give some certainty to the market that we are not just dumping shares [and] that there actually will be someone who is left with part of the responsibility*" (Hougaard, 2018, p. 1).

Although lockups are not a legal requirement for IPOs in the Nordic market, it has become common practice to restrict the holdings of pre-IPO shareholders for a pre-specified period, typically 180 or 360 calendar days (Goergen, Khurshed, and Renneboog, 2006). A key feature of lockup agreements is that the lockup period's duration and related terms are stated in the IPO prospectus, thereby making the lockup expiration date a completely observable event. However, even though lockup-specific information is publicly available, previous empirical research suggests that insiders' share disposals at lockup expiration tend to generate an

[1] TCM Group A/S is a Denmark-based manufacturer and supplier of kitchen and bathroom furnishings.
[2] "Lockup agreement", "lockup provision", "lockup restriction", and "lockup period" are used interchangeably throughout the thesis.
[3] "Lockup expiration", "lockup expiration day", "lockup expiration date", and "expiration" are used interchangeably throughout the thesis.
[4] The selling shareholder in the TCM IPO was Innovator International S.à r.l., which is owned by IK Small Cap I Fund (*51%*) and certain co-investors (*49%*) as limited partner entities. IK Small Cap I Fund is advised by IK Investment Partners Limited, which is a UK-based PE firm.

abnormally negative stock price reaction (Ofek and Richardson, 2000; Field and Hanka, 2001; Brav and Gompers, 2003). This contradicts the conventional outlook of the semi-strong form of the efficient market hypothesis (EMH), according to which investors are expected to have incorporated the lockup expiration event into their expectations at the time of IPO. To caution investors, it is often emphasized in IPO prospectuses that insiders' share disposals may affect the stock price at lockup expiration. This can for example be observed in the IPO prospectus for TCM, which states that "*after the expiration of such lockup obligations, these persons will be free to sell their shares. […] Any such sales of shares could have a material adverse effect on the public trading price of shares*" (tcmgroup.dk, 2018, p. 49).

The lockup effect is therefore vital for TCM's stakeholders to take into consideration. Since TCM's 180-day lockup on IK Investment Partners is set to expire on 23 May 2018, a highly important question prevails on how the stock price reaction will transpire. This is where the purpose of our thesis has its outset, namely to examine whether lockup expirations influence abnormal stock price reactions for Nordic stocks, as well as consider which drivers are expected to have an impact on such abnormal stock price reactions from an *ex ante* perspective.

1.1 Background and research question

This thesis has its outset in a broad extent of previous research that has observed significantly negative abnormal returns for stock prices when lockup agreements expire. One of the pioneers within this academic area, Ofek and Richardson (2000), investigated IPOs in the US market and reported significant evidence of the prevailing phenomenon. Since then, other notable studies in the US (Field and Hanka, 2001; Bradley, Jordan, Roten, and Yi, 2001; Brav and Gompers, 2003; Brau, Carter, Cristophe, and Key, 2004) have also found evidence of abnormal returns at lockup expiration, which has fuelled a novel and heavily debated topic among empirical researchers. One of the first studies that shifted focus beyond the US was conducted by Espenlaub, Goergen and Khurshed (2001), who assessed IPOs that had taken place on the London Stock Exchange. Here, they also observe negative abnormal returns at lockup expiration, however, their findings do not bear any statistical significance. Accordingly, Goergen *et al.* (2006) expanded this view by investigating the German and French markets where they found similarly insignificant evidence. Overall, empirical studies on the European markets have not observed evidence that complies with the initial findings of the US studies. Hence, these suggest a possible absence of significantly negative abnormal returns at lockup expiration in the European markets.

Our thesis seeks to explain this conundrum in modern day finance literature, namely why abnormal returns transpire at lockup expiration in markets that are assumingly efficient. We contribute to the existing field of research by specifically addressing the Nordic markets, which to our knowledge have not yet been explored

by existing literature. Furthermore, we seek to investigate explanatory predictors of abnormal returns at lockup expiration by employing a holistic approach in explaining the observed differences in abnormal returns.

The purpose of this thesis is thereby formulated by the following research question:

Research Question:

Do abnormal stock returns prevail when IPO lockup agreements expire in the Nordic markets, and if so, why?

The research question is supported by the following sub-questions, to specify the scope of this thesis:

1) Using an event study approach, is it possible to observe statistically significant evidence of abnormal stock returns when the lockup agreements of Nordic IPOs expire?
2) Are there any *ex ante* cross-sectional differences that may explain the abnormal stock returns at lockup expiration? If so, how do these differences relate to lockup characteristics, IPO characteristics, and lockup period characteristics?
3) Based on our findings on abnormal stock returns and *ex ante* cross-sectional differences, which focal implications must be taken into consideration by relevant stakeholders?

1.2 Scope and delimitation

The main objective of this thesis is to investigate abnormal price reactions at lockup expiration, as well as examine a selection of *ex ante* cross-sectional predictors that may have an impact on such abnormal returns. In this sense, our assessment of cross-sectional predictors will only evolve around public information that can be attained prior to the expiration date. In turn, this implies that explanatory factors that occur at the time of lockup expiration are deemed to be irrelevant according to the scope of this thesis. We will therefore disregard potential reactions that transpire beyond the expiration date, thereby rendering long-term effects irrelevant to the focal purpose of this thesis.

In accordance with our research objective, we will assert our core focus to abnormal returns at lockup expiration and potential *ex ante* predictors. However, to put our findings into perspective and draw upon vitally implicative inferences, we will complement our analysis by considering the trading activity and transaction costs that prevail concurrently with lockup expiration. We will not provide an in-depth assessment of these factors in the same manner as with abnormal returns, however, they have been deemed relevant for complementing our findings and thereby ensuring a comprehensive discussion of implications with which we can address our research objective and the core purpose of this thesis.

Naturally, we must briefly remark that we acknowledge that a broad-spanned selection of characteristics may have an impact on stock prices (*and accordingly also abnormal returns*), which inevitably cannot be exhaustively accounted for within the scope of our thesis. Nevertheless, we will trifurcate our selection of cross-sectional predictors to represent distinctly influential characteristics, which collectively are considered to yield the most optimal representation of reality as possible.

2 Theoretical framework

In the following theoretical framework, we will elaborate upon fundamental economic theory that is required to construct our hypotheses on abnormal returns at lockup expiration. We will firstly consider the EMH, from which our research question has its outset, and subsequently cover the focal concepts of signalling theory, commitment theory, and the downward-sloping demand curve, as well as their influence in the context of lockup agreements.

2.1 Efficient Market Hypothesis

The EMH asserts that a security is always valued at its fair price, as it reflects all available information in the market (Fama, 1970). It is thus considered to be impossible for investors to profit on over- or undervalued stocks, as the price epitomises a fair equilibrium. The EMH exists in three different forms: 1) weak form, where current prices reflect all historical information that is available to the public, 2) semi-strong form, in which prices are assumed to incorporate and adjust for newly published information, and 3) strong form, which states that prices reflect all available information, including information that is held by insiders. Since the expiration date of a lockup is disclosed in the IPO prospectus, the semi-strong form of the EMH will be applicable for our study.

While the EMH is supported by a large body of previous research[5] (Roberts, 1959; Samuelson, 1965; Fama, 1970; Jensen, 1978), there also exists a great extent of dissension on the theory[6] (Greenspan, 1998; Barber and Odean, 1999; Shleifer, 2000; Malkiel, 2003). Critics of the EMH point to market deficiencies, such as the stock market crash in 2007/2008, to emphasize that stock prices are inclined to deviate from their fair value. Theory on behavioural finance attributes market imperfections to cognitive biases (*e.g. information bias, overconfidence, and overreaction*) and reasoning errors among investors (Kahneman and Tversky, 1979).

[5] As emphasized by Jensen (1978), "*I believe there is no other proposition in economics which has more solid empirical evidence supporting it than the EMH*" (Jensen, 1978, p. 1)

[6] As famously stated by Alan Greenspan (1988), Chairman of the US Federal Reserve's Board, "*There is one important caveat to the notion that we live in a new economy, and that is human psychology […] which appears essentially immutable*" (Greenspan, 1988, pp. 1-2)

Investors are thus susceptible to biases that result in mispricing of securities, for example leading up to a stock's lockup expiration.

Recently, it has been attempted to combine the two distinctions in a new paradigm. Here, the concepts of the rational and behavioural view are reconciled with an adaptive market hypothesis (AMH) (Lo, 2004), in which it is assumed that investors are neither fully rational nor completely biased. Instead, the AMH asserts that investors make investments based on trial-and-error and best-guesses. The fundamental logic of the AMH borrows from evolutionary science, as the changing business environment is believed to make old strategies obsolete and thereby calls for an adaptive realization of new optimal strategies (Lo, 2004). In line with this attention to the changing business environment, it has recently been debated whether the prevalence of artificial intelligence substantiates the EMH's applicability (Marwala, 2015). As financial markets are becoming more infused with computer traders that incorporate artificial intelligence, it is argued that the EMH will consequently improve in applicability.

Although there exists an immense ongoing debate on the EMH, one cannot completely disregard its important role in economic theory. The EMH is a vital theoretical concept for our study since a significant prevalence of abnormal returns would signify evidence against the theory.

2.2 Information asymmetry, signalling theory, and commitment theory

An important theoretical explanation for the importance of lockups is that they function as a signalling solution to an information asymmetry problem (Brav and Gompers, 2003; Krishnamurti and Thong, 2008).

The implications of information asymmetry were originally popularised by Akerlof (1970), who coined the "lemons problem*"* by metaphorically relating financial markets to a market for used cars. In this example, sellers have full insight into the condition of a car, whereas individuals who intend to buy the car possess an informational disadvantage. Since a buyer cannot ascertain the true quality of the car, a price will be offered that lies below the car's true value. Consequently, high-quality cars are withdrawn from the market, thereby resulting in a market consisting of low-quality cars (*i.e. "bad lemons"*).

The information asymmetry problem is often referred to in conjunction with IPOs since a firm's original owners may have information that potential outside investors do not know of. Therefore, outside investors are subject to an informational disadvantage. To circumvent this disadvantage and the implications that are demonstrated by Akerlof's "lemons problem" (1970), certain signalling solutions must be employed to convey information to outside investors regarding the firm's true value (Leland and Pyle, 1977). According to signalling theory, "good companies" (*i.e. those with a greater possibility of success*) must always convey such signals to the market. For example, Leland and Pyle (1977) suggest that original owners of a firm should

possess a significant stake in connection with an IPO, to convey that their interests are in line with the firm's best interests. If no such signals are taken into use, the asymmetric information problem will prevail and thereby cause adverse selection in the IPO market.

As an extension to the implications of signalling theory, the concept of commitment theory suggests that "*insiders cannot just put their money where their mouth is; rather, they must commit to keep it there if the signal is to be credible*" (Brau, Lambson, and McQueen, 2005, p. 520), for example by not only owning an equity stake in the firm, but also committing to locking it up in the IPO aftermarket. At the outset of an IPO, it is therefore not only important to convey signals to outside investors, but also assure that such signals are credible. This is especially important for firms where the information asymmetry problem is prevalent. Such firms must therefore employ signalling and commitment devices to not only signal that their interests are in line with the firm's best interests, but also to convey their commitment to continue to do so in the IPO aftermarket.

2.3 Downward-sloping demand curves and liquidity restrictions

Lockup agreements also bear a significant effect from a market mechanism point of view, as they can impact the equilibrium price that is derived from supply and demand (Scholes, 1972; Shleifer, 1986).

The fundamental idea of the downward-sloping demand curve is that there exists an inverse relationship between demanded quantity and price (Ofek and Richardson, 2000). There are several explanations to why demand curves possess a downward slope. Firstly, the law of "diminishing marginal utility" suggests that a consumer's marginal utility decreases when consumption of a product increases, thereby making the consumer willing to pay a lower price (Beattie and LaFrance, 2006). Secondly, the "income effect" emphasises that consumers can buy more of a good when its price declines (*ceteris paribus*), thus causing an overall rise in real demand[7] (Romer, 2012). Lastly, the "substitution effect" proposes that when a substitutable good becomes relatively less expensive (*ceteris paribus*), it will appear cheaper than similar goods and thereby experience an increase in demanded quantity (Romer, 2012).

When supply increases and causes a shift in the supply curve (*ceteris paribus*), the interaction between the supply and demand curve will yield a decrease in price due to the downwards slope of the demand curve. This mechanism is therefore vital at lockup expiration, as there occurs a supply shock when investors gain access to previously locked up shares (Field and Hanka, 2001). This concept is also referred to as the "float effect" (Ofek and Richardson, 2000; Field and Hanka, 2001; Cao, Field, and Hanka, 2004).

[7] In other words, one can buy more of a good with the same level of demand when its price declines

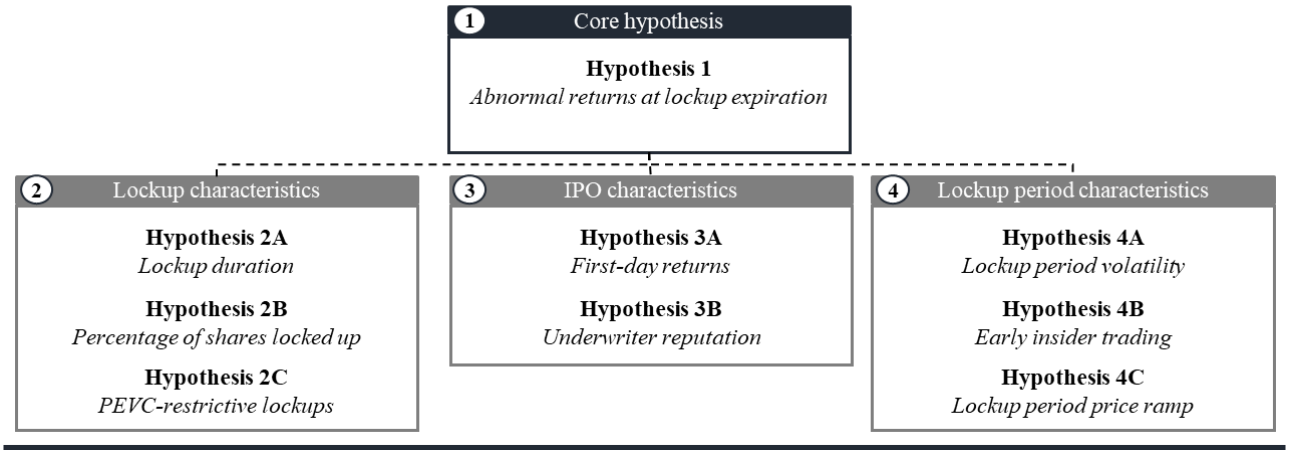
Lockups are a prime example of selling restrictions that prevent the ability of certain corporate insiders to sell their shares in the firm. Apart from lockups, selling restrictions are also often an integrate specification of executive stock or stock-option based compensation contracts (Kahl, Liu, and Longstaff, 2003). Due to the restrictive nature of lockups, certain insiders that are subject to a lockup will bear the cost of having a moderately illiquid and undiversifiable portfolio until lockup expiration. From the perspective of the firm, such selling restrictions are vital for retaining key employees and other shareholders that have a substantial influence on the firm's strategic and financial outlook. This will also incentivize such shareholders to undertake actions that improve the medium- to long-term prospects of the firm, rather than simply cashing out in the immediate aftermarket. Furthermore, as mentioned with respect to information asymmetry, it is also deemed highly beneficial for the firm to retain such shareholders to convey credible signals to the market that a continued commitment to the firm's performance will take place.

However, from a converse point of view, such selling restrictions may also impair the potential welfare of the restricted shareholders. Kahl et al. (2003) establish an important theoretical standpoint regarding this matter according to a mathematically derived model. Here it is hypothesized that when a large portion of shareholders' wealth is restrained by lockup restrictions, these shareholders will possess an inadequate ability to counterbalance the risk exposure of their portfolio. Holding all else equal, this will induce their portfolio risk and may consequently lead to a higher probability of share disposals at lockup expiration that are motivated by diversification needs. Kahl et al. (2003) assert great importance to this notion, as such share disposals may surprise outside investors if they do not recognize this possibility and incorporate it in their expectations in due time ahead of lockup expiration.

3 Hypothesis development

In the following section, we set out to develop a selection of hypotheses that are focal for testing and discussing the implications of lockup expirations in the Nordic markets. Each hypothesis will be based on previous research (*in terms of theoretical concepts and empirical findings*), as well as remarks from practitioners and our own financial reasoning. The core focus of the hypotheses is the negative cumulative abnormal return (CAR) that previous research has observed surrounding the expiration date of lockup agreements (Ofek and Richardson, 2000; Field and Hanka, 2001; Brav and Gompers, 2003). In addition, we intend to assess cross-sectional differences and their expected relationship with CAR from an *ex ante* perspective prior to lockup expiration. As illustrated by Figure 1 below, our cross-sectional hypotheses are split into three categories that each represent a set of characteristics that may have an impact on abnormal returns at lockup expiration.

FIGURE 1: Overview for categorization of hypotheses



Hypothesis 1 addresses abnormal returns at lockup expiration whereas Hypotheses 2 through 4 represent cross-sectional characteristics that may have an impact on such abnormal returns. With respect to the cross-sectional characteristics, the hypothesis development will assert focus on 1) how a specific characteristic affects the likelihood of insiders' share disposals at lockup expiration, and 2) why investors may over- or underestimate the degree of such disposals, thus yielding an abnormal price reaction.

3.1 Hypothesis 1: Abnormal returns at lockup expiration

According to the semi-strong form of the EMH, there should not occur any abnormal price reactions when a lockup expires, as such information is publicly available in the IPO prospectus. Market participants can attain a broad selection of lockup-specific information from the prospectus, such as the duration of the lockup period, the number of shares that are locked up, as well as a description of all shareholders whose holdings are subject to a lockup. Therefore, any price reaction at lockup expiration should already have been accounted for, either in the offer price or during the first day of trading (Ofek and Richardson, 2000). In addition to this logic, it is assumed that a firm's stock price is based on unbiased expectations by rational investors (Bradley *et al.*, 2001; Brav and Gompers, 2003). Therefore, even though unexpected events may occur at the time of lockup expiration for a specific firm (*which would yield an unexpected price reaction*), the abnormal return at lockup expiration should on average be zero to reflect the unbiased expectations by rational market participants. Brau *et al.* (2004) stress that it must be reasonable to assume that rational investors are aware of any potential reactions due to supply shocks or information asymmetry and will incorporate such in their predictions. Hence, regardless of informational misalignments or market mechanisms, investors are assumed to always establish their expectations in an unbiased and rational manner, thereby stressing that "*a persistent negative abnormal return should not exist in an efficient market*" (Green, 2017, p. 2).

Nevertheless, empirical studies on abnormal returns at lockup expiration have proved evidence against the semi-strong form of the EMH. Ofek and Richardson (2000) conducted one of the earliest studies, where they investigated the abnormal returns at lockup expiration for 1,662 US firms that had been taken public in the period from 1996 to 1998. Their results showed a negative CAR that ranged between -1% and -3% (*depending on the applied event window*) with which they suggested "*a new anomalous fact against market efficiency*" (Ofek and Richardson, 2000, Abstract).

Field and Hanka (2001) also invalidate the semi-strong form of the EMH in a lockup context. Based on a sample of 1,948 IPOs that had taken place in the US from 1988 to 1997, they observed that firms on average experienced a significant CAR of -1.5% when applying a 3-day event window surrounding the expiration date. They also highlighted a noteworthy observation that 63% of the sample firms had a negative CAR during the event window. These results are directly comparable to those of Bradley *et al.* (2001), who used a sample of 2,529 IPOs in the US during the exact same period. Their analysis yielded a highly significant average CAR of -1.6% when applying a 5-day event window. Furthermore, when narrowing their event window down to solely focus on the expiration date, they observed a negative abnormal return of -0.7% with similar significance.

Additional empirical studies have considered US IPOs in the exact same period (Brav and Gompers, 2003; Brau *et al.*, 2004), where evidence once again indicated significantly negative CARs around lockup expiration. These studies attribute the negative CAR to the downward-sloping demand curve and accredit the use of lockups as a means of resolving information asymmetries. Hence, it is suggested that investors make untimely predictions that are furthermore distorted by an informational misalignment. Brau *et al.* (2004) additionally consider the notion on biases among investors, as they argue that investors become increasingly nervous as the expiration date approaches. This contradicts the fundamental assumption that investors are completely rational with unbiased expectations.

Espenlaub *et al.* (2001) conducted one of the first studies on abnormal returns at lockup expiration outside of the US market, by assessing 188 IPOs that had taken place on the London Stock Exchange from 1992 to 1998. Here, they found a negative CAR that on average ranged between -0.5% and -2.5% (*depending on applied event windows and sub-samples*), which is comparable to that of the US studies. However, the results for the UK IPOs did not bear any statistical significance. The authors emphasized that the IPOs in the UK were more complex and diverse than those in the US, as they do not conform to a generally standardized lockup period of 180 days (Espenlaub *et al.*, 2001; Brau *et al.*, 2004). More recently, the authors revisited their original study and performed an analysis on 233 IPOs that had taken place in the UK during the previously applied period from 1992 to 1998 (Espenlaub, Goergen, Khurshed, and Remenar, 2013). Here, a more rigorous analysis based

on characteristic lines[8] was performed to control for risk. However, once again the results yielded limited evidence of abnormal returns at lockup expiration.

Ahmad (2007) also investigates the UK market, with a sample of 268 firms that have gone public on the London Stock Exchange from 1995 to 2006. Here, several analyses are performed on the overall sample and detailed sub-samples. Ahmad (2007) finds significantly negative CARs across all models when applying event windows of 21 and 41 days. However, when narrowing the event windows down to a more concise length of 3 and 5 days, there is not observed any significant results. When an event is easily determined (*as it is with lockup agreements, since the event is set to the expiration date*) it is generally recommended that one considers narrow windows to assure robust representability of abnormal returns (Armitage, 1995). Hence, the presence of abnormal returns at lockup expiration for UK IPOs is conclusively discredited.

The pervasiveness of abnormal returns has also been assessed for firms that have gone public in Germany and France (Goergen *et al.*, 2006) [9]. The results for these markets add to the findings of the UK studies, as they also confirm the absence of significantly abnormal returns at lockup expiration. The authors conclusively stress the importance of further investigating price reactions to lockup expirations in the European markets.

Overall, previous studies have found mixed empirical evidence of abnormal returns at the time of lockup expiration. The early studies on the US market observed significantly negative CARs, however, when expanding the outlook towards the European market, the findings have been proven to be insignificant. It is therefore highly relevant to consider whether one can support the semi-strong form of the EMH when assessing the Nordic markets. Thus, our main hypothesis will be as following:

Hypothesis 1*: We expect zero cumulative abnormal return at lockup expiration*

3.2 Hypothesis 2A: Lockup duration

When assessing the implications of lockups in general, it is of great relevance to integrate inferences from the "portfolio diversification hypothesis" (Pagano, 1993; Pagano, Panetta, and Zingales, 1998; Bodnaruk, Kandel, Massa, and Simonov, 2008) and the "informative selling hypothesis" (Aggarwal, Krigman, and Womack, 2002; Chen, Chen, and Huang, 2012). These hypotheses can be used to explain the motivation of insiders' share disposals at lockup expiration. The portfolio diversification hypothesis suggests that insiders sell their shares at lockup expiration due to portfolio diversification and liquidity needs. It is therefore argued that such share disposals do not convey any information about the current valuation of the firm. Alternatively, the

[8] A "characteristic line" is applied in regression analyses to summarize a specific security's systematic risk and rate of return. The concept is a performance assessment tool within modern portfolio theory (Markowitz, 1952, 1959).
[9] 138 and 268 IPOs that have taken place on the German Neuer Markt and the French Nouveau Marché, respectively, during the period from 1996 through 2000

informative selling hypothesis suggests that insiders will dispose of their shares at lockup expiration, as they are privy to private negative information regarding the firm's true value or outlook. These hypotheses are useful when assessing the probability and potential magnitude of share disposals at lockup expiration.

Ahmad (2007) argues that lockup duration functions as a credible signalling device to represent firm quality. With respect to this notion, insiders of high-quality firms who possess positive information regarding the firm's future performance are assumed to be less likely to sell their shares at lockup expiration. Therefore, insiders of high-quality firms have greater propensity to accept longer lockup periods, as they intend to signal their positive inside information regarding the firm's promising outlook (Ahmad, 2007). Consequently, the insiders of high-quality firms that in fact do sell at lockup expiration are believed to be motivated by portfolio diversification needs rather than possessing an informational advantage. Conversely, Haggard and Xi (2017) emphasise that insiders of low-quality firms may also choose to sell their shares at lockup expiration due to negative private information. Consequently, share disposals in such scenario will be motivated by both diversification needs and an informational misalignment, thus implying a greater potential magnitude of share disposals.

Due to the prevalence of information asymmetry, outside investors cannot determine the true value of the firm and will bear greater uncertainty in their predictions regarding insider sales on lockup expiration. Holding all else equal, when insiders possess negative information (*which is proxied by shorter lockup durations*), there is a greater probability that outside investors will underestimate insiders' selling activity, which will translate into an abnormally negative price reaction (Courteau, 1995).

In line with this logic, if longer lockup duration is an adequate proxy for high-quality firms, one may assume that insiders are more inclined to hold on to their shares. Therefore, the magnitude of share disposals will be relatively smaller such that there exists a lower probability of exceeding investors' expectations. Holding all else equal, abnormal returns will be absent at lockup expiration in such a scenario.

The empirical findings of Ahmad and Jelic (2014) support the view on lockup duration as a signal of firm quality, as they observe that firms with longer lockup periods demonstrate greater survival rates (*i.e. an indication of firm quality*) than those with shorter lockup periods. When comparing the abnormal returns at lockup expiration between firms with longer and shorter lockup periods, Ahmad (2007) found evidence of significantly negative CARs among firms with shorter lockups. These findings were based on a sample of 268 IPOs in the UK during the period from 1995 to 2006.

Boreiko and Lombardo (2013) also find evidence of the signalling hypothesis when analysing abnormal returns at lockup expiration for 174 Italian IPOs in the period from 1999 to 2009. When applying an event window of 5 days (-2, +2), they find that lockups with durations of 180 days or less have a significantly negative CAR, both during the event window and on the expiration date itself. However, they did not observe significant

CARs among firms with lockups that are longer than 180 days. This sub-sample approach thus supports the notion that a longer lockup period conveys a signal of high quality, which in turn implies an absence of abnormal returns at lockup expiration.

The relationship between lockup duration and abnormal returns at lockup expiration is a heavily debated topic within previous empirical research. We therefore find it highly relevant to assert such focus to this study. We discussed this view with Sebastian Hougaard by addressing the Swedish IPO market, which historically has experienced a greater investor appetite within the small-cap and mid-cap segments. Here, it was emphasized by example that smaller firms are often associated with greater uncertainty, which stems from their opaqueness and short-spanned track-record. Sebastian Hougaard explains that "*the risk is definitely higher […] and this will not be a decent investment until they have proven themselves […] Therefore, you would want them to be locked up for a longer time*" (Hougaard, 2018, p. 6). This complies with Ahmad (2007), who argues that firms that encompass a higher degree of uncertainty must convey credible signals to outside investors by employing longer lockups in order to alleviate misjudgements by outside investors that stem from information asymmetry.

In summation, we expect that longer lockups are used as signalling device by high-quality firms to solve uncertainty issues that are related to information asymmetry. We therefore construct the following hypothesis:

***Hypothesis 2A**: We expect that lockup duration has a positive relationship with cumulative abnormal return at lockup expiration*

3.3 Hypothesis 2B: Percentage of shares locked up

It is often cautioned in a listing prospectus that a supply shock of shares can occur when a lockup expires, in the sense that insiders may choose to instantly dispose of their shares (Field and Hanka, 2001). This is also evident in the prospectus for TCM, as it states that "*the market price of the shares may decline as a result of sales of shares in the market […] Any such sales of shares could have a material adverse effect on the public trading price of the shares*" (tcmgroup.dk, 2018, p. 49).

Abnormal returns at lockup expiration can be explained by the logic of the downward-sloping demand curve (Ofek and Richardson, 2000). When a sudden positive shift in supply occurs, the stock price is expected to drop according to the new intersection of the supply curve and downward-sloping demand curve. Since the expiration of a lockup is 1) entirely known and observable and 2) bears great potential economic importance given existing literature on supply shocks (Scholes, 1972; Mikkelson and Partch, 1985; Holthausen, Leftwich, and Mayers, 1990), the market should immediately incorporate the expected price impact into the stock price at the time of IPO[10]. Therefore, regardless of the magnitude of the potential supply shock that could occur at

[10] Discounted at the required return on the stock

lockup expiration, there should on average exist no significantly abnormal price reactions. However, since outside investors cannot ascertain whether insiders intend to dispose of their shares at lockup expiration, they must construct a probabilistic prediction of possible outcomes. It therefore becomes of great importance to assess the implications of locking up a large proportion of shares relative to the overall free float of the stock.

The amount of equity that is held by insiders at the time of IPO can serve as a signal of the firm's quality (Leland and Pyle, 1977), in the sense that insiders of high-quality firms are more inclined to retain a greater number of shares. They will thus discern benefits of diversification in favour of benefitting from the promising outlook of owning shares in a high-quality firm. However, Leland and Pyle (1977) add to this notion that lockup periods are relatively short (*in the sense that they most often are equal to or shorter than 360 days*) when compared to the strategic time horizon of firms in general. They therefore argue that the cost of holding additional equity will not be paramount, thus rendering it easy for insiders of low-quality firms to imitate such large equity holdings to attain a similar signalling value. Since insiders of low-quality firms may potentially sell out at the first chance they get, which is motivated by holding negative private information rather than for diversification purposes, one would assume a greater probability of shares flooding the market at lockup expiration than otherwise expected (Leland and Pyle, 1977).

One can also explain the price reaction at lockup expiration with the occurrence of speculative price bubbles. Hong, Scheinkman, and Xiong (2005) develop a mathematical model with which they argue that the probability of speculative price bubbles is high when the free float of tradable shares is limited. For example, this is the case for firms where a large proportion of shares are subject to a lockup relative to the free float. In this setting, one will assume that investors have heterogeneous beliefs, are influenced by overconfidence, and face short-selling constraints (Hong *et al.*, 2005). The stock price will therefore exceed the firm's fundamental value due to two reasons. Firstly, there is an "optimism effect*"* where the stock price is biased upwards by heterogeneous initial priors. When the beliefs of initial priors are heterogeneous, the stock price will only reflect the beliefs of those that are optimistic, as the conservative investors merely remain inactive due to short-selling constraints (Miller, 1977; Chen, Hong, and Stein, 2002). Secondly, there is a "resale option effect" where investors are willing to pay a price that exceeds their own belief of true value, as they expect other buyers to be willing to pay a premium in the future (Harrison and Kreps, 1978; Scheinkman and Xiong, 2003).

In line with this logic, when a large proportion of equity is locked up, the beliefs of outside investors are more likely to yield a valuation that exceeds the firm's true value (*ceteris paribus*). A bubble thus arises as investors anticipate the option to resell their shares to those that have even higher valuations of the stock. In this sense, it is argued that firms with a higher percentage of locked up shares (*relative to free float*) have a greater probability of being affected by speculative bubbles. When short-selling restrictions are relaxed at lockup expiration, the price bubble will likely burst since the firm's true value becomes evident to not comply with

the speculated price. Holding all else equal, this unexpected value realization among investors will result in an abnormally negative price reaction.

Brav and Gompers (2003) conduct an empirical study on the relationship between locked up shares and abnormal return at lockup expiration. They based their study on 2,871 US IPOs that had taken place from 1988 to 1996. They construct two percentage-measures of locked up shares, namely locked up shares relative to total shares outstanding and relative to post-IPO insider shares. It is observed that both proxies have a significantly negative impact on CAR at the time of lockup expiration, thus suggesting that a greater fraction of shares locked up is associated with more negative price reactions. Nowak (2015) supports this finding, as he observes that firms with a lower free float experience a significantly negative CAR at lockup expiration. This result is explained by the notion that firms with a lower free float relative to locked up shares may potentially have a greater number of shares brought to the market at lockup expiration. Hence, the results can be attributed to the downward-sloping demand curve and outside investors' inaccurate predictions concerning the magnitude of insiders' share disposals at lockup expiration.

Nowak (2015) splits the total sample into two sub-samples by dividing the observations according to the median percentage of free float. He observes a consistently negative CAR when applying broad event windows[11], whereas the significant effect disappears when narrowing the event window down to 5 days or less. Furthermore, it is observed that the magnitude of free float shares does not have a significant impact when performing a cross-sectional regression on the entire sample. This finding is explained to stem from the proxy-measurement of free float relative to locked up shares, as it unavoidably is an imperfect *ex ante* proxy-estimate of the actual number of shares that will be brought to the market at lockup expiration (Nowak, 2015).

Brau *et al.* (2004) do however find a significantly negative relationship between locked up shares and abnormal return when performing a cross-sectional regression, which is substantiated by a sample of 2,120 US IPOs from 1988 to 1998. Their cross-sectional regression is applied to a 5-day event window (-4, 0), from which it is found that CAR on average decreases by 0.03 percentage points for each additional percentage point of locked up shares relative to total shares outstanding. This relationship is observed to be significant at the 5% significance level and is concluded to support the theoretical view on asymmetric information and the downward-sloping demand curve. As more shares become subject to a lockup, insiders will have less ability to signal the true value of the firm to the market. Combined with a greater possibility of shares flooding the market, which yields the implications of the downward-sloping demand curve, this effect will induce uncertainty among investors and cause an abnormally negative market reaction to the lockup expiration.

[11] Nowak (2015) observes a negative CAR of -8.95% for firms with a lower free float when applying a 21-day event window (-10, +10), which is significant at the 1% significance-level. When applying a broader event window of 32-days (-1, +30), he observes a negative CAR of -13.19%, which also is significant at the 1% significance-level.

Sebastian Hougaard emphasizes that when stocks have a large proportion of locked up shares relative to the free float, this will "*suppress the market price [because investors] know there will be a fairly large sell-down [at some point after lockup expiration]*" (Hougaard, 2018, p. 3). Subsequently, we then refer to the theoretical assumption that investors anticipate the lockup expiration ahead of time and will therefore already have incorporated it in their valuation of the stock, to which Sebastian Hougaard argues that "*a part of it might be [investors] remembering that the lockup actually expires*" (Hougaard, 2018, p. 4). Hence, it is possible that investors do not fully incorporate their expectations for the lockup expiration in due time. This argument relates to the behavioural logic of Kahneman and Tversky (1979), who suggest that investors may not be consistently rational. Sebastian Hougaard adds that "*it's a lot about psychology [and] people preparing themselves for future sell-downs after a lockup. […] It isn't as rational [but] it's also difficult to know whether [a sell-down actually will occur]*" (Hougaard, 2018, p. 4).

Due to the abovementioned implications of the downward-sloping demand curve, information asymmetry, and investor beliefs, we assert great importance in assessing the impact that the number of locked up shares may have on the price reaction at lockup expiration. We therefore construct the following hypothesis:

***Hypothesis 2B**: We expect that the percentage of locked up shares relative to free float has a negative relationship with cumulative abnormal return at lockup expiration*

3.4 Hypothesis 2C: PEVC-restrictive lockups

IPOs are generally considered to be a favourable exit strategy for private equity and venture capital (PEVC) firms (Fenn, Liang and Prowse, 1995). With respect to PE firms, their investment strategy asserts focus on relatively short-term financial gains, which constitutes a trademark inherited in their investment strategy and operational DNA (Fenn *et al.*, 1995). This notion is also emphasized by Sebastian Hougaard, who argues that "*PE owners […] will sell at the first given instance they can. That's fairly common and anticipated by that market as well*" (Hougaard, 2018, p. 3). PE firms typically have an investment horizon of 10 years (Fenn *et al.*, 1995), in which capital must be committed, called, and redistributed back to the limited partners (LPs). This suggests that holding periods for individual investments are relatively short-spanned when compared to other types of block investments, such as direct investments by institutional investors. Therefore, exit opportunities such as IPOs are often utilized by PE firms to sell their shares and redistribute the returns of the investment back to the LPs (Brau, Francis, and Kohers, 2003).

With respect to VC firms, Espenlaub, Khurshed, and Mohamed (2009) study the exit behaviour of VC firms in the UK and find that IPOs are the most preferred exit channel followed by M&A. In accordance with this finding, Goergen *et al.* (2006) argue that VC firms prefer to exit from their investments at the earliest

opportunity after a portfolio firm has been taken public. This is due to the fact that an IPO constitutes the final stage of such VC firms' investment horizon.

Thus, due to the shared short-term outlook of PEVC firms' investment profile in the setting of an IPO, there should (*ceteris paribus*) exist a greater likelihood of shares flooding the market once the PEVC-shareholders are released from their lockups. In addition to the higher probability of share disposals when PEVC-restrictive lockups expire, the magnitude of the float effect may also be substantially larger. This is supported by the assumption that PEVC-shareholders that do not make a complete exit at IPO often retain a substantial post-IPO equity stake (Fenn *et al.*, 1995). When considering such large equity holdings in conjunction with the short-spanned investment horizon of PEVC-shareholders, this will entail a higher probability of a potential float effect that encompasses a substantial magnitude of shares.

The notion that PEVC-restrictive lockups are associated with a potentially greater magnitude of share disposals at lockup expiration is empirically investigated by Bradley *et al.* (2001). Here, they examine differences in expiration date trading volume between lockups that restrict VC firms and lockups for other shareholders. For VC-restrictive lockups, trading volume is observed to peak one trading day after lockup expiration. The trading volume is found to peak at a level that is nearly 100% larger than the pre-expiration level, which remains approximately 30% larger during the following month. For lockups that do not restrict VC-shareholders, Bradley *et al.* (2001) observe a similar pattern, however, it is deemed to be immensely smaller. These results are consistent with the argument that PEVC-shareholders tend to liquidate their positions immediately after lockup expiration, which leads to a substantial supply shock.

Applying the theoretical concept of the downward-sloping demand curve, a large sell-down at lockup expiration should imply an outward shift of the supply curve with a corresponding lower equilibrium price. However, the float effect should already be incorporated in the price at the time of IPO, due to the public availability and economic significance of lockup information. Regardless of the probability and magnitude of the potential supply shock, rational investors should on average anticipate the trading volume at lockup expiration. Hence, in order for the float effect to persist, the theory prescribes that there should exist specific characteristics for PEVC-restrictive lockups that induce added uncertainty into the construction of the average outside investor's expectations.

In line with this logic, Bradley *et al.* (2001) conduct an empirical study to investigate the relationship between abnormal returns at lockup expiration and VC-restrictive lockups. They find that lockup expirations on average are associated with significantly negative abnormal returns and that such negative price reactions are concentrated among VC-restrictive lockups. When such VC-restrictive lockups expire, Bradley *et al.* (2001) observe an average return of -1.25% on the expiration date, as well as a CAR of -2.81% when applying a 5-day event window. Although the price reactions for lockups that do not restrict VC-shareholders also are found to be negative and statistically significant, the VC-restrictive lockups yield an immensely more negative price

reaction. Bradley *et al.* (2001) suggest that such negative price reactions that transpire when VC-restrictive lockups expire are the result of an ownership transfer from VC-shareholders to traditional equity investors, and that the observed abnormal price response is a float effect that occurs even though the expiration date is anticipated.

Theory on information asymmetry may arguably explain why the float effect prevails although it is fully anticipated. In such a setting, PEVC-shareholders possess an informational advantage due to outside investors' unobtainability of the expertise required by PEVC firms (Arthurs, Nam, and Park, 2014). Hence, it is possible that a strong exit pressure in the IPO aftermarket and expectations of large returns incentivize PEVC-shareholders to utilize their informational advantage, thus elevating their own returns by expropriating wealth from outside investors. In such a scenario, PEVC-shareholders promote earnings management to induce stock prices prior to lockup expiration. PEVC-shareholders may employ a "pump-and-dump" strategy, whereby they hype a firm's stock and underlying fundamentals during the lockup period to inflate demand, and thereafter take advantage of the market's bullish sentiment by selling their shares at a premium at lockup expiration (Arthurs *et al.*, 2014).

In conclusion, we acknowledge that PEVC-restrictive lockups are associated with substantial float effects and potential complicative implications that stem from information asymmetry between insiders and outside investors. We therefore construct the following hypothesis:

***Hypothesis 2C**: We expect that PEVC-restrictive lockups have a negative impact on cumulative abnormal return at lockup expiration*

3.5 Hypothesis 3A: First-day returns

Aggarwal *et al.* (2002) develop a model with which it is argued that insiders strategically accept IPO underpricing to ensure that sufficient value realisation has taken place when disposing their shares at lockup expiration. This view is substantiated by the notion that a greater extent of underpricing induces the probability of a larger first-day return, which subsequently attracts attention to the stock and creates an information momentum. Such an information momentum could for example stem from induced interest by research analysts or the media.

From a market mechanism point of view, this will shift the demand curve for the stock outwards and yield a higher equilibrium price. Holding all else equal, the underpricing effect will thus allow insiders to attain a higher price when selling their shares at lockup expiration. This underpricing effect generates an opportunity cost to the firm in the form of forgone IPO proceeds (Ritter, 1991), which is traded off in favour of the benefits of information momentum. The fundamental theory of Aggarwal *et al.* (2002) and Ritter (1991) assumes that

informational disadvantages are to some extent depleted by underpricing, which is supported by Chemmanur (1993) who argues that underpricing generates an information momentum that encourages investors and research analysts to produce information regarding the firm. In this manner, the more information that is provided regarding a firm, the more probable it will be that a firm can depict its true quality to the market. Investors can therefore establish predictions with a greater degree of certainty.

Tolia and Yip (2003) conceptualize the impact of an IPO's first-day returns on the stock price reaction at lockup expiration. In line with the categorization of Krigman, Shaw, and Womack (1999), they define IPOs with first-day returns between 10% and 60% as "hot" IPOs, whereas those with first-day returns of 0% or below are defined as "cold" IPOs. Here, the fundamental idea is that insiders are less inclined to dispose of their shares immediately after lockup expiration when an IPO has been identified to be "hot". Conversely, investors will predict that "cold" IPOs will bear greater propensity to continue to perform poorly, therefore implying that insiders will make a sell-down of shares after lockup expiration to cut their losses. These actions are thus considered to impact the stock price negatively at the time of lockup expiration.

However, the empirical findings of Tolia and Yip (2003) do not prove any evidence in favour of their hypothesised outcome. Their sample consists of 407 US IPOs from October 1999 to September 2000, where the observations are categorized into four groups according to the magnitude of first-day returns[12]. Their results indicate that all IPOs, regardless of categorization, on average experience abnormal returns of -1% on the date of lockup expiration. Furthermore, they find that the negative abnormal return is only significant for "hot" IPOs, which is contrary to their hypothesized outcome. Tolia and Yip (2003) acknowledge that this effect can be attributed to profit-taking behaviour by investors who anticipate the forthcoming release of locked up shares.

When assessing the daily abnormal returns during an event window of 21 days (-10, +10), Tolia and Yip (2003) observe a high degree of variation in the magnitude and significance of the daily abnormal returns. Although they on average only find a significantly negative abnormal return for "hot" IPOs on the day of lockup expiration, they also observe significantly negative abnormal returns on alternative days in the event window across all categorizations. Therefore, they suggest that future research should investigate whether a significant relationship can be observed across an entire sample of IPOs, by performing a cross-sectional regression rather than analysing distinct sub-samples.

Krigman *et al.* (1999) also investigate IPO underpricing and argue that "*first-day winners continue to be winners over the first year, and first-day dogs continue to be relative dogs*" (Krigman *et al.*, p. 1015). With a sample of 1,232 large-cap IPOs in the period from 1988 to 1995, they show that first-day returns predict the

[12] Tolia and Yip (2003) categorise their observations as "Cold IPOs" (*first-day return of 0% or less*), "Cool IPOs" (*first-day return between 0% and 10%*), Hot IPOs (*first-day return between 10% and 60%*), and "Extra Hot IPOs" (*first-day return above 60%*).

direction of excess returns during the following year. This compares to the findings of Affleck-Graves, Hegde and Miller (1996) who study the link between first-day return and short-term aftermarket performance, where they observe that the risk-adjusted returns during the first three months of trading are in the same direction as the initial first-day return.

In line with the theoretical outlook of Aggarwal *et al.* (2002) and Tolia and Yip (2003) we will investigate whether the induced information momentum and increased demand that is generated by larger first-day returns will impact the abnormal return at lockup expiration negatively. We therefore construct the following hypothesis:

***Hypothesis 3A**: We expect that first-day returns have a positive relationship with cumulative abnormal return at lockup expiration*

3.6 Hypothesis 3B: Underwriter reputation

Underwriter reputation[13] is theorized to convey credible signals of a firm's true value to less informed investors. Arthurs, Busenitz, Hoskinsson, and Johnson (2009) find that lockup duration acts as a substitute signal to prestigious underwriter backing and conclude that lockup duration is a more costly and inferior signalling effect, such that it is used in lieu of underwriter reputation.

Brav and Gompers (2003) concur that high-quality underwriters are less likely to engage in wealth expropriation as the underwriters will engage in more rigorous monitoring and not allow any opportunistic behaviour for the insiders to take advantage of the outside shareholders. Thus, firms with high-quality underwriters can arguably reduce the risk of unexpected share disposals by insiders and thereby abnormally negative price reactions at lockup expiration.

One can argue that underwriter quality is associated with less information asymmetry regarding the firm's true value in the IPO aftermarket (Yung and Zender, 2010). In line with this logic, underwriter quality constitutes a certification effect, whereby firms that are certified by high-quality underwriters experience induced transparency and a reduction in the severity of asymmetric information.

Given the bounded rationality of outside investors and the lack of operating history to verify the credibility of the firm's signals, underwriter quality is a safeguard that mitigates the outside investors' uncertainty regarding the firm's true value and prospects, as well as the forthcoming actions of insiders at lockup expiration. However, underwriter quality may not signify credibility in the same degree as a lockup agreement, thus not rendering lockups obsolete (Arthurs *et al.*, 2009). Credibility is based on the bonding cost of the signal, where

[13] "Underwriter reputation" and "underwriter quality" are used interchangeably throughout this thesis. This is based on the assumption that underwriters' reputation is directly linked to their quality.

it can be argued that lockups bear a higher bonding cost than underwriter quality. Whereas lockups coerce insiders to commit to keep their money where their mouth is, underwriter quality does not entail the same degree of contractual guarantee in the aftermarket. The outside investor can observe the reputation and merits of an underwriter, however, whether this reputation and expertise will translate into positive externalities for the company remains uncertain. Although underwriter quality is difficult to imitate in the sense that high-quality underwriters are assumed to only "pick the best horses", the bonding costs can be less severe for the firm than for the underwriter (Arthurs *et al.*, 2009). Thus, the credibility of the signalling of underwriter reputation will depend on the incentives of the underwriter and whether these work in favour of the insiders or outside investors.

In this matter, Carter and Manaster (1990) argue that reputable underwriters are highly incentivised to ensure the greatest degree of transparency and representability of the firm's true value. This implies that the bonding costs and thus the credibility of the signal will be high. Reputable underwriters have developed their reputation for strong due diligence over time, which has further resulted in a reputation of strong reliability and legitimacy. If a reputable underwriter was to issue shares of a firm, which provides incorrect information, the revelation of such deception would not only harm the firm but also the underwriter's reputation. In turn, this would impede the underwriter's ability to attract investors for future issues, thus creating a strong incentive for the underwriter to ensure that the information concerning the firm is as accurate as possible. Consequently, the stronger the reputation of the underwriter, the more severe will the downside be for the underwriter's reputation, thus ensuring a stronger bonding cost to be signalled to outside investors.

Contrarily to this theoretical outlook, empirical evidence of the relationship between underwriter reputation and abnormal returns at lockup expiration suggests a negative relationship. Brau *et al.* (2004) measure underwriter reputation according to the volume of issues for each underwriter in the year prior to the IPO relative to the total market volume in the same year. They base the measurement of reputation on the year prior to the IPO to acknowledge the possibility of varying underwriter reputation over the time span of the sample. Although statistically insignificant, they report a negative and economically significant estimate for underwriter reputation when regressing against a 5-day CAR. Accordingly, Bradley *et al.* (2001) report that the largest price declines at lockup expiration occur for firms with higher underwriter quality. Field and Hanka (2001) measure underwriter quality as the underwriter's percentage of market share in terms of dollar values in the respective year of the IPO. They observe that IPOs with reputable underwriters experience somewhat more negative CARs with marginal significance. However, they also report that the significance of the underwriter quality effect is highly sensitive to the applied event window.

Dong, Michel, and Pandes (2011) analyse the relationship between the quality of underwriters and the long-run performance of IPOs. They define three underwriter functions that may improve firms' long-run performance, namely 1) marketing, 2) certification and screening, and 3) information production. This

relationship is found to be positive and is especially strong among IPOs with a high degree of uncertainty. If one were to apply this logic to the context of lockup expirations (*thus assuming compatibility with a short- to medium-term outlook*), a similar positive relationship could be hypothesised. Therefore, reduced uncertainty as a result of high underwriter quality would optimise investors' predictions and thus yield less severe price reaction at expiration date.

Conclusively, we expect that underwriter quality is associated with a binding signal that reduces information asymmetry and uncertainty that prevails leading up to lockup expirations. However, we are also aware of the empirical evidence that counterpose this argument. Nevertheless, we present the following hypothesis:

***Hypothesis 3B**: We expect that underwriter reputation has a positive relationship with cumulative abnormal return at lockup expiration*

3.7 Hypothesis 4A: Lockup period volatility

One may pose that the negative price reaction at lockup expiration stems from outside investors underestimating the degree to which insiders desire to dispose of their shares due to diversification needs (Ofek and Richardson, 2000). One can exemplify such a scenario with stocks that have a high degree of volatility in their underlying price. Under such a scenario, insiders bear greater asset risk since their holdings possess substantial portfolio risk. It is thus believed that price volatility functions as a vital proxy for the need of insiders to diversify their asset risk. In line with this logic, Ofek and Richardson (2000) argue that the magnitude of the abnormally negative price reaction at lockup expiration is expected to be directly related to the stock's underlying volatility, as investors underestimate the degree of share disposals at lockup expiration that are motivated by diversification needs.

Brav and Gompers (2003) add to this logic that the abnormally negative price reaction at lockup expiration depends on the degree to which a firm is informationally transparent. Here, they argue that the abnormal price reaction should be more pronounced for firms that have a greater prevalence of information asymmetry (*which is proxied by higher price volatility*). This view suggests that price volatility not only leads to a greater amount of share disposals that are motivated by diversification needs, but also represents the uncertainty that originates from informational misalignment between insiders and outside investors. When a great extent of information asymmetry prevails, investors become uncertain of the quality of the information that is known by insiders. Hence outside investors face a higher degree of uncertainty regarding share disposals at lockup expiration, as such disposals not only may be motivated by diversification needs but also by exploitation of an informational misalignment. Therefore, the price reaction at lockup expiration will be abnormally negative for stocks with high volatility.

Additionally, one can assert great importance to overconfident trading and short-selling constraints when discussing the implications of stock price volatility in a lockup setting (Doran, Jiang, and Peterson, 2014). Speculative price bubbles are believed to be accompanied by large trading volume and high price volatility (Scheinkman and Xiong, 2003), where overconfident investors engage in active trading activity and conservative investors remain passive due to short-selling restrictions. The heterogeneous beliefs of optimistic investors consequently generate fluctuations in the valuation of the firm, and due to the lack of counteracting short-selling transactions, one will observe an induced level of stock price volatility (Doran *et al.*, 2014).

To elaborate on this view, consider a simplified example where two groups of investors possess the same beliefs and each hold 50% of the free float shares for a given stock. Subsequently, if one group's valuation of the stock increases due to overconfidence, it will purchase all the opposing group's shares. In the scenario where the overconfident group of investors attains all the free float shares, the stock price will solely depend on that group's beliefs. In contrast, if both groups remain in the market and each hold 50% of the free float shares, the stock price would depend on the average of the groups' beliefs. Hence, the variance of the average valuations between the two groups will be lower than the variance of only the overconfident group's beliefs. In this manner, the pervasiveness of overconfidence and short-selling restrictions (*e.g. lockup provisions*), will lead to an induced level of volatility (Hong *et al.*, 2005).

The joint impact of investor overconfidence and short-selling restrictions is thus expected to cause a more negative price reaction at lockup expiration, as less optimistic investors can counteract the predominant degree of overconfidence when short-selling restrictions are relaxed (Doran *et al.*, 2014). Hong *et al.* (2005) support this notion, as they emphasize that return volatility is tied to the magnitude of speculative trading. If volatility-overpricing is driven by overconfident beliefs, one will expect highly volatile stocks to have larger price reductions at lockup expiration.

The results of Ofek and Richardson (2000) show that high-volatility stocks experience significantly abnormal price declines at lockup expiration, thus implying an unexpected degree of share disposals. On average, it is found that an increase of one standard deviation in volatility leads to an added impact of -1.02% on CAR[14]. Furthermore, they find the daily average volatility for the stocks in the sample to be 4%, which converts into 60% on an annual basis. It is thus inferred that if such stocks are focal to an investor's portfolio at the time of lockup expiration, one will expect large sell-downs that are driven by the motivation of diversification (Ofek and Richardson, 2000).

Brav and Gompers (2003) also find significant evidence of the negative relationship between volatility and abnormal returns at lockup expiration. They observe that a negative coefficient is consistent with the notion that opaqueness (*proxied by high volatility*) is associated with a more negative price reaction at lockup

[14] This is found when applying a 2-day event window (-1, 0)

expiration. Based on a sample of 1,818 US IPOs during the period from 1988 to 1996, their results indicate that (*on average*) an increase of one standard deviation in volatility will lead to an added impact of -0.3% on CAR[15]. This result is highly significant and is deemed to become even more robust when simplifying the model to only account for other variables with significant coefficients. These findings are mainly attributed to the effect of a low degree of transparency (*i.e. high information asymmetry*) where the limiting nature of short-selling restrictions functions as a fundamentally influencing factor (Brav and Gompers, 2003).

An alternative approach for investigating volatility in a lockup context is employed by Doran *et al.* (2014), who conduct natural experiments that involve shocks to short-selling constraints, where one of the experiments investigates the expiration of lockup provisions[16]. They assert great importance to the nature of a lockup provision since its expiration 1) enables a potential increase in the number of free float shares, 2) relaxes previous selling constraints, and 3) provides lendable shares to short-selling investors (Ofek and Richardson, 2000; Duffie, Gârleanu, and Pedersen, 2002). The core findings of Doran *et al.* (2014) comply with their theoretically hypothesized condition, where overconfident beliefs function as a fundamental driver for price volatility. Furthermore, they conclude that their predictions would not hold if the high-volatility stocks were not subject to compulsory short-selling constraints, as counteracting trading activity would eradicate stock price abnormalities. Hence, the prevalence of overconfidence and short-selling constraints become vital drivers for the negative relationship between volatility and abnormal returns at lockup expiration.

Due to the significant evidence from previous research on price volatility in a lockup context, we find it highly relevant to investigate the impact of stock price volatility on abnormal returns at lockup expiration. The hypothesis on price volatility has therefore been constructed as following:

***Hypothesis 4A**: We expect that lockup period volatility has a negative relationship with cumulative abnormal return at lockup expiration*

3.8 Hypothesis 4B: Early insider trading

Although the IPO prospectus specifies the expiration date of the lockup, the underlying restriction can be waived, cancelled or modified at the discretion of the underwriter, which implies that insiders may be subject to an early release from the lockup (Patel, 2018).

For example, Carnegie Investment Bank was the Joint Global Coordinator for the IPO of Orphazyme A/S in November 2017. The company was initially subject to a 180-day lockup where they subsequently got an early

[15] This is found when applying a 5-day event window (-2, +2)
[16] Besides lockup expirations, Doran *et al.* (2014) also consider the introduction of tradable options and explicit bans on short sales of financial firms in the fall of 2008

release from a smaller portion of their shares. Sebastian Hougaard, who was one of Managing Directors from Carnegie Investment Bank that were involved with this IPO, states the following about the early release:

> "*This is an agreement done with the banks and you can't be released from it reactively. […] We did do a small release form the lockup for Orphazyme […] in order to pay part of an agreement they had with their partners. But they were actually prohibited from honouring their obligation because of the lockup. It was fairly easy to give, but nevertheless they formally had to ask us and ask to be released for that small amount of shares. But you can be released*." (Hougaard, 2018, p. 1)

> "*Does it make commercial sense, also for the market to digest? […] it is a way to tell investors that at least the banks will assure that there will only be sell downs or new issues if there is a good reason to do so*" (Hougaard, 2018, p. 2)

Thus, underwriters may grant early releases from lockups, if there is a financially and strategically viable reason to do so.

The findings by Brav and Gompers (2003) concur with Sebastian Hougaard's statement. They argue that underwriters will only release insiders from lockups prematurely if this is in the best interest of the company and its stakeholders. In their sample, the authors observe that 15% of the firms had insider sales prior to lockup expiration. In addition, they note that the magnitude of the sales is relatively small, as the median percentage of early disposals relative to the number of shares locked up was only 0.8%.

When examining a sample of 201 UK IPOs in the period from 1999 to 2014, Ahmad, Aussenegg and Jelic (2017) investigate director and VC firm insider trades leading up to lockup expiration. Here they argue that early disposals by insiders should neither be interpreted as a lack of commitment nor an indication of unfavourable prospects, thus conveying a negative signal to outside investors. Conversely, early insider purchasing should be interpreted as a signal of faith in the firm and thus convey a positive signal to outside investors (Ahmad *et al.*, 2017).

Alternatively, the empirical results from Ahmad *et al.* (2017) imply that insiders optimise their timing when selling shares prior the lockup expiration. Here, insiders are proved to purchase (*sell*) after statistically significantly negative (*positive*) abnormal returns. Hoque and Lasfer (2009) also report that early sales (*purchases*) occur after a preceding positive (*negative*) price sentiment in the market. In their sample, they observe that 14% of the lockups had early sales and 31% had early purchases. The sales are found to generate significantly negative abnormal returns on the announcement day as well during the subsequent trading period. In contrast, the purchases are observed to generate significantly positive abnormal returns, however, only on the specific announcement date. Hence, the negative price reaction of early sales seems to persist whereas the information content of the purchases is relatively short-lived. The authors suggest that further research should

investigate further into these implications and therefore we assert great importance in incorporating early insider trading in our analysis of abnormal returns at lockup expiration.

There is a very limited degree of empirical evidence that investigates the impact of early insider trading on abnormal returns at lockup expiration. It is possible that early insider trading conveys credible signals of a firm's true quality, however, it may also be the case that insider expropriate wealth from outside investors by timing their permission to be released early from a lockup. Although empirical results have not established a clear relationship between early insider trading and abnormal returns at lockup expiration, we assert that the signals of the early releases will persist in the market and thus act as an indicator of how the price reaction will transpire at lockup expiration. Therefore, we construct the following hypothesis:

***Hypothesis 4B**: We expect that early insider purchasing (selling) during the lockup period has a positive (negative) relationship with cumulative abnormal return at lockup expiration*

3.9 Hypothesis 4C: Lockup period price ramp

Since investors cannot predict the degree of share disposals at lockup expiration with complete certainty, we have thus far considered the "informative selling hypothesis" and the "portfolio diversification hypothesis" in various settings to assess specific characteristics that impact investors' motivation for selling shares at lockup expiration. Another possible theory to explain the selling behaviour of insiders is the "disposition effect" (Chen *et al.*, 2012). This concept was originally popularized by Shefrin and Statman (1985) who elaborated upon the implications from the theoretical outlook of Kahneman and Tversky (1979). The disposition effect claims that investors tend to realize successful investments too quickly and keep unsuccessful investments in their portfolio for too long (Chen *et al.*, 2012).

In a lockup context, this logic suggests that firms with a positive price ramp prior to lockup expiration will experience a high degree of share disposals by insiders when their lockups expire. A price ramp[17] reflects a series of consecutive price movements in the same direction and is often analysed to infer the momentum of stock price movements. Hence, the greater the momentum (*i.e. larger price run-up*) the more likely it is that insiders will dispose of their shares at lockup expiration.

Due to this increased probability of insider selling at lockup expiration, it becomes vital to consider how the stock price will react according to investor beliefs. The study of Chen *et al.* (2012) proves that insiders are more likely to be net sellers at lockup expiration when the stock price has undergone a large price run-up during the 30 trading days prior to expiration. One can argue that consecutive increases in a stock price may

[17] A positive ramp will also be referred to as a price run-up or a positive price-run. Hence, a negative price ramp is also referred to as a price run-down or a negative price-run.

overweigh investors' portfolios in favour of the stock, thus providing a selling-incentive to rebalance their portfolio. It can therefore be suggested that the disposition effect is comparable to the implications from the portfolio diversification hypothesis. Ofek and Richardson (2000) also attribute price run-up to the portfolio diversification hypothesis, as they argue that a large price run-up will make investors reconsider their portfolio composition and diversification needs. Furthermore, this is also observed by Ahmad *et al.* (2017) when assessing the UK market, where they conclude that insiders (*and more specifically, directors*) follow a contrarian strategy by selling their shares after a significant increase in share price.

Field and Hanka (2001) incorporate a variable for a stock's price run-up in their analysis on abnormal returns at lockup expiration. They hypothesize that investors are more eager to sell their shares when the stock price has risen over a long period of time. However, they do not find the run-up to be a significant predictor of abnormal returns, thus implying that share disposals will not be unexpected.

However, this may also be due to the fact that the authors attribute the price run-up to two opposing effects. Firstly, they emphasize that investors' willingness to perform a share sell-down may stem from overconfident intentions to profit off momentum. In line with the theory on overconfidence (Chen *et al.*, 2002; Kahl *et al.*, 2003; Doran *et al.*, 2014), this suggests a greater propensity for unexpected share disposals and thus an abnormally negative price reaction at lockup expiration. Secondly, Field and Hanka (2001) assume that positive price-runs reflect a firm's high quality. From an investor perspective, this notion implies a diminishing magnitude of the potential supply shock and informational asymmetry that can prevail at the actual lockup expiration, thus suggesting a less negative price reaction.

Furthermore, this view can be extended by the concept of information momentum, where stocks with large price run-ups will attract more investor attention, which implies that investors will have a greater likelihood of determining the firm's true value (Haggard and Xi, 2017). Hence, a potentially lower magnitude of share disposals and a greater likelihood of value realization will cause an absence of abnormal price reactions at lockup expiration.

Positive price-runs can also be related to overvalued stocks for which it is argued that IPOs cannot sustain an inflated value over a longer period. The share prices of such stocks must therefore conform to their true value in the IPO aftermarket. Haggard and Xi (2017) emphasize that the duration of a typical lockup is a reasonable period for such value realization to take place. Consequently, if a stock's price run-up proxies the degree of investors' price realization, one would expect less likelihood of abnormal price reactions at lockup expiration (*ceteris paribus*)[18].

When testing their hypotheses empirically, Haggard and Xi (2017) observe that larger price run-ups prior to the event window are significantly associated with a more negative CAR at lockup expiration. This result is

[18] Assuming that IPOs are (*on average*) priced at their fair value.

based on 3,328 US IPOs during the period from 1993 to 2014. Due to this significantly negative relationship, Haggard and Xi (2017) revisit their hypothesized outcome that large price run-ups imply a greater extent of value realization among investors, thus a diminishing likelihood of abnormal price reactions at lockup expiration. This initial hypothesis assumes that IPOs are on average priced at their fair value. Hence, although some stocks will be deemed either over- or undervalued, the overall effect of value realization will on average suggest an absence of abnormal price reactions. Instead, when revisiting this initial hypothesis, they conclusively refer to Purnanandam and Swaminathan (2004) who prove that median IPOs are overvalued when comparing to industry peers. Substantiated by this finding, Haggard and Xi (2017) suppose that when stocks with large price run-ups attract investors' attention, there will be a greater likelihood of investors determining that such stocks in fact are overvalued. When restrictions are relaxed at lockup expiration, the authors therefore suppose that stocks with large price run-ups are more likely to unexpectedly be identified as overvalued, which would be proven by a more negative price reaction at lockup expiration (*ceteris paribus*)[19].

Although Haggard and Xi (2017) find empirical evidence of a significantly negative relationship between price run-up and CAR at lockup expiration, we acknowledge that a substantial body of previous research argues in favour of a or positive relationship between the two variables. We assert great importance in assessing the impact that stock price run-up has on abnormal returns at lockup expiration. We have constructed the price-run hypothesis as following:

***Hypothesis 4C**: We expect that a positive price ramp during the lockup period has a positive relationship with cumulative abnormal return at lockup expiration*

4 Methodology

In the following section, we will outline the methods that have been applied throughout the course of this thesis. Firstly, the overarching research philosophy and the appertaining research approach are explained and put into the context of the research objective. Secondly, the sample selection and data collection procedures are briefly outlined. Thirdly, the event study approach is determined for analysing abnormal returns in conjunction with Hypothesis 1. Lastly, the construction of variables for the cross-sectional analysis is described and subsequently followed by a walkthrough of the statistical framework for the cross-sectional analysis.

[19] This conclusive inference of Haggard and Xi (2017) assumes that the median IPO is overvalued (Purnanandam and Swaminathan, 2014). It is thus suggested for further research to investigate whether this notion holds on average.

4.1 Research philosophy and approach

The following section will firstly present and explain the overarching research philosophy and the accompanying beliefs and assumptions that guide this research. It will elaborate upon the chosen philosophy's impact on ontology, axiology, as well as the research approach applied throughout the thesis.

The overall philosophy guiding our research is pragmatism which entails that theoretical concepts and empirical findings are applied to explain the implications of the expiration of lockups. Pragmatism "*recognise[s] that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities*" (Saunders, Lewis, and Thornhill, 2012, p. 144).

This integrative perspective is first and foremost apparent in the ontological view of the research. Ontology concerns the nature of reality and is associated with a central question of whether social entities need to be perceived objectively or subjectively (Bryman, 2012). We draw on both aspects of ontology: we acknowledge that certain features of the equity markets, such as institutional structures and free market mechanisms, are neither subject to interpretation nor dependent on the social actors within them. However, we argue that many of the aspects considered and the effects observed are social constructs dependent on the actions and perceptions of the various agents (*e.g. insiders, outside investors, underwriters*) involved in the IPO and subsequent aftermarket trading. Moreover, the analysis and interpretation of objective and quantitative market data also involve subjective decision making. An example is the argumentation behind the event window chosen for our event study and for previous event studies conducted in the research field. The observed abnormal returns and the inference concerning the efficiency of financial markets are highly sensitive to the method applied and thus becomes a social phenomenon dependent on the researcher itself.

The choice of pragmatism also impacts the axiology and research approach of this thesis. Axiology is concerned with the assessment of the researcher's values and the role they have in the research process (Saunders *et al.*, 2012). We both try to understand the underlying mechanisms of general efficiency in financial markets as well as try to explain a modern finance conundrum that is the occurrence of abnormal returns in efficient markets. We follow an abductive research approach which combines deductive and inductive reasoning to optimise our inferences. Our hypotheses have their outset in existing literature and theory, and are complemented with practical notions from our interviews and own logical reasoning. Thus, the outcome of our analysis may either be conclusive or help to develop a new understanding of the underlying market structures of lockup expirations. Our empirical results are subject to interpretation and can either confirm or reject our beliefs about the underlying mechanisms. If these beliefs are rejected, we seek to heighten our understanding of the underlying mechanisms, thereby providing inductive reasoning for our conclusions.

4.2 Sample selection and data collection

The sample for our study consists of Nordic IPOs that have taken place on Nasdaq OMX Nordic[20], Oslo Stock Exchange, and First North since January 2009. The time-period commences in 2009 to avoid any disturbances that may have occurred as a result of the financial crisis in the years prior to 2009. Initially, a complete overview of Nordic IPOs in the selected time-period is constructed with secondary data from Thomson One and Mergermarket. Both sources provide lockup-specific information for all IPOs, however, in order to triangulate the data and thereby assure the highest possible accuracy in the final sample, it has been deemed necessary to also hand-collect prospectuses for all IPOs.

The prospectuses are collected from company websites and press releases, as well as from prospectus-databases that are provided by each country's financial supervisory authority[21]. A total of 405 prospectuses are collected, of which certain IPOs have been excluded as they do not include lockups. Furthermore, after thorough assessment, we have also excluded IPOs either due to active lockups[22], inaccessible data, or distortive instances such as bankruptcies and takeovers. Consequently, the final sample consists of 141 IPOs.

Data on historical stock prices[23], trading volume, and bid-ask spreads is collected from S&P Capital IQ. The most liquid share class is used in cases where a firm has several share classes, as we assume that this ensures the most optimal reflection of the market's reaction. Furthermore, we have collected data on insider trading from FactSet. Alternatively, one could have attained insider trading data by contacting the financial supervisory authority of each country, however, FactSet is deemed to be the most optimal source as it provides a comprehensive and streamlined dataset.

4.3 Event study approach

An event study is a statistical method in empirical finance for assessing the impact of a particular event on the value of a firm (Bodie, Kane and Marcus, 2014). Assuming rationality in the market, an event will immediately be reflected in the share price of a firm (MacKinlay, 1997; Campbell, Lo, and MacKinlay, 1997). In the context of this thesis, the event study approach is suitable for investigating how the market reacts to the expiration of a lockup, and thereby if any abnormal returns can be observed. Since the expiration of a lockup provision is public information (*which can be attained from the IPO prospectus*), we will assume that the semi-strong form of the EMH is applicable. As emphasized by Fama (1991), the event study approach is optimal for testing the semi-strong form of the EMH.

[20] OMX Stockholm, OMX Copenhagen, OMX Helsinki and OMX Iceland
[21] Finanstilsynet (DK), Finansinspektionen (SE), Finanstilsynet (NO), Finanssivalvonta (FI), Fjármálaeftirlitid (IS)
[22] Lockups that are yet to expire, as of 22 March 2018
[23] Adjusted closing prices that account for dividends and stock-splits

The event study approach has been used by several notable contributors within the field of research on abnormal returns at lockup expiration (Bradley *et al.*, 2001; Espenlaub *et al.*, 2001; Field and Hanka, 2001; Brav and Gompers, 2003). It is thereby possible for us to discuss our findings while comparing them to existing research.

4.3.1 Defining an event and the event window

In this study, the event of interest is the expiration date of a lockup provision after a firm has gone public. It is common for IPOs to include multiple lockups with different durations, also known as "staggered lockups". This was evident in the TCM case, where the selling shareholder is locked up for 180 calendar days, whereas management and the board are locked up for 360 calendar days. For IPOs that have staggered lockups, we have used the lockup with earliest expiration for the analysis. This method was also used by Espenlaub *et al.* (2001) and is deemed to be the most optimal, since it typically is the earliest lockup in which the largest quantity of shares is restricted.

Event studies often include adjacent trading days surrounding the event in order to capture its full potential impact. This can for example be due to information leakage or other informative signals that cause untimely market reactions (MacKinlay, 1997). Therefore, instead of assessing only one date, the event study considers several trading days known as the "event window". However, there is not used a common fixed event window across the existing field of research. Field and Hanka (2001) used a 3-day window, beginning 1 trading day before the event and ending 1 trading day after (-1, +1), as well as a 7-day window (-5, +1). Arthurs *et al.* (2014) also used a 7-day window, although with a symmetric selection of trading days (-3, +3). This symmetric approach for selecting days for the event window is rather common for event studies within the field of research on lockups. Bradley *et al.* (2001) constructed event windows of (-1, +1) and (-2, +2), whereas Brav and Gompers (2003) and Brau *et al.* (2004) used an event window of (-10, +10). It is important to note that shorter event windows are recommended when the event itself is easy to determine, as it will ensure optimal representation of any potential abnormal returns (Armitage, 1995). This was duly noted by Brav and Gompers (2003) as they observed that the largest abnormal returns take place within a sub-window of (-1, +2) in their overall window of (-10, +10). Espenlaub *et al.* (2001) also addressed this issue, as they applied several symmetric windows of 1, 3, and 11 trading days. In line with the approach of Bradley *et al.* (2001), we will apply a 5-day event window of (-2, +2) for the event study, which is supported by the recommendations of Armitage (1995) and MacKinlay (1997).

4.3.2 Estimation window

When assessing whether the return of a stock is abnormal, one must compare the actual return with an expected return, which is predicted by a market model. Before setting up the market model, it is necessary to construct an "estimation window", with which one can predict how the share price should have progressed without the prevalence of an event. Therefore, the estimation window shall not include the event itself. Widely different estimation windows have previously been used within the field of research. Bradley *et al.* (2001) used a window of (-80, -10), Brau *et al.* (2004) used (-90, -11), whereas other studies suggest larger windows of more than 100 trading days (Armitage, 1995; MacKinlay, 1997; Field and Hanka, 2001).

In order to prevent any overlap between the event window and estimation window, the last day of estimation is set to 5 trading days before the event. Since the shortest lockup duration in our sample is 90 calendar days, we will commence the estimation window 60 trading days before the event[24], to assure a sufficient selection of trading days regardless of timing within the calendar year. Hence, we will apply an estimation window of 56 trading days (-60, -5). This is comparable to the estimation windows that are used by Bradley *et al.* (2001) and Brau *et al.* (2004). The 56-day estimation window is deemed sufficient to attain a robust estimate, while acknowledging that a longer window would improve upon the precision of one's estimates. This dilemma of not constructing longer estimation windows due to the prevalence of short lockup durations has also been discussed in previous research (Bradley *et al.*, 2001; Field and Hanka, 2001; Brau *et al.*, 2004).

4.3.3 Market model and abnormal return

Our event study employs a market model for estimating the expected return for a stock within the event window. There are different approaches for calculating the expected return, with the most common methods being the market model and constant mean model (MacKinlay, 1997). The constant mean model incorporates the assumption that a stock's mean return is constant over time, whereas the market model assumes the relationship between stock return and market return to be linear. In line with Brown and Warner (1985) and MacKinlay (1997), we recommend using the market model, as it accounts for systematic risk that stems from variance in the market return.

[24] Due to timing within the calendar year, there exists some variation in the number of available trading days among the stocks with lockup durations of 90 calendar days. To ensure adequate matching of trading days, we suggest that one converts the 90 calendar days to a maximum of 60 trading days.

The market model is expressed as following:

$$E[R_{i,t}] = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (1)$$

The return for stock "i" on trading day "t" ($R_{i,t}$), is expressed by the idiosyncratic risk of stock "i" (α_i), the systematic risk of stock "i" (β_i), the return of the market on trading day "t" ($R_{m,t}$), and an error term ($\varepsilon_{i,t}$) that is normally distributed with a mean of 0.

We estimate beta for each firm by regressing its daily returns with a value-weighted index that represents the stock's respective market within the Nordics[25]. The market model is applied in the estimation window (-60, -5) for each stock, from which we attain estimates of alpha (α_i) and beta (β_i). These are assumed to be constant during the event window when calculating the abnormal return.

The formula for abnormal return (AR) is expressed as following:

$$AR_{i,t} = R_{i,t} - E[R_{i,t}] = R_{i,t} - (\alpha_i + \beta_i R_{m,t}) \quad (2)$$

The abnormal return for stock "i" on trading day "t" ($AR_{i,t}$) is found by subtracting the expected return for stock "i" on trading day "t" ($\alpha_i + \beta_i R_{m,t}$) from the actual return for stock "i" on trading day "t" ($R_{i,t}$). The abnormal return is calculated for each trading day in the event window.

Next, we calculate the daily average abnormal return (AAR):

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \quad (3)$$

For calculating the average abnormal return, all abnormal returns ($AR_{i,t}$) are summated and divided by the number of observations (N). With this measure, one can observe the abnormal returns on average for each trading day in the event window.

Since the event window includes several days, one must also calculate the cumulative abnormal return (CAR) for each stock:

$$CAR_{i,\tau1,\tau2} = \sum_{t=\tau1}^{\tau2} AR_{i,t} \quad (4)$$

Here, the CAR for stock "i" ($CAR_{i,\tau1,\tau2}$) is found by aggregating the abnormal returns of stock "i" from each day of the event window, which begins at trading day $\tau1$ ($t = -2$) and ends at trading day $\tau2$ ($t = +2$). This measure shows the total sum of a given stock's abnormal returns in the entire event window.

[25] We thereby use the OMX Copenhagen Index (OMXC), OMX Stockholm Index (OMXS), OMX Helsinki Index (OMXH), OMX Iceland Index (OMXI) and Oslo Exchange Index (OSEAX) for firms that are listed in Denmark, Sweden, Finland, Iceland and Norway, respectively

Lastly, we calculate the average cumulative abnormal return (ACAR):

$$ACAR_{\tau1,\tau2} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i,\tau1,\tau2} \qquad (5)$$

The ACAR is calculated similarly to the average abnormal return, however, we now average the CAR for all stocks. This entails a measure that is neither specific to a given trading day within the event window nor a given stock in the sample.

4.4 Expiration date analysis and variables

We have constructed additional expiration date variables to complement our findings on CAR from the event study. This will allow us to put our main findings into perspective and substantiate an adequate discussion on policy implications. We have established expiration date variables on 1) abnormal volume and 2) bid-ask spreads.

4.4.1 Abnormal volume

For analysing the abnormal volume at lockup expiration, we will conduct an event study that is similar to the approach for abnormal return. We therefore apply the same event window (-2, +2) and estimation window (-60, -5). However, a constant mean model is now employed (*as opposed to a market model*) for calculating the expected trading volume, which is in with the methodology of Field and Hanka (2001).

For each firm in the sample, we calculate the average daily trading volume in the estimation window and apply it when estimating the abnormal trading volume in the event window. The abnormal volume is calculated as following:

$$AV_{i,t} = \frac{V_{i,t}}{V_i} - 1 \qquad (6)$$

The abnormal trading volume of stock "i" for each trading day "t" ($AV_{i,t}$) is based on the actual trading volume for stock "i" on trading day "t" in the event window ($V_{i,t}$) and the expected daily trading volume for stock "i" from the constant mean model (V_i).

Once the abnormal trading volume of stock "i" is calculated for each trading day in the event window, we estimate its average abnormal trading volume for the entire event window:

$$AAV_{i,\tau1,\tau2} = \frac{1}{\tau2 - \tau1 + 1}\sum_{t=\tau1}^{\tau2} AV_{i,t} \qquad (7)$$

The average abnormal volume of stock "i" is based on the entire event window, which lasts from trading day $\tau 1$ (-2) through trading day $\tau 2$ (+2). We calculate the sum of daily abnormal trading volumes for stock "i" ($AV_{i,t}$) and divide it by the number of trading days in the event window.

4.4.2 Transaction costs

In addition to abnormal volume, we will also investigate the ability of outside investors to profit from a potential abnormal return at lockup expiration. Pontiff (1996) argues that costly arbitrage might prevent investors from making investments that otherwise would correct the temporary mispricing of a given stock. In line with previous research (Ofek and Richardson, 2000; Brav and Gompers, 2003), we will consider the average transaction cost for a stock during the event window (-2, +2):

$$Transaction\ cost\ (\%) = \frac{1}{\tau 2 - \tau 1 + 1} \sum_{t=\tau 1}^{\tau 2} \frac{P_{ask,i,t} - P_{bid,i,t}}{P_{bid,i,t}} \qquad (8)$$

The average transaction cost is based on each day in the estimation window and is calculated as the bid-ask spread for stock "i" relative to its bid price.

4.5 Data selection for cross-sectional hypotheses

In the following, we intend to explain how we have constructed independent variables to represent the hypotheses for the cross-sectional analysis. The hypotheses represent three distinct themes to set the scope for our analysis, namely 1) lockup characteristics, 2) IPO characteristics, and 3) lockup period characteristics. When combined, these will ensure an adequate assessment of the variation in the dependent variable, namely the CAR.

4.5.1 Independent variables on lockup characteristics

Hypothesis 2A addresses the lockup duration for each IPO in the sample. Bradley *et al.* (2001) and Field and Hanka (2001) treat this variable by grouping their observations according to lockup durations that are either less than (*or equal to*) 180 calendar days, or longer than 180 calendar days. Due to the more heterogeneous nature of Nordic lockups, we assume that Nordic lockup durations may deviate from the standardized structure of either 180 or 360 days. Therefore, to capture the full effect of this potential variation, we suggest a discrete measurement of calendar days as the best suited approach for lockup duration.

Hypothesis 2B concerns the portion of locked up shares at the time of IPO. To establish a variable that is comparable among all firms, we use a relative measurement of locked up shares as a percentage of total shares offered to the public in connection with the IPO (*i.e. the "free-float"*). The free-float represents the sum of newly issued shares and existing shares offered. We exclude the impact of whether an over-allotment option is fully or partly exercised, as this potential effect concerns the post-IPO period and is not known for certain at the time of IPO.

Hypothesis 2C considers whether a lockup provision restricts a PEVC-shareholder. We employ a dummy variable to distinguish between PEVC-restrictive lockups and those that do not restrict PEVC-shareholders, by assigning the value of 1 to the former and 0 to the latter. This approach is in line with that of Brau *et al.* (2004), Field and Hanka (2001) and Hoque (2011). We have not distinguished between PE- and VC-shareholders since there exists no common definition for the specific stages of financing. This logic is emphasized by BVCA and PWC (2014), with the focal notion being that venture capital itself can be an investment strategy within the scope of PE. Furthermore, we are aware that PEVC-restrictive lockups may also include other shareholders that are non-PEVC. Such instances can potentially induce ambiguous effects, however, it cannot be avoided due to the fundamental structure of the lockup. We will return to this issue when discussing the output of the analysis.

4.5.2 Independent variables on IPO characteristics

Hypothesis 3A concerns the first-day return of an IPO, for which there exist varying approaches for constructing an optimal measurement. A noteworthy methodology is employed by Tolia and Yip (2003) who apply the concept of "Hot vs. Cold" IPOs, where an IPO is defined as either "Cold", "Cool", "Hot" or "Extra Hot", dependent on the magnitude of its first-day return. However, the bounds in the "Hot vs. Cold" approach are determined subjectively and do not follow a common framework. Therefore, we will disregard the categorical variable framework of Tolia and Yip (2003), and instead construct the variable as a realized percentage return. This return will be based on the adjusted closing price on the first trading day relative to the offer price, for which we collect data from S&P Capital IQ.

Hypothesis 3B addresses the role of underwriter reputation. There is no common method for measuring the reputation of an underwriter, as it can be based on different characteristics such as size, regional focus, or experience (*either in terms of volume or value*). Yung and Zender (2010) based their assessment of underwriter reputation on a publication by Carter and Manaster (1990), in which they rank highly reputable underwriters as those with low variation in type of issued firms. In line with Yung and Zender (2010), we will also measure underwriter reputation according to rankings. However, we will instead base our rankings on value, in order to reflect each underwriter's overall involvement with IPOs. These rankings are collected as league tables from

Thomson One's database and are based on total IPO proceeds, with full credit to each underwriter (*see Appendix 1 for league table criteria*). For each year in the sample period, the highest ranked underwriter will be assigned a value of 1, the second ranked underwriter will be assigned a value of 2, and so forth. Underwriters that are not in the top-25 league table for a given year are assigned a value of 26. We will apply rolling calendar-year windows and consider an underwriter's rank value from the year prior to the IPO, so it reflects the concurrent market sentiment. Furthermore, if multiple underwriters are affiliated with an IPO, we will consider the average rank of all involved underwriters. In this manner, an IPO with multiple high-ranked underwriters will be better positioned than those that include less reputable underwriters.

4.5.3 Independent variables on lockup period characteristics

For the independent variables on lockup period characteristics, we shift focus to the post-IPO period up until lockup expiration (*i.e. the lockup period*).

Hypothesis 4A considers the volatility of each stock price during the lockup period. For this variable, Doran *et al.* (2014) constructed an estimate based on idiosyncratic volatility, defined as the standard deviation of a stock's daily residual returns according to the Fama and French three-factor model (Fama and French, 1993). However, we suggest that one extends this measurement to also include the systematic risk for a stock. This ensures representation of the total uncertainty that is related to both firm-specific risk and overall market uncertainty for a given period. The independent variable on volatility is therefore defined as the standard deviation of a stock price within the estimation window (-60, -5). By using the defined estimation window, one ensures complete comparability with CAR, which is based on beta- and alpha-estimates for the same estimation window. Our approach for measuring volatility is in line with the methodology of Harper, Johnston, and Madura (2005) and Nowak (2015) and is based on stock prices that are attained from S&P Capital IQ.

Hypothesis 4B addresses purchases and sales made by insiders prior to lockup expiration. As previously mentioned, we have collected data from FactSet as it has been deemed the most comprehensive and streamlined provider of such information. The data represents the total insider position at the end of each month. The measurement of lockup period insider trading is thus constructed by the percentage change from the first end-of-month insider position post-IPO, to the last end-of-month insider position before lockup expiration[26]. Our estimate of insider trades includes all registered insiders (*i.e. also those that are not restricted by a specific lockup provision*), as the focal notion is that any insider trades prior to lockup expiration provides signals to the market regarding the true value of the firm.

[26] Due to data availability, this measurement has not been based on the estimation window.

Lastly, Hypothesis 4C concerns a stock's price-run leading up to lockup expiration. Since a price-run reflects a series of consecutive price movements in the same direction, we construct this variable by calculating a stock's cumulative daily stock return during the estimation window (-60, -5). For example, a hypothetical stock price that increases by equal increments from 10 ($t = -60$) to 20 ($t = -6$), and then drops to 10 on the final day in the estimation window ($t = -5$), would yield an actual return of 0% and a cumulative return of approx. 20%. Hence, the cumulative return allows us to account for series of consecutive price movements and thereby attain an optimal representation of a stock's price-run.

4.6 Control variables

Apart from the independent variables that have been established to signify our cross-sectional hypotheses, our analysis will also include control variables that potentially have an impact on the CAR at lockup expiration. We acknowledge that one can account for the potential influence of countless factors, however, in the following we consider those that have been deemed most influential by the existing field of research on lockups (Ofek and Richardson, 2000; Espenlaub *et al.*, 2001; Field and Hanka, 2001; Brav and Gompers, 2003).

Size

We expect larger firms to possess a greater propensity to provide information to the public. Since a high degree of transparency will have the causal effect of reducing information asymmetry and price uncertainty (Brau *et al.*, 2004), we expect firm size to have an impact on abnormal return at lockup expiration. To account for size in the analysis, we will consider a firm's market capitalisation (*in terms of EURm*) at the time of its IPO. This approach is in line with the methodology of Brav and Gompers (2003).

Market-to-book ratio

In addition to firm size, we also control for whether the growth opportunities of a firm affect the abnormal return at lockup expiration. To measure such growth opportunities, Brav and Gompers (2003) apply a book-to-market ratio, where the book value of a firm's equity is considered in relation to the price that market participants are willing to pay. Brav and Gompers (2003) emphasize that firms with low book-to-market ratios are generally associated with a high degree of risk and growth opportunities. In line with this notion, we will apply an inverse measurement (*i.e. market-to-book ratio*) at the time of each IPO. Firms with higher market-to-book ratios are thereby associated with a greater extent of growth opportunities.

Inverted offer price

Low-priced stocks have previously been proven to represent firms with higher uncertainty (Beatty and Ritter, 1986; Tinic, 1988). In line with this logic, the offering price of a stock will indicate the degree of *ex ante* uncertainty for a given IPO. In line with Brau *et al.* (2004), we will consider the inverted offer price of an IPO as an indication of such uncertainty. We therefore expect that a higher inverted offer price will have a negative influence on the abnormal return at lockup expiration.

Fixed effects

To eliminate potential fixed effects that are related to the year in which a lockup expires, we will construct a categorical year variable. Lockups that expire in 2010 are assigned a value of 0, those that expire in 2011 are assigned a value of 1, and so forth. This methodology allows us to account for any influence that time may have on abnormal returns and is similar to that of Brav and Gompers (2003).

As the Nordic markets inevitably have different characteristics, we acknowledge that potential region-specific fixed effects may impact abnormal returns at lockup expiration. Therefore, we apply a categorical variable that represents the geographic region of the Nordic stock exchanges. Firms that are listed in Sweden, Finland, Norway, Denmark, and Iceland are assigned values of 0, 1, 2, 3, and 4, respectively.

We also explore the possibility of various industry effects within our sample. For example, Bradley *et al.* (2001) suggest that high-tech firms are on average more likely to have negative abnormal returns at lockup expiration, as their heavy reliance on R&D induces uncertainty regarding the stock price. To account for any such industry effects that may impact the abnormal return, we will apply a categorical variable that represents the primary industry of each firm. We have based our industry classifications on industry-codes that are collected from S&P Capital IQ.

As one may have noticed, we have assigned the value of zero to the base level for each categorical variable. This is done to avoid the dummy variable trap and in turn the presence of perfect multicollinearity.

4.7 Regression methodology for cross-sectional analysis

The following section on the regression methodology for the cross-sectional analysis is based on the econometric theory provided in Baddeley and Barrowclough (2009) and Wooldridge (2012). For the purpose of investigating the cross-sectional determinants of the CARs from our event study, Ordinary Least Squares (OLS) estimation will be applied. OLS involves estimating the line of best fit through the observations on the

dependent variable and the explanatory variables[27]. OLS estimation has the advantage of being computationally simple whilst still being able to yield unbiased and reliable estimators.

In order for estimators to be unbiased and consistent, the Gauss-Markov OLS assumptions for Best Linear Unbiased Estimators (BLUE) have to be satisfied:

1. The error term follows a normal distribution with mean equal to zero; $E(\varepsilon_i) = 0$ for all i
2. No autocorrelation; $cov(\varepsilon_i, \varepsilon_i) = 0$ for $i \neq j$
3. Homoscedasticity; $\sigma_i^2 = \sigma_j^2 = \sigma^2$ for all i and j
4. Model is correctly specified; no omitted or surplus explanatory variables
5. Exogeneity; $cov(\varepsilon_i, X_i) = 0$
6. Linearity in the parameters
7. No perfect multicollinearity; no perfect linear association between explanatory variables

In this section, each of the 7 Gauss-Markov assumptions outlined above will be explained, and methods used to secure compliance with these assumptions will be outlined.

4.7.1 Assumption 1 - The error term follows a normal distribution

When estimating parameters through OLS estimation, we can make inferences about whether or not our hypotheses on the relationship between CAR and our explanatory variables are capturing what is observed in our real world dataset. However, if we want to test the accuracy of our inferences, we have to add the assumption of normality of the error term. With non-normality, t-distribution is only an approximation and will thus result in some inaccuracy concerning p-values.

With that being said, OLS does not per se require normal errors in order to estimate coefficients efficiently. In large samples, you can apply the central limit theorem to obtain correctly estimated p-values. It is acknowledged among econometricians that normality plays less of a role in showing that the OLS estimators are the best linear unbiased estimators. As Gelman and Hill (2006) puts it: "*The regression assumption that is generally least important is that the errors are normally distributed. In fact, for the purpose of estimating the regression line (as compared to predicting individual data points), the assumption of normality is barely important at all. Thus, in contrast to many regression textbooks, we do not recommend diagnostics of the normality of regression residuals*" (Gelman and Hill, 2006, p. 46).

[27] Explanatory variables, predictors, hypothesis variables, and independent variables are used interchangeably throughout this thesis

Although the normality assumption is often referred to as redundant when estimating best linear unbiased estimators, we will still test the assumption by analysing QQ-plots and performing Jarque-Bera and Sharpiro-Wilke tests.

4.7.2 Assumption 2 - No autocorrelation

Autocorrelation is present in a dataset when the assumption that the covariance between error terms is zero is violated. Coefficient estimates remain unbiased, however, they are not efficient since the residuals do not only capture random and unimportant factors but also deterministic factors. Thus, the residuals from our sample regression will correlate with each other and, in turn, be non-random.

Autocorrelation is commonly a problem in time series regression, however, it can exist in cross-sectional data. Spatial autocorrelation occurs if the data follows a natural spatial ordering where the residuals across cross-sectional units are correlated.

In our dataset, there exist only a few reasons why the residuals should correlate over time or space. Firstly, stock prices in general and the beta values in our market model are affected by the state of the Nordic markets at the specific point in time. This should already have been accounted for by including a control variable for the year of the IPO. Secondly, spatial autocorrelation might occur if there are certain conditions and institutional structures shared among firms on the same exchange or within the same industry. This is indeed plausible, which is also why we attempt to capture these effects by including control variables for exchange and industry. As we have not been able to identify any other obvious reasons for why our residuals should be correlated, we assume no autocorrelation when performing our regression analysis.

4.7.3 Assumption 3 - Homoscedasticity

The assumption of homoscedasticity requires that the variance of the error is constant across observations. Constant error variance means that if one obtains repeated samples of data, the variance of the error for each observation would be the same as the variance of the error for all the other observations. However, if heteroscedasticity is present, the error variance will vary systematically across observations as our explanatory variables vary. If the assumption of homoscedasticity is violated, OLS estimators become inefficient and the variance estimates become biased, which in turn will cause misleading conclusions regarding t and F tests.

In order to test the assumption of homoscedasticity, we will perform Breusch-Pagan’s heteroscedasticity test and White’s general heteroscedasticity test.

4.7.4 Assumption 4 - Model is correctly specified

For a regression model to be correctly specified it should neither have any relevant variables with predictive power omitted nor include any irrelevant explanatory variables. Generally, a well-specified regression model has the attributes of parsimony, theoretical consistency, identifiability, goodness of fit, and predictive power. To achieve this, theory and previous empirical research must guide the selection of the appropriate variables. Through our extensive literature review and hypothesis development, we have identified our cross-sectional hypotheses and the appertaining variables.

Our hypothesis variables will at first glance merely be candidate variables for our final regression model. Our goal is to estimate a parsimonious regression model that describes the differences in CAR across all sample units simplistically and effectively; the goal is to derive a model that is simple in terms yet useful. Therefore, we perform a stepwise regression procedure whereby we enter and remove the explanatory variables to and from our model until we observe no justifiable reason to proceed.

When narrowing down our model specification, we automatically disregard certain cross-sectional hypotheses. The hypotheses regarding the omitted variables will therefore be discredited. For such variables, a thorough theoretical and logical reasoning will be provided to substantiate the insignificance of these specific hypothesised relationships with CAR. The hypotheses regarding the variables included in the final model will be scrutinized further and thereafter concluded upon.

It should be emphasised that model building is an art rather than a science. It is based on subjective decision-making and the final model will merely be one out of many feasible and justifiable specifications.

4.7.5 Assumption 5 - Exogeneity

Violation of the assumption of exogeneity creates the problem of endogeneity. Endogeneity occurs when an explanatory variable is correlated with the error term. When an explanatory variable and the error term are correlated, OLS estimates will include some of the influence of the errors and, as a result, the coefficient estimates will be both biased and inconsistent.

Endogeneity often stems from omitted variable bias where one or more omitted variables are correlated with one or more of the included explanatory variables. We will investigate the problems of endogeneity and omitted variable bias closely when performing the stepwise regression procedure.

4.7.6 Assumption 6 - Linearity in the parameters

Linearity means that the mean of the response, $E(Y_i)$, at each set of values of the predictors, (x_{1i}, x_{2i},…), is a linear function of the predictors. That is, the regression equations for our regression models must be a linear function.

To assess this assumption, we will graphically examine the linear relationship between the residuals and fitted values, as well as between the residuals and the explanatory variables.

4.7.7 Assumption 7 - No perfect multicollinearity

Perfect multicollinearity is the extreme version of multicollinearity that occurs when there exists a perfect linear correlation between explanatory variables (*i.e. the correlation between two or more explanatory variables is exactly equal to ±1*). Perfect multicollinearity will make OLS estimation spurious as it is impossible separate the individual effects of the explanatory variables. As a result, variances will be infinitely large and confidence intervals will be infinitely wide.

Perfect multicollinearity is seldom present when performing regression analysis, however, imperfect multicollinearity is a common issue for econometricians. Imperfect multicollinearity is evident when the correlation coefficient is large but less than 1 in absolute terms. With imperfect multicollinearity, OLS estimation will not become spurious as is the case for perfect multicollinearity. However, one's estimation will be less accurate, as standard errors of coefficient estimates will be large, t-statistics of individual coefficients appear low and insignificant, R^2 pertains to a high value despite of low t-statistics, and some of the signs of the coefficients may be opposite of the true relationship.

To detect this problem, we will check the simple pairwise correlation coefficients between the explanatory variables by computing a correlation matrix. In addition, we will construct Variance Inflated Factors (VIFs), which are compared to an upper limit rule-of-thumb value of 10.

4.8 Interview methodology

With an aim of triangulating the findings of this thesis, we conduct interviews with industry practitioners that are involved with the construction of lockup provisions. This is done for multiple reasons. Firstly, the interviews provide practical insights into the relevance of the research objective of our thesis and its implications for the stakeholders. Secondly, the interviews seek to qualitatively substantiate the empirical results, as we ask the interviewees similar questions as those being quantitatively tested in our empirical

analysis. Finally, we desire a practical perspective to accommodate our theoretical framework and literature review when formulating the hypotheses.

The interviews have been conducted with Sebastian Hougaard (*Managing Director at Carnegie Investment Bank*) and Chantal Pernille Patel (*Partner at Gorrissen Federspiel*). Both interviewees were involved with the IPO of TCM. We have therefore asserted great focus to the IPO of TCM, as the interviews will allow for a deeper understanding of the dynamics behind lockups case. For both interviews, we prepared a standardised set of questions which were sent to the interviewee prior to the interview. These questions were then used as a guidance when conducting the interviews with the possibility to ask additional questions to clarify or further elaborate upon specific issues. Both interviews were recorded and transcribed, as shown in Appendix 17 and Appendix 18.

5 Event study analysis

In the following, we employ an event study approach for assessing our initial hypothesis on the abnormal return at lockup expiration according to Hypothesis 1, as well as investigating complementary expiration date variables to put the implications of our results into perspective. As mentioned in the methodology section, we apply a 5-day event window (-2, +2) and a 56-day estimation window (-60, -5). The event study will include an assessment of the yielded results and the implications that one can infer when comparing the results with the hypothesized outcome. This section encompasses 1) an event study on abnormal returns, 2) a complementary event study on abnormal volume, as well as 3) a complementary assessment of transaction costs.

5.1 Abnormal return at lockup expiration

As expressed by Hypothesis 1, the event study on abnormal returns at lockup expiration allows us to test the semi-strong form of the EMH:

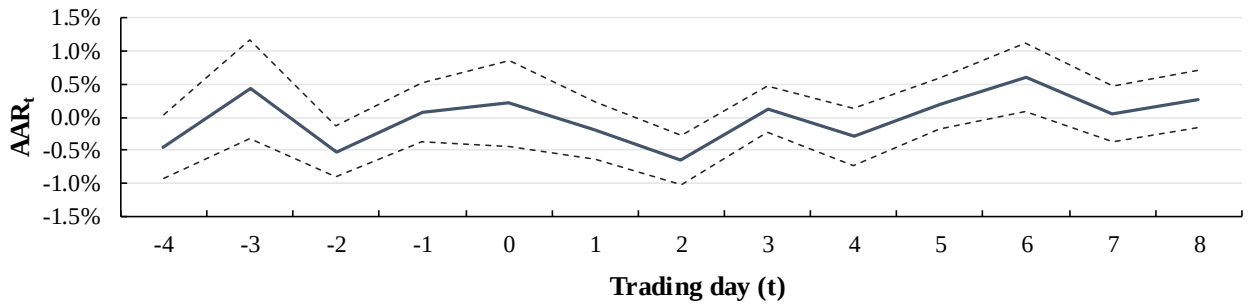
Hypothesis 1*: We expect zero cumulative abnormal return at lockup expiration*

Furthermore, we will test Hypothesis 1 according to the following null hypothesis:

$$H_0: ACAR_{\tau 1,\tau 2} = 0$$

Initially, we consider the daily AAR of the full sample for a broad selection of days surrounding the event window. The development of the daily AAR is shown in Figure 2.

FIGURE 2: Daily development of average abnormal returns (AAR_t) (t= -4, +8)



The solid line represents the daily development of average abnormal returns throughout an expanded selection of trading days surrounding lockup expiration, including the event winow (-2, +2). The dotted lines represent the upper- and lower bounds of the 95% confidence interval for average abnormal returns.

Figure 2 shows the daily AAR for a 13-day period (-4, +8) and the upper- and lower bounds for the 95% confidence interval for AAR. The graph cannot span a broader selection of trading days, since it is not possible to include trading days from the estimation window (*which ends at* $t = -5$) nor any trading days that take place after 21 March 2018[28]. One can observe that the AAR is positive at the lockup expiration date ($t = 0$), and immediately drops to a negative value on the two following dates ($t = +1$, $t = +2$). The initial drop in AAR immediately after lockup expiration slightly rebounds over the following trading days. The development of AAR does not show a clear trend but does indicate a noteworthy market reaction immediately after lockup expiration. The bounds of the 95% confidence interval suggest that AAR varies between a positive and negative value of 1% throughout the depicted trading days. Furthermore, the confidence-bounds suggest that AAR is significant at a 5% level on day -2, +2, and +6, since the 95% confidence interval excludes 0% on these trading days. The results for the daily AAR are tabulated in Table 1 below.

[28] The event study is performed as of 22 March 2018. Therefore, the latest adjusted closing price that can be attained at the time of analysis is for 21 March 2018. The sample includes several recent IPOs where the lockup expiration takes place close to the time of the analysis. For example, the lockup for Paxman AB expires on 9 March 2018. Therefore, we cannot include trading days that are later than $t = 8$, since this date is 21 March 2018 for the case of Paxman AB.

TABLE 1: Daily development of average abnormal returns (AAR_t) (-4, +8)

Trading day	AAR		SD	N	SE	t-stat	p-value	Lower 95%	Upper 95%
-4	**-0.4%**	*	2.9%	141	0.002	1.83	0.069	-0.9%	0.0%
-3	0.4%		4.5%	141	0.004	1.15	0.252	-0.3%	1.2%
-2	**-0.5%**	**	2.3%	141	0.002	2.60	0.010	-0.9%	-0.1%
-1	0.1%		2.7%	141	0.002	0.37	0.715	-0.4%	0.5%
0	0.2%		3.9%	141	0.003	0.65	0.518	-0.4%	0.9%
1	-0.2%		2.6%	141	0.002	0.88	0.378	-0.6%	0.2%
2	**-0.6%**	***	2.2%	141	0.002	3.50	0.001	-1.0%	-0.3%
3	0.1%		2.1%	141	0.002	0.74	0.460	-0.2%	0.5%
4	-0.3%		2.6%	141	0.002	1.36	0.177	-0.7%	0.1%
5	0.2%		2.3%	141	0.002	1.02	0.308	-0.2%	0.6%
6	**0.6%**	**	3.1%	141	0.003	2.36	0.020	0.1%	1.1%
7	0.0%		2.5%	141	0.002	0.23	0.821	-0.4%	0.5%
8	0.3%		2.6%	141	0.002	1.26	0.211	-0.2%	0.7%

The coloured rows represent trading days where AAR is significant with at least 10% significance. The table depicts trading days surrounding the event, including those that are considered in the event window (-2, +2).
**p<0.1; **p<0.05; ***p<0.01*

The AAR is found to be negative on 5 out of the 13 (= *38%*) depicted trading days surrounding the event date. There are three degrees of significant observations in Table 1, namely 1) a negative AAR at $t = -4$, which is significant at the 10% level, 2) a negative AAR at $t = -2$ and a positive AAR at $t = +6$, which are significant at the 5% level, as well as 3) a negative AAR at $t = +2$, which is significant at the 1% level. Before we consider the significantly negative price reaction that occurs immediately after lockup expiration ($t = +2$), these findings are furthermore noteworthy since they indicate a premature and significantly negative abnormal return several days before the date of lockup expiration ($t = -4$, $t = -2$), as well as a significantly positive and delayed abnormal return after lockup expiration ($t = +6$). However, the observations on day -4 and day +6 are arguably too far from lockup expiration to be considered as directly affected by the event. This notion is supported by Armitage (1995), who emphasizes that shorter event windows are recommended when the event itself is easy to determine, as it will ensure optimal representation of the effects that stem from lockup expiration.

Before we establish inferences from the results, we calculate CAR according to different event windows to test the sensitivity of our event study. Table 2 shows the results for CAR when applying our preselected 5-day event window (-2, +2) and other alternative event windows.

TABLE 2: Average cumulative abnormal return (ACAR) according to different event windows

Event window	ACAR		SD	N	SE	t-stat	p-value	Lower 95%	Upper 95%
(-1, +1)	0.1%		5.79%	141	0.005	0.21	0.838	-0.86%	1.06%
(-2, +2)	**-1.1%**	**	5.75%	141	0.005	2.18	0.031	-2.02%	-0.10%
(-3, +3)	-0.5%		6.91%	141	0.006	0.85	0.399	-1.64%	0.66%
(-4, +4)	**-1.2%**	*	8.61%	141	0.007	1.70	0.091	-2.67%	0.20%
(-2, +3)	**-0.9%**	*	6.10%	141	0.005	1.80	0.073	-1.94%	0.09%
(-2, +4)	**-1.2%**	**	6.81%	141	0.006	2.13	0.035	-2.36%	-0.09%
(-1, +2)	-0.5%		5.79%	141	0.005	1.12	0.266	-1.51%	0.42%
(-1, +3)	-0.4%		6.12%	141	0.005	0.80	0.424	-1.43%	0.61%
(-1, +4)	-0.7%		6.81%	141	0.006	1.23	0.219	-1.84%	0.43%

The coloured rows represent trading days where ACAR has been observed with a minimum of 10% significance. The table depicts various event windows to represent the sensitivity of our analysis. The applied event window is highlighted by the dotted lines.
**p<0.1; **p<0.05; ***p<0.01*

In Table 2, we apply various symmetric and asymmetric event windows surrounding the date of lockup expiration. Firstly, one can observe that nearly all event windows yield an ACAR that is negative. The ACAR ranges from -1.2% to 0.1%, which is narrower than what has been observed by previous research. The US studies found significantly negative ACARs that range between -1% to -3% (Ofek and Richardson, 2000; Bradley *et al.*, 2001; Field and Hanka, 2001; Brav and Gompers, 2003; Brau *et al.*, 2004), whereas the European studies observe insignificantly negative ACARs of -0.5% to -2.5% (Ahmad, 2007; Espenlaub *et al.*, 2001; Espenlaub *et al.*, 2013; Goergen *et al.*, 2006). Our results thus suggest that the variation in ACAR is less sensitive to the applied event window than what has previously been observed. Furthermore, our results indicate that the percentage of stocks that have a negative CAR varies between 52% and 61% among the different event windows. This is comparable to the finding of Field and Hanka (2001) who observe that 63% of their observations have a negative CAR.

The analysis on ACAR yields a p-value of 0.031 and 0.035 for the 5-day (-2, +2) and 7-day (-2, +4) event windows, respectively, thus substantiating significance at the 5% level. It is highly noteworthy that these results comply with the preselected event window of 5 trading days (-2, +2), which was proposed as the most optimal event window in the methodology section. Due to the limited difference between the magnitude and significance of ACAR for the two event windows, we still adhere to apply the symmetric 5-day event window (-2, +2).

In this manner, our event study on abnormal returns suggests that Nordic IPOs on average experience a significantly negative CAR of -1.1% at lockup expiration, which is deemed to be significant at the 5% level. We can thus reject the null hypothesis for the event study on abnormal returns and conclude that CAR on average is significantly different than zero:

$$H_0: ACAR_{\tau 1,\tau 2} = 0$$

The null hypothesis is rejected

Our event study on abnormal returns at lockup expiration provides significant evidence against the semi-strong form of the EMH in the Nordic market. It should not be possible to observe abnormal price reactions in a semi-strong form efficient market, as rational expectations are based on publicly accessible lockup-specific information from the IPO prospectus. Our findings thus suggest that the market fails to fully incorporate public information related to a forthcoming lockup expiration date. This result is highly important since previous research on lockup expirations in Europe has failed to observe significantly abnormal returns with similarly narrow event windows (Ahmad, 2007; Espenlaub *et al.*, 2001; Espenlaub *et al.*, 2013; Goergen *et al.*, 2006).

The underlying cause of the significantly negative ACAR of -1.1% cannot be fully determined before we have assessed the results of the cross-sectional analysis. However, the development of AAR in Figure 2 is somewhat compatible with theory on the downward-sloping demand curve (Ofek and Richardson, 2000; Brav and Gompers, 2003). The graph indicates a sudden price reaction after lockup expiration, with a significantly negative AAR of -0.6% on the second trading day ($t = 2$). This can partly be attributed to new shares entering the market, which implies that investors seem to underestimate the number of shares that are sold after lockup expiration.

There are however certain characteristics of the graph that slightly contradict the theory on downward-sloping demand curves. Firstly, we observe that a significantly negative AAR occurs on two of the trading days prior to lockup expiration, namely at $t = -2$ and $t = -4$. This premature reaction cannot be explained by the downward-sloping demand curve unless some of the locked up shares have been subject to an early release. Secondly, we observe a significantly positive AAR of 0.6% several days after lockup expiration, namely at $t = +6$. This delayed reaction can arguably be attributed to induced demand from investors that are exploiting the sudden price drop. Due to the delayed reversal of the stock price, one could argue that the abnormal price reaction at lockup expiration is a result of a temporary price pressure[29] rather than a permanent consequence of a downward-sloping demand curve (Field and Hanka, 2001).

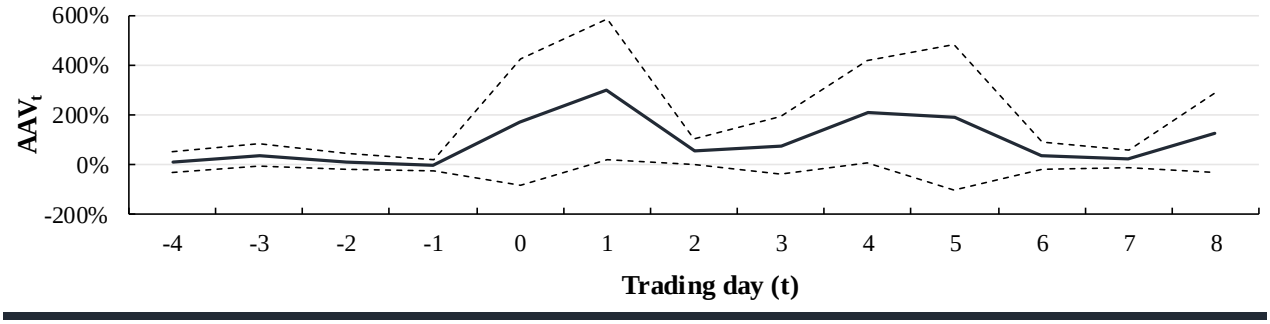
With respect to information asymmetry, the significantly negative AAR after lockup expiration ($t = +2$) could possibly be a result of a misalignment in the quality of information held by insiders and outside investors (Field and Hanka, 2001; Brav and Gompers, 2003; Brau *et al.*, 2004). If one were to suppose that insiders have possessed negative private information prior to lockup expiration (*thus implying that outside investors have overvalued the stock due to their informational disadvantage*), then the significantly negative AAR after lockup expiration could be a consequence of an unexpected value realization. However, we cannot ascertain such implications based on the event study's results. This will be elaborated further upon when we have attained the results from the cross-sectional analysis.

[29] A fundamental attribute of price pressures is that they only have a temporary effect and are reversed within a few days (Barclay and Litzenberger, 1988; Mikkelson and Partch, 1985).

5.2 Abnormal volume at lockup expiration

To support our findings from the event study on abnormal returns, we will also assess the abnormal volume during the days surrounding lockup expiration. The development of AAV for the full sample is shown in Figure 3, which includes the same trading days as Figure 3.

FIGURE 3: Daily development of average abnormal volume (AAV_t) (t= -4, +8)



The solid line represents the daily development of average abnormal volume throughout an expanded selection of trading days surrounding lockup expiration, including the event winow (-2, +2). The dotted lines represent the upper- and lower bounds of the 95% confidence interval for average abnormal volume.

There are several imperative observations to be made from Figure 3. Firstly, one can observe from the bounds of the 95% confidence interval that there is very limited variation in AAV during the trading days prior to lockup expiration. The AAV immediately increases at the time of the event ($t = 0$), with the largest AAV occurring on the following trading day ($t = +1$). Simultaneously, the broadened spread of the 95% confidence interval indicates that there is an immense variation in trading volume on these days. The spread of the confidence interval diminishes during the subsequent days ($t = +2$, $t = +3$), which is followed by another sudden increase in AAV where the confidence interval once again suggests a larger variation in trading volume.

When comparing the development of AAV in Figure 3 with AAR in Figure 2, one can observe that the two upsurges in trading volume precedes the significantly negative AAR of -0.6% ($t = +2$) and the significantly positive AAR of 0.6% ($t = +6$). Since there is very limited evidence of abnormal trading volume during the days prior to lockup expiration, it can be argued that the AAR of -0.5% ($t = -2$) cannot be attributed to theory on the downward-sloping demand curve. As we previously hypothesized, this AAR could be the result of an early release of locked up shares. However, since we only see a slightly positive and marginally significant AAV prior to lockup expiration ($t = -3$), one cannot fully explain this drop in AAR according to trading activity. Hence the premature AAR of -0.5% ($t = -2$) must partly be affected by investor beliefs or information asymmetry problems. The prevalence of such issues will be elaborated further upon once we have attained the results from our cross-sectional analysis.

With respect to the event window (-2, +2), it is evident that the development of AAV is somewhat compatible with theory on the downward-sloping demand curve. AAV increases significantly at the time of lockup

expiration, which subsequently is followed by a significantly negative AAR. This finding complies with that of Field and Hanka (2001), who emphasize that the abnormal return is more negative when the trading volume is abnormally large. Table 3 shows the statistical results for AAV during the trading days surrounding the event window, as well as our result for the entire event window.

TABLE 3: Average abnormal volume (AAV_t) for (-4, +8) days and for (-2, +2) days

Trading day	AAV		SD	N	SE	t-stat	p-value	Lower 95%	Upper 95%
-4	11.8%		236.9%	141	0.199	0.59	0.556	-27.7%	51.2%
-3	**37.9%**	*	268.6%	141	0.226	1.68	0.096	-6.8%	82.6%
-2	12.3%		191.2%	141	0.161	0.77	0.444	-19.5%	44.2%
-1	-1.8%		146.5%	141	0.123	0.15	0.882	-26.2%	22.6%
0	171.5%		1512.3%	141	1.274	1.35	0.180	-80.3%	423.3%
1	**302.2%**	**	1693.3%	141	1.426	2.12	0.036	20.2%	584.1%
2	**55.1%**	**	299.8%	141	0.252	2.18	0.031	5.2%	105.0%
3	78.3%		706.3%	141	0.595	1.32	0.190	-39.3%	195.9%
4	**213.8%**	**	1250.7%	141	1.053	2.03	0.044	5.6%	422.1%
5	193.3%		1756.0%	141	1.479	1.31	0.193	-99.1%	485.6%
6	36.5%		328.3%	141	0.276	1.32	0.189	-18.2%	91.1%
7	25.7%		222.5%	141	0.187	1.37	0.173	-11.4%	62.7%
8	129.6%		953.3%	141	0.803	1.61	0.109	-29.2%	288.3%
Event window	Mean AAV		SD	N	SE	t-stat	p-value	Lower 95%	Upper 95%
(-2, +2)	**107.3%**	**	488.3%	141	0.411	2.61	0.0101	26.0%	188.6%

The coloured rows represent trading days where AAV has been observed with a minimum of 10%
**p<0.1; **p<0.05; ***p<0.01*

The daily AAVs within the event window (-2, +2) indicate that trading activity ramps up significantly at the time of lockup expiration. On the day of the event ($t = 0$), the trading activity increases to an AAV of 171.5%. This result is however insignificant and can only be accepted at a 20% significance level. However, during the two subsequent trading days, the AAV for the entire sample surges to an average of 302.2% ($t = +1$) and then drops to an average of 55.1% ($t = +2$). Both results are significant at the 5% level. It is thus clear that the event window portrays an immediate and significant increase in the abnormal trading volume. One can therefore infer that lockup expiration on average influences the average trading volume for the entire sample, which implies that pre-IPO shareholders with locked up shares most likely start to dispose of their shares at lockup expiration.

When considering the average AAV for the entire event window (-2, +2), one can observe that the abnormal trading volume amounts to an average of 107.3%. This result is highly significant since it can be accepted at the 5% level and nearly approaches significance at the 1% level ($p \approx 0.0101$). Although AAV drops from an average of 302.2% ($t = +1$) to 55.1% ($t = +2$), it does appear to remain above the average trading activity from the estimation window (-60, -5) for the following trading days. After the event window, the AAV is on

average 112.9% from the 3rd ($t = +3$) to the 8th ($t = +8$) trading day after lockup expiration[30]. Hence, this result indicates a permanent increase in the trading volume after lockup expiration.

It is highly noteworthy that the significantly positive upsurges in AAV occur simultaneously with the significantly negative AAR of -0.6% ($t = +2$) and significantly positive AAR of 0.6% ($t = +6$). This parallel relationship suggests that the initial negative market reaction ($t = +2$) could be temporary, as it may be the case that the suppressed stock price is met by induced demand and thereby reverses as trading activity once again spikes during the subsequent trading days ($t = +4$, $t = +5$). If we assume this to be true, our findings would more accurately exemplify a temporary price pressure rather than a permanent price drop (Field and Hanka, 2001). However, since we cannot further expand our assessment of trading days[31] (*and since long-term effects are beyond the scope of this thesis*), we cannot completely discredit the implications of a downward-sloping demand curve.

The statistically significant AAV of 107.3% that has been estimated for our event window (-2, +2) is highly comparable with the empirical results of previous research. It has generally been observed that AAV ranges between 56% and 80% immediately after lockup expiration, which is followed by a minor decline to a permanent level of ~40% (Ofek and Richardson, 2000; Field and Hanka, 2001; Brav and Gompers, 2003). Our findings thus comply with previous empirical studies on abnormal trading volume, in the sense that we also find suggestive evidence of a permanent increase in trading volume after lockup expiration. Furthermore, we acknowledge that the induced trading volume can partly be attributed to other effects, such as new information reaching the market and investors reacting to insiders' selling activity. For example, unexpected excessive sales by insiders may signal bad news about a firm's prospects. Since our event study's results cannot definitively ascertain the fundamental cause of the market's significantly abnormal reaction, we will discuss these implications when investigating the relationship between the explanatory variables and CAR in the cross-sectional analysis.

5.3 Transaction costs at lockup expiration

Before we commence the cross-sectional analysis, we will briefly consider the average transaction costs that prevail during the event window. This is done to determine whether investors can earn a profit from exploiting the significantly negative ACAR of -1.1%. The average transaction costs (*calculated as the percentage bid-ask spread relative to the bid price*) and absolute value of ACAR for the event window are shown in Table 4 below.

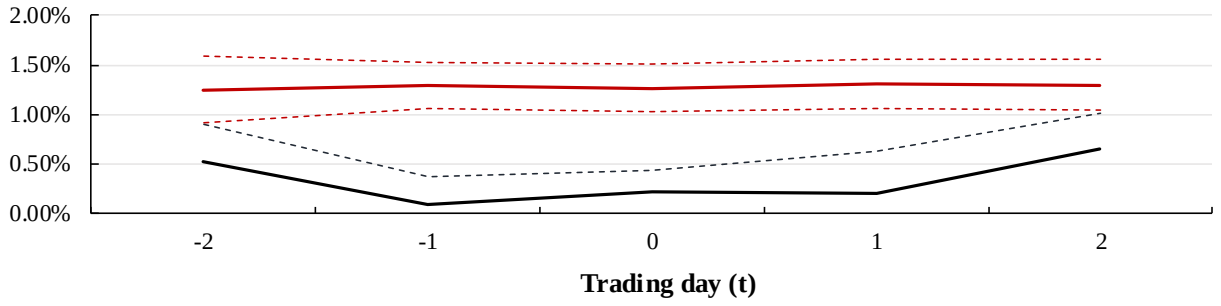
[30] There is a slight upward skew incorporated in the average AAV for this post-lockup period (+3, +8). The median AAV for the same period is 103.9%.
[31] See footnote 29 where we explain the selected range of trading days to be depicted in Figure 2 and Figure 3

TABLE 4: Transaction costs and absolute ACAR for the event window (-2, +2)

		Transaction costs				
Event window	ABS(ACAR)	Mean	SD	N	Lower 95%	Upper 95%
(-2, +2)	1.06%	1.31%	1.3%	141	1.10%	1.53%

As shown in Table 4, the average transaction cost for the entire sample amounts to 1.31%. At a first glance, this exceeds the absolute value ACAR and thus implies that it is too costly to profit off the abnormal mispricing. However, when assessing the 95% confidence interval for average transaction costs, it becomes evident that there only is a difference of 0.04 percentage points between the absolute value of ACAR and the lower bound of the confidence interval for average transaction costs. Furthermore, a 99% confidence interval would yield a lower bound of 1.03%, which thereby would overlap with the absolute value of ACAR. It is therefore of great importance to expand the analysis and consider the daily development of the average transaction costs and absolute values of AAR, which is depicted in Figure 4 and tabulated by Table 5.

FIGURE 4: Transaction costs and absolute AAR_t within the event window (t= -2, +2)



The solid red line represents the daily average transaction costs throughout the event window, whereas the red dotted lines represent the upper- and lower bounds of the associated 95% confidence interval. The solid blue line represents the absolute value of average abnormal returns throughout the event window, whereas the blue dotted line represents the upper bound of the associated 95% confidence interval.

TABLE 5: Transaction costs and absolute AAR_t within the event window (-2, +2)

		Transaction costs				
Event window	ABS(AAR)	Mean	SD	N	Lower 95%	Upper 95%
-2	0.51%	1.25%	2.0%	141	0.9%	1.6%
-1	0.08%	1.29%	1.4%	141	1.1%	1.5%
0	0.21%	1.26%	1.4%	141	1.0%	1.5%
1	0.19%	1.31%	1.5%	141	1.1%	1.6%
2	0.64%	1.30%	1.5%	141	1.0%	1.6%

ACAR is depicted by its absolute value to optimally compare with transaction costs. The table depicts the trading days that are included in the event window.

When assessing the daily development of the average transaction costs and absolute values of AAR throughout the event window, it becomes clear that (*on average*) one cannot benefit off the abnormal price reaction at lockup expiration. One should especially consider the absolute values of AAR at $t = -2$ and $t = +2$ since

these estimates were found to be statistically significant in the event study on abnormal returns. On both trading days, the transaction costs are on average too large to exploit the mispricing.

Furthermore, it can be observed in Figure 4 that the lower bound of the 95% confidence interval for transaction costs does not overlap the upper bound of the 95% confidence interval for the abnormal value of AAR. Although the difference seems to be narrow at $t = -2$, it can be observed in Table 5 that there exists a 0.01 percentage point difference between the two bounds. There could arguably be observed an overlap between the two bounds if one were to apply a 99% confidence interval. However, this will not be applied since we accepted our results from the event study on abnormal returns at a 5% significance level.

Due to the findings from our event study on abnormal returns, which suggest a significantly negative ACAR of -1.1%, it is possible that the market is neither rationally nor optimally incorporating public information into their valuation of stocks. Hence, since the abnormal returns at lockup expiration were found to be significant, the question prevails on why such an abnormality in stock prices is not eradicated by arbitrageurs. While we cannot attain a comprehensive answer to this question, it is possible to assess the limitations of arbitrage in a lockup context, and how such limitations can explain the stock price reaction at lockup expiration.

Our findings on transaction costs suggest that there is an immensely limited opportunity for arbitrageurs to benefit off any mispricing in stock prices at lockup expiration (*ceteris paribus*). In line with this observation, Espenlaub *et al.* (2001) argue that the relatively small magnitude of abnormal returns implies that any mispricing of stocks cannot not be exploitable through arbitrage. Investors generally face holding costs (*e.g. opportunity cost of capital*) in addition to trading costs (*e.g. brokerage fees*) which bear the combined effect of impeding investors from exploiting any such inefficiencies in the market (Pontiff, 2006).

In addition, Ofek and Richardson (2000) emphasize that the creation of short positions is often hampered in a lockup context, as a limited free float prior to lockup expiration can render any arbitrage opportunities obsolete. Hence, apart from the complications from transaction costs, it may be the case that investors only have access to an insufficient number of lendable shares throughout the lockup period in the IPO aftermarket.

In conclusion, even if market participants can predict the number of shares that are sold at lockup expiration with great certainty, their actions for profiting off abnormal stock reactions will likely be impeded by costly arbitrage, unfavourable holding costs, as well as fundamental risk factors. When combined, these issues may suggest that arbitrageurs (*and investors alike*) choose not to undertake an exploitative trading strategy, thus implying that mispricings (*on average*) still will prevail at lockup expiration.

6 Cross-sectional analysis

Our event study on abnormal returns yielded significant evidence of a negative ACAR of -1.1% at lockup expiration when applying a 5-day event window (-2, +2). As the next step of our analysis, we will now advance to the cross-sectional analysis to investigate a selection of underlying characteristics among our sampled firms that are likely to have an impact on CAR.

Firstly, we will inspect our sample by performing statistical, descriptive, and graphical analyses which will substantiate a thorough understanding of the sample distribution. Secondly, we will through an iterative stepwise regression procedure narrow down our model specification, starting with a Base Model that includes all explanatory variables. Herein, we will derive the Final Model according to statistical analyses, theoretical concepts, as well as our own financial and logical reasoning, which will jointly ensure that we arrive at a final model that is optimally fitted to our dataset. Finally, when the Final Model is adequately specified we will provide a thorough assessment and interpretation of our results.

6.1 Dataset inspection and descriptive statistics

Before we commence the stepwise regression, we will briefly comment on noteworthy observations that can be made from the summary statistics for our sample, as shown by Table 6 below.

TABLE 6: Summary statistics for dependent and cross-sectional variables

Hypothesis	Variable	N	Mean	Median	SD	Min	Max
1	CAR	141	-0.011	-0.012	0.058	-0.182	0.276
2A	DURATION	141	234.000	180.000	86.575	90.000	365.000
2B	SHARES_LOCKUP	141	1.791	1.427	1.547	0.041	10.102
2C	PE_VC	141	0.504	1.000	0.502	0.000	1.000
3A	UNDERPRICING	141	-0.062	-0.049	0.120	-0.661	0.434
3B	UNDERWRITER_RANK	141	12.752	9.000	9.026	1.500	26.000
4A	VOLATILITY	141	0.025	0.022	0.015	0.009	0.103
4B	EARLY_INSIDER_TRADING	141	-0.004	0.000	0.128	-0.622	0.554
4C	PRICE_RAMP	141	0.043	0.011	0.227	-0.945	1.430

The variables in Table 6 represent each of the hypotheses that were presented in the hypothesis development. Hypothesis 1 represents the dependent variable which is analyzed in an isolated setting in the event study. Hypotheses 2 through 4 represent the cross-sectional variables that represent each of the 3 categorisations of hypothesised characteristics.

The summary statistics report the mean, standard deviation, median, and range for the dependent and explanatory variables that are used in the cross-sectional analysis. The mean lockup duration is 234 calendar days, with a median of 180 days. This finding is highly comparable to that of Brau *et al.* (2004) who observe a mean duration of 231 calendar days, with a median of 180 days. On average, ~179% shares are subject to

lockup relative to the free float, which is substantially larger than what is observed by several previous empirical studies (Brav and Gompers, 2003; Harper *et al.*, 2005; Nowak, 2015). This finding is as expected since we calculate the percentage of locked up shares relative to free float at IPO rather than total shares outstanding at IPO.

On average, our sampled IPOs experience a negative first-day return of -6.2%. It is evident that there is an overweight of negative first-day returns throughout our sample, as only 38 ($\approx 27\%$) IPOs yield positive returns on the first day of trading. This finding is highly noteworthy, as it complies with the results of Purnanandam and Swaminathan (2004) who prove that the median IPO in fact is overvalued[32] when compared to industry peers. We assert great importance to this overweight of negative first-day returns in our sample, as it not only will characterise the relationship between underpricing and abnormal returns at lockup expiration, but also the interference with other explanatory variables. This latter notion is for example discussed by Haggard and Xi (2017), who argue that large and positive price-runs attract investors' attention and consequently lead to a greater likelihood of value realization. Given the finding of Purnanandam and Swaminathan (2004) on median IPOs being overvalued, this induced likelihood of value realization consequently implies that investors (*on average*) will deem stocks to be overvalued when a stock's positive price-run has drawn their attention.

We are aware of the potential influence of outliers in our sample. Such outliers typically indicate either measurement errors or that the sample distribution has heavy tails (Grubbs, 1969; Stock and Watson, 2011). In the former scenario, one must either discard the potential outliers or apply statistical methods that alleviate their distortive influence. In the latter scenario, the sample's skewness implies that one must be cautious when making inferences that assume a normal distribution. Since our variables represent minor modifications of financial data, we do not believe that measurement errors are prevalent in our sample. However, it is although possible that our data is affected by heavy-tailed distributions. As noted in the methodology section, Gelman and Hill (2006) argue that the assumption of normality is barely important when estimating regression lines. In addition, there exists no rigid mathematical definition for determining potential outliers, as such an approach is somewhat subjective (Stock and Watson, 2011). Therefore, we will not exclude potential outliers, but instead be highly aware of their potential influence when making inferences according to our findings. We provide a thorough assessment of the sample distribution and potential outliers in Appendix 3.

6.2 Stepwise regression

The stepwise regression encompasses an iterative process in which we narrow down our Base Model predictors according to the Gauss-Markov OLS assumption of no specification errors. In this sense, our Final Model must

[32] Proxied by first-day returns

be accurately specified to ensure that the coefficient estimates are unbiased and consistent. This will allow us to arrive at a parsimonious and correctly specified regression model once the iterative process has been conducted. In the stepwise regression process, we will firstly run a Base Model which includes our specified cross-sectional predictors of abnormal returns at lockup expiration. Here, we will also briefly elaborate upon model diagnostics to verify the validity of OLS assumptions across our dataset. After having analysed and interpreted the outputs from the Base Model, we will further scrutinise the least significant variables while keeping the remaining variables in the regression equation until later inspection. Based on statistical interpretation, theoretical understanding, and logical reasoning, the variables that are considered to be redundant will be removed from the cross-sectional model and the appertaining hypotheses will be discredited. This process will be iterated until we see no justifiable reason to proceed, thereby arriving at the Final Model for our cross-sectional analysis.

6.2.1 Base model

Our stepwise regression has its outset in a Base Model, which contains all explanatory variables and control variables to ensure an optimal analysis of our cross-sectional hypotheses. The Base Model is expressed as following:

$$\begin{aligned} CAR_i = \alpha &+ \beta_1 DURATION_i + \beta_2 SHARES\_LOCKUP_i + \beta_3 UNDERPRICING_i \\ &+ \beta_4 UNDERWRITER\_RANK_i + \beta_5 PE\_VC_i + \beta_6 VOLATILITY_i \\ &+ \beta_7 EARLY\_INSIDER\_TRADING_i + \beta_8 PRICE\_RAMP_i + \beta_9 YEAR_i + \beta_{10} INDUSTRY_i \\ &+ \beta_{11} EXCHANGE_i + \beta_{12} M\_B_i + \beta_{13} OFFER\_PRICE_i + \beta_{14} SIZE_i + \varepsilon_i \end{aligned} \tag{9}$$

Furthermore, Table 7 below shows the yielded results of a multivariate regression when we initially regress CAR on the hypothesis variables.

TABLE 7: Multivariate regression output for Base Model

	Dependent variable
Independent variables	CAR
DURATION	-0.00002
	p = 0.812
SHARES_LOCKUP	-0.010**
	p = 0.020
PE_VC	0.004
	p = 0.726
UNDERPRICING	-0.067
	p = 0.160
UNDERWRITER_RANK	0.0001
	p = 0.857
VOLATILITY	-0.368
	p = 0.358
EARLY_INSIDER_TRADING	-0.025
	p = 0.570
PRICE_RAMP	-0.077***
	p = 0.002
Constant	0.054
	p = 0.324
Observations	141
R^2	0.280
Adjusted R^2	0.058
Residual Std. Error	0.056 (df = 107)
F Statistic	1.259 (df = 33; 107)

The model includes the following control variables: YEAR, INDUSTRY, EXCHANGE, M_B, OFFER_PRICE, and SIZE
**p<0.1; **p<0.05; ***p<0.01*

One can observe from Table 7 that the initial regression yields several striking results. Firstly, although the Base Model has an R^2 of 28.0%, the adjusted R^2 shows an unfavourably low value of 5.8%. This stems from the Base Model's coefficient of determination being penalised for including several explanatory predictors. Furthermore, the insignificant F-statistic of 1.259 can be explained by the inclusion of the categorical control variables on year, industry, and exchange. These control variables take up 10, 8 and 4 degrees of freedom, respectively, which drastically reduces the joint significance of the model[33].

We perform initial model diagnostics for the Base Model to verify the validity of OLS assumptions across our dataset. Through visual inspection of statistical graphs and various econometric tests, we investigate the compliance with the seven Gauss-Markov assumptions outlined in the section on the regression methodology for the cross-sectional analysis. Here, we only encounter one minor discrepancy, namely that the residuals seem to follow a heavy tailed distribution. However, we believe that the implications of non-normality of the

[33] See Appendix 6 for statistical definitions and formulas.

errors do not affect the inference from our cross-sectional analysis. Financial data is typically non-normally distributed, and as explained in our regression methodology, OLS estimation does not necessarily require normal errors to estimate coefficients efficiently. Thus, we will not perform any remedial actions, however, we will still take this condition into account when interpreting results henceforward (*see Appendix 7 for an overview of methods used to secure compliance with the OLS assumptions. In addition, see Appendix 8 for an in-depth walkthrough of the model diagnostics for the Base Model*).

With respect to the individual coefficients for the hypothesis specific variables in Table 7, it is observed that only two predictors (*namely SHARES_LOCKUP and PRICE_RAMP*) are statistically significant at a 5% level. The coefficient estimates of the two predictors are both negative, which implies that CAR will decrease by ~0.01 and ~0.08 percentage points when SHARES_LOCKUP and PRICE_RAMP increase by 1 percentage point, respectively. While the negative relationship between the SHARES_LOCKUP and CAR complies with our hypothesized outcome in Hypothesis 2B, the coefficient for PRICE_RAMP is contrary to what we expected in Hypothesis 4C. Before diving further into an assessment of inferences that can be made from these coefficients, we will for now assert great relevance in keeping the variables for PRICE_RAMP and SHARES_LOCKUP in our model.

Furthermore, one can observe that the coefficients for all the other variables are insignificant at a 10% significance level. For example, the coefficients for UNDERPRICING and VOLATILITY have p-values of 0.160 and 0.358, respectively. At a glance, one could argue that these variables should be excluded from the model. However, when assessing the coefficients for DURATION, UNDERWRITER_RANK, PE_VC, and EARLY_INSIDER_TRADING, it is evident that these coefficients possess an immensely larger degree of insignificance, as their p-values surpass a significance level of 50%.

To substantiate these implications of the multivariate regression, we also perform univariate regressions of CAR on each of the cross-sectional variables. The isolated effects of these variables are presented in Table 8 below.

TABLE 8: Univariate regression output for Base Model

	Dependent variable							
	CAR							
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DURATION	0.00001							
	p = 0.865							
SHARES_LOCKUP		-0.006**						
		p = 0.039						
PE_VC			0.007					
			p = 0.482					
UNDERPRICING				-0.016				
				p = 0.697				
UNDERWRITER_RANK					0.0001			
					p = 0.920			
VOLATILITY						-0.595*		
						p = 0.066		
EARLY_INSIDER_TRADING							-0.026	
							p = 0.495	
PRICE_RAMP								-0.072***
								p = 0.001
Constant	-0.013	0.001	-0.014**	-0.012**	-0.011	0.004	-0.011**	-0.007
	p = 0.364	*p = 0.887*	*p = 0.044*	*p = 0.037*	*p = 0.184*	*p = 0.650*	*p = 0.030*	*p = 0.119*
Observations	141	141	141	141	141	141	141	141
R^2	0.0002	0.031	0.004	0.001	0.0001	0.024	0.003	0.081
Adjusted R^2	-0.007	0.024	-0.004	-0.006	-0.007	0.017	-0.004	0.074
Residual Std. Error (df = 139)	0.058	0.057	0.058	0.058	0.058	0.057	0.058	0.055
F Statistic (df = 1; 139)	0.029	4.375**	0.499	0.153	0.499	3.455*	0.469	12.210***

**p<0.1; **p<0.05; ***p<0.01*

The output shown in Table 8 provides three useful insights. Firstly, the coefficients for PRICE_RAMP and SHARES_ LOCKUP once again pertain to a significantly negative value. This substantiates our reasoning for including these variables in our model. Secondly, the highly insignificant coefficients for DURATION, UNDERWRITER_RANK, PE_VC, and EARLY_INSIDER_TRADING are nearly unaffected when considering the variables in an isolated setting. Lastly, the moderately insignificant coefficients for UNDERPRICING and VOLATILITY are very different when isolated from the multivariate regression. The coefficient on VOLATILITY is now significantly negative, whereas the coefficient on UNDERPRICING loses a great degree of its previously observed moderate significance.

Due to these findings, we choose to keep UNDERPRICING and VOLATILITY in our model to scrutinize the large differences in their significances and coefficients between the multivariate and univariate regressions. However, since both the multivariate and univariate regressions assert immense insignificance to the coefficients for DURATION, UNDERWRITER_RANK, PE_VC, and EARLY_INSIDER_TRADING, we

will in the following sections apply statistical and economic reasoning to determine whether these variables bear any explanatory power when investigating abnormal returns.

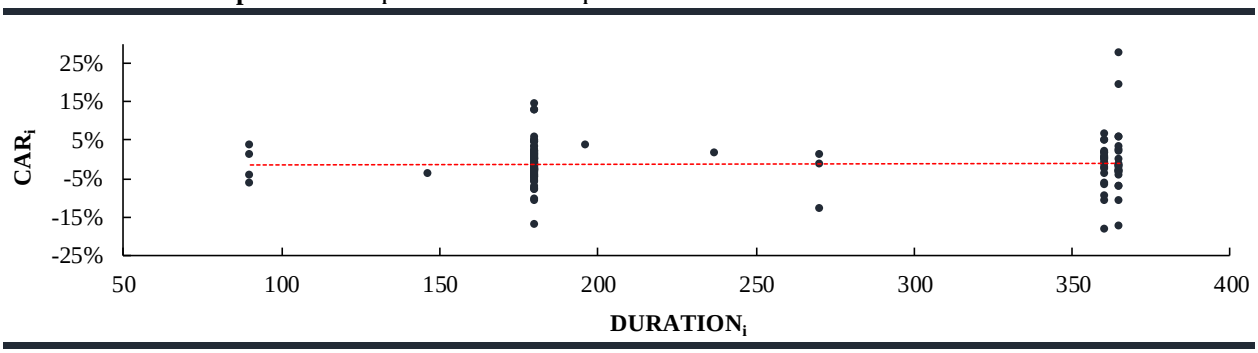
Lockup duration (DURATION)

The relationship between lockup duration and abnormal returns at expiration date was initially hypothesized by Hypothesis 2A, in which we expected a positive relationship. From a statistical point of view, Hypothesis 2A is tested in the Base Model according to the following null hypothesis:

$$H_0: \beta_1 = 0$$

As observed from the results of the multivariate regression output for the Base Model in Table 7, the coefficient for DURATION is highly insignificant ($p = 0.812$) and has a value of nearly zero ($\beta_1 \approx -0.00002$). Therefore, the multivariate regression results for the Base Model suggest that there does not exist a statistically significant relationship between DURATION and CAR. To gain complete insight into this relationship, we construct a scatterplot as shown by Figure 5.

FIGURE 5: Scatterplot for CAR_i and $DURATION_i$



As shown by the scatterplot for CAR and DURATION, there are not any notable differences in CAR between the two main clusters of lockup durations, namely 180 and 360 calendar days. The CARs for both clusters are somewhat evenly dispersed around zero and do not show an apparent inclination towards our hypothesized outcome. There are arguably some outliers towards the positive and negative end of both clusters, however, removing these potential outliers will not improve upon the linear relationship between CAR and DURATION (*see Appendix 9*).

The uniformity of lockup durations might explain this non-existent relationship. Previous empirical studies on lockup agreements in the European markets observe that a more heterogeneous approach is undertaken for lockup durations than what has been observed in the US. However, when closely examining our dataset for the Nordic market, it becomes evident that 89 out of the 141 IPOs in our sample ($\approx 63\%$) have a lockup duration of exactly 180 calendar days. This overweight of 180-day lockups is somewhat comparable to the

findings of Field and Hanka (2001), who show that the proportion of 180-day lockups in the US market increased from 43% in 1988 to more than 90% by 1996. Hence, when considered in conjunction with the notable data clusters in the scatterplot of Figure 5, our findings for the Nordic markets suggest that lockup durations moderately conform towards a standardised format. This notion is also brought forth by Chantal Pernille Patel who says that "l*ockups are something that is market practice […] they are made after the same pattern. The period […] is 180 days for the company and the selling shareholders […] and then it is 360 or 365 […] for management and board members*"[34] (Patel, 2018, p. 2).

It is thus apparent that the implications of lockup standardisation complicate the likelihood of observing a significant relationship between lockup duration and abnormal returns at lockup expiration. It is highly probable that standardisation eradicates the potential signalling value of a lockup period's duration. In this sense, outside investors cannot recognize lockup duration as a signalling device for representing firm quality (Brav and Gompers, 2003; Ahmad, 2007; Haggard and Xi, 2017). Instead, lockup duration is arguably considered as a commonly prespecified lockup-characteristic, from which one cannot infer any vital signals of valuable information.

Although lockup duration has not been proven to bear statistical significance, there is however some economic reasoning to be made when considering the correlation matrix for our cross-sectional variables (*see Appendix 8*). Here, one can observe that DURATION has a correlation of 0.33, 0.33, and 0.25 with SHARES_LOCKUP, UNDERWRITER_RANK, and VOLATILITY, respectively. The small magnitude of these correlations does not suggest statistical significance but does however allow us to establish three economically relevant inferences. Firstly, the correlation with VOLATILITY suggests that longer lockups are applied when a great extent of uncertainty persists regarding a firm's prospects. Secondly, the correlation with UNDERWRITER_RANK proposes that longer lockup periods are applied when less reputable underwriters are involved with an IPO. This complies with the notion that reputable underwriters assert less uncertainty to an IPO (Carter and Dark, 1993; Yung and Zender, 2010; Dong *et al.*, 2011), thus allowing an economic inference that UNDERWRITER_RANK and DURATION are potentially substitutable devices for mitigating the pervasiveness of uncertainty. Lastly, the correlation with SHARES_LOCKUP shows that longer lockups generally exist when a greater number of shares are subject to lockup. This is highly relevant, as one can infer that larger potential supply shocks are positioned further towards the future, thus giving investors more leeway to attain sufficient information and construct their predictions on the extent of a potential supply shock at lockup expiration.

Although DURATION has been found to have a minor extent of economic relevance, we cannot justify its inclusion in our model due to its statistical insignificance. Therefore, we have not found evidence for

[34] Translated from Danish.

Hypothesis 2A as we fail to reject the null hypothesis which states that the coefficient for DURATION is equal to zero.

$$H_0: \beta_1 = 0$$

We fail to reject the null hypothesis on DURATION

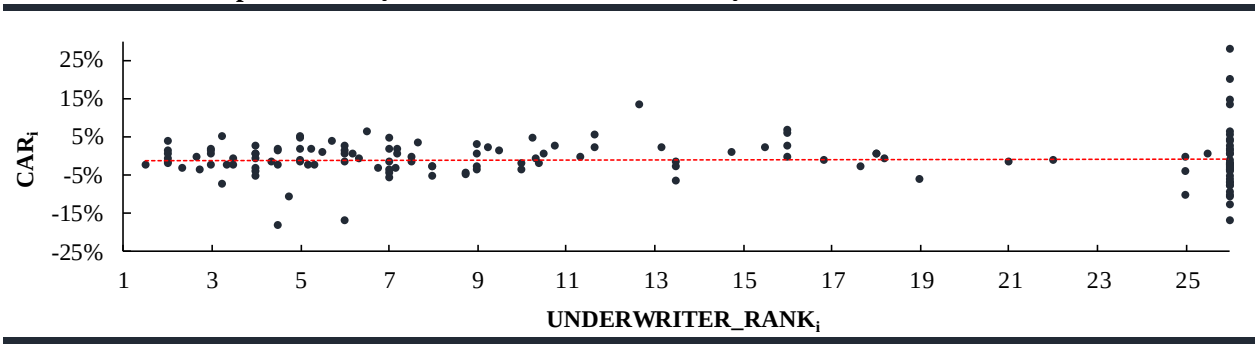
Underwriter reputation (UNDERWRITER_RANK)

The relationship between underwriter reputation and abnormal returns at expiration date was initially addressed by Hypothesis 3B, in which we hypothesized a positive relationship. From a statistical point of view, Hypothesis 3B is tested in the Base Model according to the following null hypothesis:

$$H_0: \beta_4 = 0$$

The multivariate regression for the Base Model in Table 7 yielded a highly insignificant coefficient for UNDERWRITER_RANK ($p = 0.857$), which has a coefficient of nearly zero ($\beta_4 \approx 0.0001$). Hence, the multivariate regression results for the Base Model suggest that there exists no statistically significant relationship between UNDERWRITER_RANK and CAR. To attain a complete understanding of these implications, we construct a scatterplot as shown by Figure 6.

FIGURE 6: Scatterplot for CAR_i and $UNDERWRITER\_RANK_i$



When considering the scatterplot in Figure 6, it is evident that there is limited evidence of a notable relationship between CAR and UNDERWRITER_RANK. The coefficient estimate in the univariate regression is 0.0001, which implies that CAR on average will increase by 0.01 percentage points when involving an underwriter that is one rank lower in the league-table for the year prior to IPO. This relationship has the opposite direction than what we hypothesised, however, as the p-value ($p = 0.920$) in the univariate analysis indicates, this relationship is highly uncertain and troublesome to make any meaningful inference from.

It is possible that the rank value of 26 (*applied for underwriters that are not ranked in the top-25 league tables*) complicates the relationship between the two variables, however, the upper and lower ends of CAR within this

data point of UNDERWRITER_RANK prove that there is a high dispersion of observations[35]. It is therefore not deemed probable that this grouping of observations causes the insignificant estimate of the coefficient on UNDERWRITER_RANK.

The insignificant relationship between CAR and UNDERWRITER_RANK is arguably due to the specific dynamics of the Nordic IPO market. As opposed to the US IPO market, many of the highest ranked underwriters in our Nordic league tables are not domestic. Due to their size, expertise, and global reach, international underwriters are often highly ranked in markets where they do not have any region-specific ties. For example, in the top-25 league table for 2016 (*see Appendix 2*), 9 out of 25 underwriters ($\approx 36\%$) are headquartered outside of the Nordics. These underwriters are often involved with sizeable IPOs but do not necessarily conduct as many Nordic IPOs a year as the local underwriters.

Hence, it is probable that the large international investment banks do not possess the same degree of region-specific knowledge. In addition, this superior region-specific knowledge possessed by the Nordic underwriters can by itself act as a signalling device, thereby offsetting the reputation advantage of the international underwriters. We therefore argue that the positive relationship between CAR and UNDERWRITER_RANK that has been observed in previous US studies (Field and Hanka, 2001; Yung and Zender, 2010) is not as applicable to the Nordic market. Therefore, one must revisit the construction of the variable to account for the region-specific advantages.

Previous literature suggests that underwriter reputation is an adequate proxy for information asymmetry, since reputable underwriters are believed to be more likely to mitigate information asymmetry problems (Hoque, 2014). As noted by Yung and Zender (2010), in the absence of reputable underwriters, insiders themselves may not be able to optimally convey credible promises to the market regarding their own actions at lockup expiration. However, our results do not allow us to support such findings by previous literature.

Due to the statistical insignificance and limited economic implications, we fail to reject the null hypothesis on UNDERWRITER_RANK which suggests that the coefficient is equal to zero. This enforces statistical dissension on Hypothesis 3B, in which we hypothesized a positive relationship between UNDERWRITER_RANK and CAR.

$$H_0: \beta_4 = 0$$

We fail to reject the null hypothesis on UNDERWRITER_RANK

[35] The most positive CAR in our dataset is that of Rethinking Care Sweden AB, which had Sedermera Fondskommision as underwriter – an underwriter that was not in the top-25 league table in any of the years in our sample.

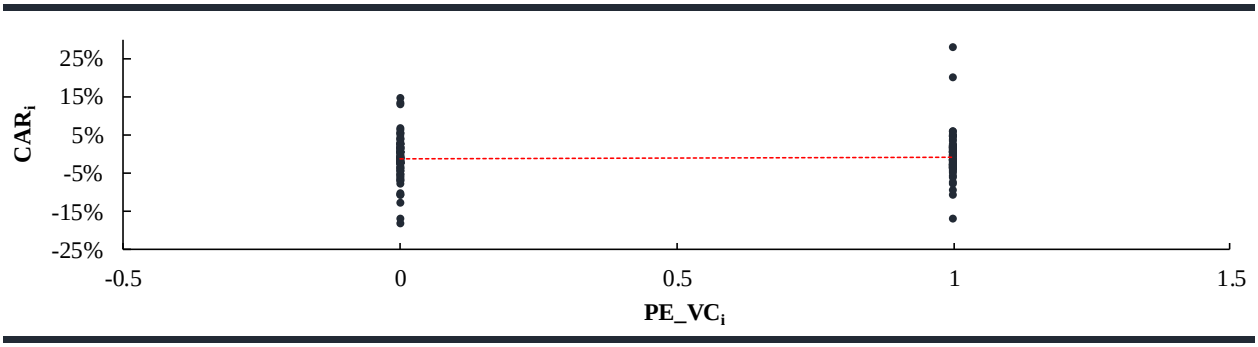
PEVC-restrictive lockups (PE_VC)

The relationship between abnormal returns at lockup expiration and lockups that restrict PEVC-shareholders was initially addressed by Hypothesis 2C, with which we hypothesized that PEVC-restrictive lockups would yield a more negative abnormal return at lockup expiration. From a statistical point of view, Hypothesis 2C is tested in the Base Model according to the following null hypothesis:

$$H_0: \beta_5 = 0$$

The multivariate regression for the Base Model in Table 7 yielded a highly insignificant coefficient for PE_VC ($p = 0.726$), which has a slightly positive coefficient ($\beta_4 \approx 0.004$). The coefficient for PE_VC implies that PEVC-restrictive lockups on average yield a CAR at lockup expiration that is 0.4 percentage points more negative than for lockups that do not restrict PEVC-shareholders. The multivariate regression results for the Base Model discredit any possibility of a statistically significant relationship between PE_VC and CAR. To attain a complete understanding of these implications, we construct a scatterplot as shown by Figure 7.

FIGURE 7: Scatterplot for CAR_i and PE_VC_i



The scatterplot in Figure 7 represents the observations on CAR and PE_VC that were analysed in the univariate regression. The coefficient estimate was found to be highly insignificant ($p = 0.482$), with a value of 0.007 (*which is very similar to the coefficient from the multivariate regression*). The scatterplot in Figure 7 does not depict any signs of a notable relationship between the CAR and PE_VC. Furthermore, there neither appears to be any remarkable outliers that are responsible for the inapparent relationship. The slope of the fitted curve would possibly become slightly negative if one were to remove the distant observations. However, the dispersion of observations is too broad to signify any evident relationship.

It is highly interesting that we do not observe a significant relationship between CAR and PE_VC, since previous literature has appointed great evidence for negative abnormal returns when PEVC-restrictive lockups expire (Bradley *et al.*, 2001; Field and Hanka, 2001; Brav and Gompers, 2003; Brau *et al.*, 2004; Nowak, 2015). Bradley *et al.* (2001) observe that the abnormal trading volume at lockup expiration is significantly larger for PEVC-restrictive lockups. They argue this effect can be attributed to the assumption that PEVC-shareholders typically own a large proportion of shares and have shorter investment horizons than other market

participants. This implies a greater supply shock at lockup expiration, which investors attempt to incorporate in their expectations. As shown in Appendix 10 where we regress the average abnormal volume at lockup expiration on our cross-sectional variables[36], the coefficient of PE_VC is significant at the 10% level ($p = 0.094$) and has a value of 1.366. The coefficient implies that abnormal trading volume at lockup expiration on average is 136.6 percentage points larger when a lockup is PEVC-restrictive. It is thus clearly understandable why investors generally expect larger share disposals when PEVC-lockups expire.

However, the question now prevails why the evidently larger disposal of shares for PEVC-lockups does not result in abnormal price reactions at lockup expiration. From a theoretical standpoint, Krishnamurti and Thong (2008) solely attribute the effect of PEVC-restrictive lockups to liquidity improvements. Hence, they suggest that the disposal of shares at lockup expiration primarily will cause a supply shock, whereas any negative abnormal returns should be explained by investors' inefficient incorporation of the expiration-event in their predictions. An abnormally negative price reaction would thus occur when the disposal of shares by PEVC-shareholders exceed their expectations.

A useful addition to these implications is brought forth by Hoque (2011), who assess lockup agreements according to the signalling effect of certification. Here, he emphasises that certification is substantiated by underwriter reputation and PEVC-reputation. We considered underwriter reputation in Hypothesis 3B, where it was hypothesized that reputable underwriters ensure a reduction in information asymmetry problems and a credible signal-conveyance to outside investors. If one were to broaden this concept to also involve PEVC-reputation, the fundamental inference would be that notable PEVC-shareholders also convey a credible signal of the firm's quality to outside investors. If one were to employ this logic, the prevalence of PEVC-restrictive lockups would have an opposing effect than our hypothesized outcome. Therefore, it is highly probable that signalling effects and market mechanisms assert ambiguous implications on abnormal returns at lockup expiration, thus justifying the statistically insignificant relationship between CAR and PE_VC.

Alternatively, one could also explain our findings according to transfer of ownership. Even though PEVC-shareholders are expected to sell their shares at lockup expiration, it is possible that they merely redistribute the shares to their LPs. Consequently, such selling activity would not constitute a supply shock in the market but rather a change in ownership. This was also emphasized by Field and Hanka (2001), who argue that actual evidence is difficult to obtain on the distribution of shares to LPs. Thus, it is difficult to explicate the cause of abnormal returns when PEVC-restrictive lockups expire, as a large sell-down by a PEVC-shareholder could simply be an internal ownership redistribution among the stakeholders of the fund. One could look further into

[36] One must note that abnormal trading volume has not been found to have a statistically significant impact on abnormal returns. This complies with what one would expect, as our findings and previous literature suggest that abnormal returns are explained from an *ex ante* perspective. Nevertheless, this detail is vital to mention since it should not be inferred that the cross-sectional variables have an indirect impact on abnormal returns through their statistically significant impact on abnormal volume.

these implications by investigating whether such data could be attained. However, this has been deemed to lie beyond the scope of our thesis.

Finally, it must be briefly noted that the coefficient for PE_VC is insignificant possibly due to the construction of our variable. The observations in our sample are assigned a dummy-value of 1 if any of the restricted shareholders in a lockup agreement are PE or VC firms. This does not take into consideration the effect of other types of locked up shareholders. For example, a single lockup agreement could impose combined restrictions on PEVC-shareholders, management, members of the board of directors, and institutional shareholders. As a matter of fact, only 26 out of the 71 PEVC-restrictive lockups in our sample ($\approx 37\%$) are purely restrictive on PEVC-shareholders.

Conversely, the remaining 45 PEVC-restrictive lockups ($\approx 63\%$) also impose restrictions on other types of shareholders[37]. When such lockups expire, one will therefore observe an ambiguous impact on the stock price due to the relatively more long-term commitment of institutional shareholders and equity-owning members of management and the board of directors. It is therefore possible that these effects oppose the hypothesized outcome of Hypothesis 2C on PEVC-restrictive lockups. However, this issue is intrinsic to the very nature of lockup agreements, as several types of shareholders may be subject to restrictions that expire on the same day. We suggest that one could look further into this issue by controlling for shareholder-types and incorporating interaction terms. This is however beyond the scope of our thesis and merely a suggestive notion for future research.

Due to the theoretical, economic, and methodological implications that are discussed above, we choose to exclude the PE_VC variable from our model. When considering this in conjunction with the statistically insignificant results from the multivariate regression (*Table 7*) and univariate regression (*Table 8*), we thus discredit the hypothesized outcome of Hypothesis 2C. Therefore, we fail to reject the null hypothesis on the relationship between CAR and PE_VC.

$$H_0: \beta_5 = 0$$

We fail to reject the null hypothesis on PE_VC

[37] Mostly institutional cornerstone investors and shareholding members of management and the board of directors

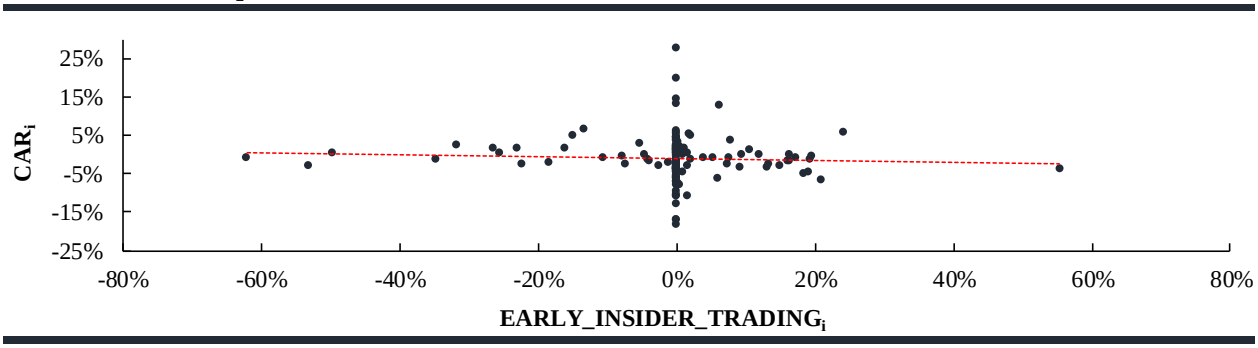
Early insider trading (EARLY_INSIDER_TRADING)

The relationship between early insider trading and abnormal returns was initially addressed by Hypothesis 4B, in which we hypothesized a positive relationship between the percentage change in insider shares prior to lockup expiration and abnormal returns at lockup expiration. From a statistical point of view, Hypothesis 4B is tested in the Base Model according to the following null hypothesis:

$$H_0: \beta_7 = 0$$

The multivariate regression for the Base Model in Table 7 yielded a highly insignificant coefficient for EARLY_INSIDER_TRADING ($p = 0.570$) with a negative coefficient ($\beta_7 \approx -0.025$). The coefficient implies that CAR decreases by 0.025 percentage points when total insider shares increase by 1 percentage point during the lockup period. The multivariate regression results for the Base Model suggest that there exists no statistically significant relationship between EARLY_INSIDER_TRADING and CAR. To establish a comprehensive understanding of this result, we construct a scatterplot as shown by Figure 8.

FIGURE 8: Scatterplot for CAR_i and $EARLY\_INSIDER\_TRADING_i$



As shown in the univariate regression (*Table 8*), the coefficient of -0.026 for EARLY_INSIDER_TRADING is highly comparable to the output from the multivariate regression (*Table 7*). This relationship can be observed in the scatterplot in Figure 8, where the slope of the fitted line appears to be slightly negative. However, it can also be observed that most observations on EARLY_INSIDER_TRADING have a value of zero, which means that there have not occurred any insider purchases or sales during the lockup period. Specifically, 97 out of 141 observations ($\approx 69\%$) are observed to have a value of 0% for EARLY_INSIDER_TRADING. This implies that there are only 44 observations ($\approx 31\%$) that in fact determine the slope of the fitted curve in the scatterplot of Figure 8.

Furthermore, among of the 44 firms where insider trades have occurred during the lockup period, there are only 4 instances where more than 50% of the insider shares were sold and only 1 case where the insider position increased by more than 50%. One can infer from the scatterplot that the trading frequency and degree of variation in EARLY_INSIDER_TRADING is very low. Therefore, unless small variations in

EARLY_INSIDER_TRADING had large responses in CAR, it makes statistically sense that we do no observe any clear relationship.

Our hypothesized outcome for Hypothesis 4B was based on the theoretical implications of signalling, where early purchases (*sales*) would convey positive (*negative*) signals to outside investors regarding the true value of the firm. The hypothesis was substantiated by the concept of information asymmetry, where insiders are privy to private information regarding the firm's prospects. For example, in a setting where information asymmetry prevails, any purchases by insiders prior to lockup would convey a signal to outside investors that insiders know of positive information regarding the firm's prospects. However, when considering the scatterplot in Figure 8, it is evident that the slope of the fitted line contradicts our hypothesized outcome.

A possible explanation for why we do not observe any indication of a positive relationship between CAR and EARLY_INSIDER_TRADING is that investors' reactions to early trading activity may be fully incorporated in the stock price when such trades are announced. Holding all else equal, this would imply that any potential misalignment in information held by insiders and outside investors would be represented by an immediate price reaction. Therefore, potential misalignments in information would be more likely to be brought forth prior to lockup expiration.

Field and Hanka (2001) report that only 1.1% of the firms in their sample had early releases from lockup agreements. More interestingly, half of these early releases were granted without a public announcement. Hence, even though insiders were permitted to an early release from a lockup, it is possible that it has not been clear to outside investors. One could thus assume that an adequate price reaction would not occur when early insider trades are announced but would instead be delayed until the remaining locked up shares are released at lockup expiration. However, this notion of Field and Hanka (2001) is not supported by our results.

It must however be noted that our measurement of EARLY_INSIDER_TRADING encompasses all insider trades that have taken place throughout the lockup period. Therefore, our results are not directly comparable to those of Field and Hanka (2001) since their study only considers the early trading activity of locked up insiders. As mentioned in the methodology section, we assume that any insider trades prior to a lockup's expiration will convey relevant information to outside investors, thus validating our proxy for early trading activity of insiders.

However, the primary complicative consequence for our measurement is that we cannot infer whether outside investors adjust their predictions on the potential magnitude of share disposals at lockup expiration, since we have no insight on whether such early insider disposals are made by locked up shareholders. If one were to assume that the signalling value of early insider trades are incorporated in the stock price when such trades are announced, the residual effect at lockup expiration would stem from investors having adjusted their expectations on the potential supply shock.

In conclusion, when having investigated further into our dataset we suppose that early releases possibly are an exception to the norm. Furthermore, it appears to be highly probable that early insider trades are efficiently incorporated immediately after the announcement of such trades, which implies that there will persist a limited residual effect on the stock price at lockup expiration. When considering our economic and methodological implications in conjunction with the insignificant statistical output for EARLY_INSIDER_TRADING, it is evident that our results do not comply with the hypothesized outcome of Hypothesis 4B. We therefore fail to reject the null hypothesis on EARLY_INSIDER_TRADING.

$$H_0: \beta_7 = 0$$

We fail the reject the null hypothesis on EARLY_INSIDER_TRADING

6.2.2 Stepwise model 1

The dissension on Hypothesis 2A, 2C, 3B, and 4B leads to the four variables being omitted from our cross-sectional model, thus forming Stepwise Model 1:

$$\begin{aligned} CAR_i = \alpha + \gamma_1 SHARES\_LOCKUP_i + \gamma_2 UNDERPRICING_i + \gamma_3 VOLATILITY_i + \gamma_4 PRICE\_RAMP_i \\ + \gamma_5 YEAR_i + \gamma_6 INDUSTRY_i + \gamma_7 EXCHANGE_i + \gamma_8 M\_B_i + \gamma_9 OFFER\_PRICE_i \\ + \gamma_{10} SIZE_i + \varepsilon_i \end{aligned} \quad (10)$$

After initially running the Stepwise Model 1, the residuals are obtained and plotted against the four omitted variables. As can be seen from these four plots in Appendix 11, there does not exist any observable linear nor non-linear relationship between the residuals and the omitted variables, thus affirming the decision of removing these variables from the regression equation.

The multivariate regression output for Stepwise Model 1 is shown in Table 9 below.

TABLE 9: Regression output for Stepwise Model 1

	Dependent variable
Independent variables	CAR
SHARES_LOCKUP	-0.010***
	p = 0.007
UNDERPRICING	-0.069
	p = 0.143
VOLATILITY	-0.382
	p = 0.319
PRICE_RAMP	-0.079***
	p = 0.001
Constant	0.052
	p = 0.281
Observations	141
R^2	0.276
Adjusted R^2	0.087
Residual Std. Error	0.055 (df = 111)
F Statistic	1.459* (df = 29; 111)

The model includes the following control variables: YEAR, INDUSTRY, EXCHANGE, M_B, OFFER_PRICE, and SIZE
**p<0.1; **p<0.05; ***p<0.01*

From the regression output for Stepwise Model 1, one can observe that the model has begun to conform to a more correct specification. The F statistic of 1.459 is now statistically significant, however only at a 10% significance level. The significance of the coefficient estimates for the remaining variables has increased, as SHARES_LOCKUP and PRICE_RAMP are still highly significant and the p-value of the coefficient estimate for UNDERPRICING has improved from 0.160 to 0.143. However, it should be noted that the coefficient estimate for VOLATILITY and the constant term are still highly insignificant, although their p-values have improved.

Looking at the coefficient of determination, our model still suffers from a rather low adjusted R^2 of 8.7%. As previously mentioned, this is mainly due to our categorical control variables, which take up a lot of degrees of freedom. From the regression output of the Stepwise Model 1 with the control variables shown (*see Appendix 12*), one can see that only the coefficient estimate of the market-to-book variable is significant at a 10% significance level. All the levels of our categorical variables as well as the inverted offer price variable are insignificant at a 10% significance level. Therefore, we will investigate the implications of removing these categorical control variables from our regression equation. This brings us forth to the next step in the stepwise regression procedure.

6.2.3 Stepwise model 2

Stepwise Model 2 is created by omitting all of the fixed effects control variables:

$$CAR = \alpha + \delta_1 SHARES\_LOCKUP_i + \delta_2 UNDERPRICING_{i_i} + \delta_3 VOLATILITY_{i_i} + \delta_4 PRICE\_RAMP_i + \delta_5 M\_B_i + \delta_6 OFFER\_PRICE_i + \delta_7 SIZE_i + \varepsilon_i \quad (11)$$

We run different versions of Stepwise Model 2 where we enter and omit the remaining control variables to observe their individual effects. This is shown in Table 10:

TABLE 10: Regression output for Stepwise Model 2

	Dependent variable		
	CAR		
Independent variables	(1)	(2)	**(3)**
SHARES_LOCKUP	-0.007**	-0.008**	-0.007**
	p = 0.024	*p = 0.015*	*p = 0.017*
UNDERPRICING	-0.040	-0.036	-0.036
	p = 0.304	*p = 0.349*	*p = 0.359*
VOLATILITY	-0.391	-0.444	-0.456
	p = 0.204	*p = 0.163*	*p = 0.149*
PRICE_RAMP	-0.071***	-0.070***	-0.070***
	p = 0.001	*p = 0.001*	*p = 0.001*
SIZE		0.00000	
		p = 0.661	
M_B	0.0003***	0.0003***	0.0003***
	p = 0.010	*p = 0.010*	*p = 0.010*
OFFER_PRICE		0.027	0.026
		p = 0.335	*p = 0.353*
Constant	0.008	0.009	0.010
	p = 0.404	*p = 0.397*	*0 = 0.339*
Observations	141	141	141
R^2	0.171	0.178	0.177
Adjusted R^2	0.141	0.134	0.140
Residual Std. Error	0.053 (df = 135)	0.054 (df = 133)	0.052 (df = 134)
F Statistic	5.578*** (df = 5; 135)	4.107*** (df = 7; 133)	4.788*** (df = 6; 134)

The fixed effects control variables (YEAR, INDUSTRY, and EXCHANGE) are excluded from the model. Furthermore, the remaining control variables are included to differing extents as shown by the columns.

**p<0.1; **p<0.05; ***p<0.01*

When omitting all of the categorical control variables, the adjusted R^2 increases (*as expected*) to 14% across all three columns in Table 10. The F statistic becomes significant at a 1% significance level and the model generally seems to have improved in explanatory power, as it does not suffer from irrelevant surplus control variables with little explanatory power. When looking at the individual significance of the variables, omitting the categorical control variables has two conspicuous implications. Firstly, the coefficient estimate for

VOLATILITY becomes more significant, especially when including inverted offer price as a control variable. Secondly, the coefficient estimate for UNDERPRICING becomes highly insignificant regardless of which other control variables are included. We must therefore further investigate the inclusion of VOLATILITY in the model as well as its relationship with OFFER_PRICE. Thereafter, we will assess the implications for UNDERPRICING and seek to explain why we observe this insignificant effect on CAR.

Volatility (VOLATILITY) and inverted offer price (OFFER_PRICE)

From Table 10, one can observe that the coefficient estimate for VOLATILITY becomes significant at a 15% significance level when only M_B and OFFER_PRICE are included as control variables. From a theoretical standpoint, the increased significance of VOLATILITY due to the inclusion of OFFER_PRICE as a control variable makes viable sense. VOLATILITY is the risk component of our estimation period returns whereas OFFER_PRICE is the proxy variable for the risk of the firm at IPO. In theory, a higher inverted offer price should entail higher risk for the IPO (Beatty and Ritter, 1986; Tinic, 1988). When omitted from our model, this risk component will be captured in the error term. If one assumes that there is a correlation between risk at the IPO and the subsequent aftermarket risk factor, the error term will be correlated with VOLATILITY. This will result in VOLATILITY being endogenous and, in turn, this endogeneity will make our regression equation spurious and the results thereof biased and inconsistent.

We investigate the presence of endogeneity due to an observable omitted variable by testing the relationship between VOLATILITY and OFFER_PRICE (*see Appendix 13*). Firstly, the correlation between VOLATILITY and OFFER_PRICE is calculated to be 0.232, suggesting a positive relationship between risk at IPO and the aftermarket risk. Secondly, we run two regressions, namely one with OFFER_PRICE included and one with OFFER_PRICE omitted:

$$CAR_i = \alpha + \varphi_1 SHARES_{LOCKUP\,i} + \varphi_2 UNDERPRICING_i + \varphi_3 VOLATILITY_i + \varphi_4 PRICE\_RAMP_i + \varphi_5 M\_B_i + \varphi_6 OFFER\_PRICE_i + \varepsilon_i \quad (12)$$

$$CAR_i = \alpha + \varphi_1 SHARES\_LOCKUP_i + \varphi_2 UNDERPRICING_i + \varphi_3 VOLATILITY_i + \varphi_4 PRICE\_RAMP_i + \varphi_5 M\_B_i + \varepsilon_i \quad (13)$$

If the coefficient estimate of VOLATILITY changes in the same direction as the correlation between VOLATILITY and OFFER_PRICE when omitting the latter variable, it will be concluded that there exists a substantial correlation between VOLATILITY and OFFER_PRICE and, in turn, endogeneity will be present. Specifically, when omitting OFFER_PRICE, the positive correlation between the two variables will be captured in the error term, exerting a systematic upward bias on the coefficient estimate of VOLATILITY.

From the output of the two regression equations (*see Appendix 13*), one can observe that the coefficient estimate of VOLATILITY becomes less negative when omitting OFFER_PRICE, which corresponds with their positive correlation. Thus, it is concluded that omitting OFFER_PRICE from the regression equation will result in endogeneity. Endogeneity arising from an omitted variable is easily amended by including the omitted variable again if said variable is observable and measured correctly. Even though OFFER_PRICE is not an explicit predictor of CAR, it should still be included in the regression equation to ensure optimal specification. Once included in the model, the disturbance term is purged from the source of its correlation with VOLATILITY and the estimation of the coefficient should no longer be affected by endogeneity.

The coefficient estimate for VOLATILITY in column 3 for Stepwise Model 2 (*Table 10*) has a value of -0.456, which implies that CAR decreases by 0.456 percentage points when VOLATILITY increases by 1 percentage point. Thus, in addition to being statistically significant at a 15% significance level, the coefficient estimate of VOLATILITY also has a high economic significance. Therefore, due to the relatively small p-value and the high magnitude of the coefficient estimate for VOLATILITY, as well as the problem of endogeneity associated with omitting OFFER_PRICE, we continue to include both variables in the regression equation. We will not elaborate further upon the specific relationship between VOLATILITY and CAR for now, as this will be done when we have arrived at the Final Model specification.

First-day returns (UNDERPRICING)

When excluding the fixed effects control variables, the coefficient estimate of UNDERPRICING becomes highly insignificant. Specifically, UNDERPRICING becomes insignificant when YEAR is left out of the regression equation. This means that UNDERPRICING is only a significant predictor of CAR (*at a 15% significance level*) if we control for the year of the lockup expiration. As neither of levels of YEAR have any significant effects on CAR, YEAR itself does not assert any substantial effect on CAR. This implies that CAR is not dependent on any time-variant effects related to the lockup provisions in the sample. Combined with the fact that the overall explanatory power suffers from the inclusion of categorical variable with that many levels, it is hard to argue that YEAR should be included as a control variable in the regression equation.

In addition to being statistically insignificant, the coefficient estimate of UNDERPRICING also has the opposite sign than what we hypothesised. For hypothesis 3A, we expected a positive relationship between first-day returns and abnormal returns at expiration date. Furthermore, it is tested according to the following null hypothesis:

$$H_0: \delta_2 = 0$$

Contrary to our hypothesis, we estimate a coefficient for UNDERPRICING of -0.036 to -0.040 according to the columns in Table 10 for the Stepwise Model 2. The observed negative relationship is in accordance with the finding of Tolia and Yip (2003) that negative abnormal returns are only significant at a 5% significance level for "Hot IPOs"[38]. They ascribe this finding to the profit-seeking behaviour of investors who anticipate the supply shock on the expiration of lockup provisions. This explanation is built upon the work of Kahneman and Tversky (1979) who develop the prospect theory as an alternative model to the notion of perfect rationality behind buy/sell motives of investors. As explained in the development of Hypothesis 3A and 4C, the prospect theory[39] prescribes that investors are increasingly risk averse when they have something to lose, thus making them more inclined to sell positions that yield gains. In the context of IPO underpricing and lockup expirations, loss aversion implies that investors currently holding shares in a firm that was initially underpriced, assert substantial weight on retaining their potential profit. With the possible prospect of a large share price decline at expiration date, these investors emphasise the value of obtaining a certain profit over holding on to the profit generating shares and seeking additional returns.

Although Tolia and Yip (2003) only find the "Hot IPOs" category to yield statistically significantly abnormal returns, they find that all four categories of first-day returns, from "Cold IPOs"[40] to "Extra Hot IPOs"[41], on average experience negative abnormal returns. Thus, negative abnormal returns are not an isolated phenomenon for IPOs with high initial returns, but rather present across the entire sample. In addition, they report the direction of relationship to be highly sensitive to the applied event window, thereby coming short of establishing a clear and distinct relationship between first-day returns and CAR. This unclear relationship is embodied in the p-values of UNDERPRICING from the Stepwise 2 models, which all surpass a value of 0.3. These results ignite a discussion on whether the information momentum of underpricing is persistently evident throughout the lockup period.

Prior literature finds only modest evidence of the information content that underpricing is associated with. On the one hand, it can be argued that investors anchor their beliefs to initial returns and thus insufficiently adjust to new market information. For underpriced IPOs, this implies that investors are less worried about potential float effects at expiration whereas overpriced IPOs encourage an induced level of flipping activity by outside investors at the expiration date which should be seen as the appropriate response to unfavourable pricing (Lichtenstein and Slovic, 1971; Kahneman, Slovic, and Tversky, 1982; Krigman *et al.*, 1999). On the other hand, empirical research suggests that firms with the highest initial returns do not have higher aftermarket excess returns (Ritter, 1991; Carter and Dark, 1993). This entails that the informational value of underpricing may be eroded when approaching lockup expiration.

[38] IPOs with first-day return between 10%-60%
[39] From which the disposition effect is derived (Chen *et al.*, 2012)
[40] IPOS with 0 or negative first-day return
[41] IPOs with first-day return greater than 60%

Our findings concur with the latter notion and pose UNDERPRICING to be an inconsistent predictor of CAR lockup expiration. The relationship between first-day returns and abnormal returns is a rather untested area with few unanimous findings and many opposing conjectures, thus making it difficult to establish a clear, unidirectional correlation. We contribute to the field of underpricing within a lockup context by asserting that the information content of initial IPO returns vanishes during the lockup period, thus not constituting a relevant predictor of CAR at lockup expiration. We therefore conclude the following for Hypothesis 3A:

$$H_0: \delta_2 = 0$$

We fail to reject the null hypothesis on UNDERPRICING

As we fail to reject the null hypothesis for UNDERPRICING, the variable is omitted from Stepwise Model 2, thus forming the following regression equation[42]:

$$CAR_i = \alpha + \theta_1 SHARES\_LOCKUP_i + \theta_2 VOLATILITY_i + \theta_3 PRICE\_RAMP_i + \theta_4 M\_B_i + \theta_5 OFFER\_PRICE_i + \varepsilon_i \quad (14)$$

In summary, through the iterative stepwise regression process, we have excluded DURATION, UNDERWRITER_RANK, PE_VC, EARLY_INSIDER_TRADING, and UNDERPRICING as predictors of CAR at lockup expiration based on econometric analysis, theoretical foundation, and logical reasoning. Conversely, we have not found any justifiable reasons to omit SHARES_LOCKUP, VOLATILITY, and PRICE_RAMP. Altogether, this implies that the regression equation above constitutes the model specification we see best fitted when analysing cross-sectional differences in CAR at lockup expiration. We acknowledge that this specification is merely one of many justifiable models, however, we argue to the best of our knowledge that Equation 14 describes the CARs of our dataset in the most concise manner. Moreover, in order to substantiate our model specification, we will in the following section provide an alternative stepwise regression procedure which utilises a more objective measure as the inclusion/exclusion criterion.

6.2.4 Stepwise model selection by AIC

As the final procedure of the stepwise regression, we perform a stepwise model selection procedure according to Akaike's Information Criterion (AIC). This is carried out to check the validity of our rather subjective stepwise selection process by comparing it to an objective measure, namely the AIC. The AIC is given by:

$$AIC_k = n \ln(SSE) - n \ln(n) + 2(k+1), \quad (15)$$

[42] In addition to the removal of UNDERPRICING, we also omit SIZE as control variable from the regression equation. SIZE does not have any significant effects in our sample, neither with the dependent variable nor with any of the explanatory variables, thus making it redundant to include it in the regression equation.

where *n* is the sample size, *k* is the number of predictors, and *SSE* is the sum of squared errors.

AIC trades off two forces when you add and remove variables from a regression equation. Due to the properties of OLS, the first term, $(n\ln(SSE))$, decreases (*or at least does not increase*) when adding an additional explanatory variable. Conversely, the second term, $(n\ln(n) + 2(k+1))$, increases when adding an additional explanatory variable. AIC trades off these two forces so that the specific set of variables that minimises AIC become a consistent estimator of the true specification of the regression model (Stock and Watson, 2011). Thus, the statistical software will test if we have excluded any variables that might possess significantly explanatory power based on AIC. The output for the AIC stepwise regression is shown by the ANOVA table in Table 11.

TABLE 11: AIC stepwise regression ANOVA table

Step	DF	Deviance	Residual DF	Residual Deviance	AIC
1			107	0.3339297	-784.4274
2 - factor.industry	10	0.0202445192	117	0.3541742	-796.1284
3 - factor.year	8	0.0147618942	125	0.3689361	-806.3707
4 - factor.exchange	4	0.0084652074	129	0.3774013	-811.1721
5 - PE_VC	1	0.0002182720	130	0.3776196	-813.0905
6 - EARLY_INSIDER_TRADING	1	0.0006540976	131	0.3782737	-814.8465
7 - UNDERWRITER_RANK	1	0.0012108650	132	0.3794845	-816.3959
8 - SIZE	1	0.0009386049	133	0.3804231	-818.0476
9 - DURATION	1	0.0013423383	134	0.3817655	-819.5509
10 - UNDERPRICING	1	0.0024163947	135	0.3841819	**-820.6613**

The final and lowest value of AIC is shown by the coloured cell with a bold value.

The output from the AIC stepwise regression procedure (*Table 11*) confirms the choice of our Final Model. According to AIC, the Final Model should indeed include SHARES_LOCKUP, VOLATILITY, and PRICE_RAMP as explanatory variables. On the one hand, we can see from the ANOVA table of the AIC stepwise regression test that no other variable from the Base Model can lower the AIC and thus the test concludes that our model is not underspecified. On the other hand, our model could still potentially suffer from being overspecified. However, having based our assessment on our thorough economical and statistical analyses of all variables in a combined and isolated setting, we infer that this is the best specified model for our dataset (*see Appendix 14 for a comparison of the various Final Model candidates suggested by the AIC stepwise regression tool*).

Regarding the chronology of our stepwise regression procedure, our order of removing variables from the regression equation is in accordance with the AIC procedure. DURATION, UNDERWRITER_RANK, PE_VC, and EARLY_INSIDER_TRADING are the variables that decrease AIC to the greatest extent when removed, whereas UNDERPRICING is the variable that lowers the AIC the least when removed. This is the exact same chronology followed in our stepwise regression procedure and thus further underlines our choice

of the Final Model as the best specified model. We therefore reiterate our stance that SHARES_LOCKUP, VOLATILITY, and PRICE_RAMP are the most optimal final predictors of CAR at lockup expiration.

6.3 Final model

Through the stepwise regression process we arrive at the following model specification:

$$CAR_i = \alpha + \phi_1 SHARES\_LOCKUP_i + \phi_2 VOLATILITY_i + \phi_3 PRICE\_RAMP_i + \phi_4 M\_B_i + \phi_5 OFFER\_PRICE_i + \varepsilon_i \quad (16)$$

This regression equation constitutes our Final Model for the cross-sectional analysis. Below, Table 12 shows the regression output from running the Final Model.

TABLE 12: Regression output for Final Model

	Dependent variable
Independent variables	CAR
SHARES_LOCKUP	-0.007**
	p = 0.021
VOLATILITY	-0.479
	p = 0.128
PRICE_RAMP	-0.069***
	p = 0.001
Constant	0.012
	p = 0.236
Observations	141
R^2	0.171
Adjusted R^2	0.141
Residual Std. Error	0.053 (df = 135)
F Statistic	5.583*** (df = 5; 135)

The model includes the following control variables: M_B and OFFER_PRICE.
**p<0.1; **p<0.05; ***p<0.01*

The regression output indicates that our Final Model appears well specified and robust. The Final Model has an R^2 of 17.1% and a relatively high adjusted R^2 of 14.1%, compared to the Base Model's 5.8%. An adjusted R^2 of 14.1% is deemed to be more than satisfactory for our research area. Regression models with stock prices incorporated as a component in the dependent variable usually do not yield high a R^2 as it is improbable to incorporate all the factors that affect a stock price into one unified model. Furthermore, the Final Model has a highly significant F statistic, again a considerable improvement from the Base Model.

Once again, we perform model diagnostics to ensure that the Final Model complies with the OLS assumptions. And once again, the distribution of the error term seems to be the only problem. The QQ-plot as well as various normality tests imply that the distribution of the residuals still follows a heavy tails distribution, thus violating

the assumption of normality of the error term. However, as argued earlier, this will not hurt our inference as OLS does not per se require normal errors to estimate coefficients efficiently. As many econometric textbooks in fact ignore this assumption when the parameter estimates are not used for forecasting, we will disregard this assumption. A detailed investigation of the normality assumption as well as the other OLS assumptions is provided in Appendix 15 and Appendix 16.

With respect to inferences for each of the explanatory variables, we will in the following sections provide a thorough investigation of the observed relationship with CAR in the Final Model.

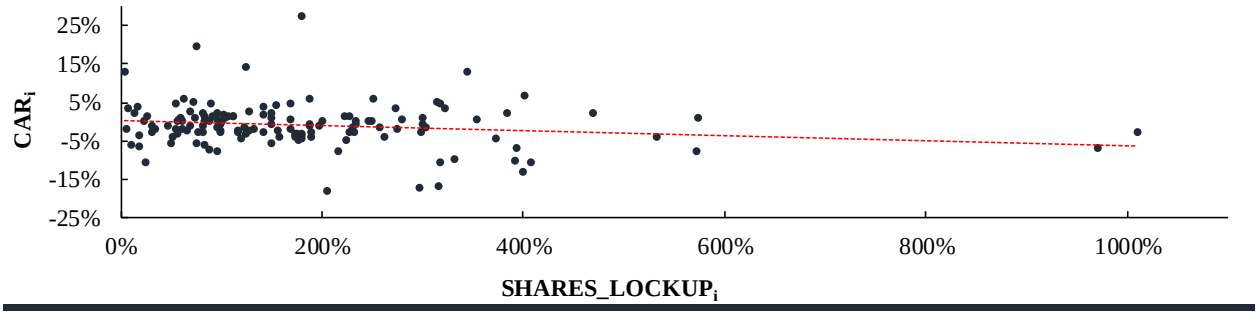
Percentage of shares locked up (SHARES_LOCKUP)

The relationship between locked up shares and abnormal returns at lockup expiration was initially addressed by Hypothesis 2B, in with which we hypothesized a negative relationship. From a statistical point of view, Hypothesis 2B is tested in the Final Model according to the following null hypothesis:

$$H_0: \phi_1 = 0$$

The multivariate regression for the Final Model in Table 12 yielded a highly significant coefficient for SHARES_LOCKUP ($p = 0.021$) with a negative coefficient ($\phi_1 \approx -0.007$). The significant coefficient implies that CAR decreases by 0.7 percentage points when the percentage of locked up shares relative to free float increases by 100 percentage points. Hence, the multivariate regression's results for the Final Model signifies evidence of a statistically significant relationship between SHARES_LOCKUP and CAR. To establish a comprehensive understanding of this result, we construct a scatterplot as shown by Figure 9.

FIGURE 9: Scatterplot for CAR_i and $SHARES\_LOCKUP_i$



The scatterplot depicts the negative relationship between CAR and SHARES_LOCKUP in an isolated setting. The slope of the fitted curve is -0.006 and is significant at the 5% level. This slope is somewhat comparable to the yielded result of the multivariate regression for the Final Model. The dispersion of observations indicates an evident inclination of positive CARs when SHARES_LOCKUP is lower than 200%, whereas CAR pertains to more negative values as SHARES_LOCKUP increases. From our summary statistics in Table 6, one can

observe that SHARES_LOCKUP has a mean value of 179% and a median value of 143%. This is substantially larger than what is observed by several previous empirical studies (Brav and Gompers, 2003; Brau *et al.*, 2004; Nowak, 2015), since we calculate the percentage of locked up shares relative to free float at IPO rather than total shares outstanding at IPO.

This relationship between CAR and SHARES_LOCKUP suggests that outside investors become more uncertain regarding the potential supply shock at lockup expiration when a greater proportion of shares are subject to a lockup. When a great magnitude of shares is subject to lockup, any minor inaccuracies in investors' predictions would lead to substantial estimation errors. This is a noteworthy inference, since outside investors will incorporate the possibility of shares flooding the market in their prediction on transpiring trades at lockup expiration. In line with this logic (*and given the significantly negative relationship between CAR and SHARES_LOCKUP as shown in Table 12*), our results suggest that there consequently is a greater likelihood of investors having underestimated the actual supply shock at lockup expiration. Negative abnormal returns therefore occur when outside investors have underestimated the magnitude of insiders' share disposals.

In addition, we can add the assumption that information asymmetry asserts a misalignment of information held by insiders and outside investors. Leland and Pyle (1977) argue that insiders' proportional ownership of shares functions as a signal of the firm's true value. In this sense, a larger value of SHARES_LOCKUP would convey a positive signal to the market on the firm's true quality, which would lead outside investors (*who possess an informational disadvantage*) to expect a lessened likelihood of informative selling at lockup expiration (*therefore share disposals would only be motivated by diversification needs*).

However, as mentioned in the hypothesis development for Hypothesis 2B, the cost of imitating such large holdings by insiders are relatively low, which implies that insiders of low-quality firms also are likely to attempt to convey such signals to the market. Such investors are more likely to engage in informative selling at lockup expiration since they are expected to sell out at the first chance they get, which is motivated by holding negative private information (Ahmad, 2007). In this setting, there would be a greater probability of shares unexpectedly flooding the market at lockup expiration (Leland and Pyle, 1977). Consequently, our result of a significantly negative relationship between CAR and SHARES_LOCKUP could indicate that information asymmetry causes investors to inaccurately predict the motivation of insider-selling, and thus miscalculate their expectation of the actual magnitude of insiders' share disposals at lockup expiration.

Brau *et al.* (2004) substantiate the theoretical outlook of Leland and Pyle (1977), as they emphasize that information asymmetry is more likely to become a problem when a greater proportion of shares are held by insiders. In this sense, the signals that are conveyed by insiders must be highly credible for outside investors to be assured that their predictions on motivated share disposals are accurate. Hence, our findings suggest that misleading signals fail to comply with the actual degree of insider-selling at lockup expiration and thus causes a sudden and abnormal price reaction.

Additionally, one can also explain the negative price reaction according to heterogeneous and overconfident investor beliefs. As argued by Hong *et al.* (2005), the probability of speculative price bubbles is high when the free float of tradable shares is limited (*i.e. when relatively more shares are subject to lockup*). Hong *et al.* (2005) assume that investors have heterogeneous beliefs, are influenced by overconfidence, and face short-selling constraints (Kahl *et al.*, 2003). When establishing such assumptions, the focal effect is that overconfidence and heterogeneous beliefs are more likely to be impactful on the stock price when short-selling constraints are prevalent and substantial.

Furthermore, such short-selling constraints will be more substantial when relatively less shares are tradable in the market (Hong *et al.*, 2005). The stock price is thus believed to exceed the firm's fundamental value due to an optimism effect and a resale option effect. According to the optimism effect, our findings suggest that the stock price only reflects the beliefs of optimistic investors since conservative investors merely remain inactive due to short-selling constraints. In addition, the resale option effect suggests that outside investors expect to attain a premium when selling their own shares due to the limited tradable supply in the market (Hong *et al.*, 2005). According to the optimism effect and resale option effect, our findings could possibly suggest that stock prices will be overvalued due to speculation when SHARES_LOCKUP is larger, thus leading to a greater likelihood of abnormally negative price reactions at lockup expiration, as insiders' selling activity will surpass the heterogeneous and overconfident expectations of outside investors.

As noted by Sebastian Hougaard, "*a part of it might be [investors] remembering that the lockup actually expires*" (Hougaard, 2018, p. 4). Hence, it is possible that investors do not fully incorporate their expectations for the lockup expiration in due time, which furthermore can be explained by information asymmetry, market inefficiency and investor overconfidence, as discussed above. In conclusion, our analysis has yielded significant evidence of a negative relationship between CAR and SHARES_LOCKUP, which complies with our hypothesized outcome in Hypothesis 2B. We will therefore reject the null hypothesis.

$$H_0: \phi_1 = 0$$

We reject the null hypothesis on SHARES_LOCKUP

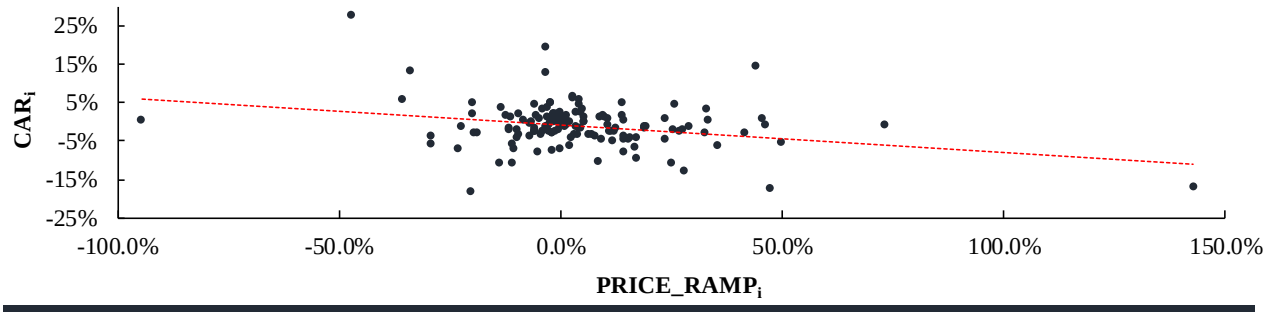
Lockup period price ramp (PRICE_RAMP)

Under Hypothesis 4C, we expected a positive relationship between PRICE_RAMP and CAR; that is, we expected a more positive lockup period price-run to be associated with a positive CAR at lockup expiration. From a statistical point of view, Hypothesis 4C is tested in the Final Model according to the following null hypothesis:

$$H_0: \phi_3 = 0$$

As shown in Table 12, the coefficient estimate for PRICE_RAMP is highly significant ($p = 0.001$) with a value of -0.069. Thus, CAR decreases by 0.069 percentage points when the cumulative lockup period return increases by 1 percentage point. This significantly negative relationship is also easily observable when plotting CAR against PRICE_RAMP in an isolated setting, as shown by Figure 10:

FIGURE 10: Scatterplot for CAR_i and $PRICE\_RAMP_i$



The scatterplot in Figure 10 shows a clearly negative relationship between PRICE_RAMP and CAR. The negative relationship between PRICE_RAMP and CAR could point towards insiders following a contrarian investment strategy at the expiration date. Chen *et al.* (2012) show that insiders are more likely to be net sellers when the stock price has undergone large run-ups during the 30 trading days prior to expiration. This was accordingly documented by Ahmad *et al.* (2017) who attributed the finding to the diversification effect. In line with Ofek and Richardson (2000), they proposed that a consecutive increase in a stock price may result in an overweight of the stock in the portfolio, thus constituting a selling incentive for the investor. Due to the implications of the diversification effect, they asserted that a sell down following a positive price run would not affect the stock price materially.

We, however, argue that the contrarian investment strategy of insiders might result in abnormal negative price reactions at expiration date. Insiders may possess private and negative information not incorporated in the market price. Following a positive price-run and bullish investor appetite, an insider with private, negative information about future outlooks will be more inclined to exploit a profit-making opportunity at the first occasion possible, namely the lockup expiration. Thus, a sell down by an insider after a positive run-up would often yield a negative signalling effect, thereby subsequently depriving the stock price. We further argue that a sell down after a positive run-up will rarely be due to diversification purposes. If we assume that the price-run up is indeed a reflection of a convergence of the share price towards to fair value of the firm, insiders will be relatively more inclined to hold on to their shares than selling them; they will discern the benefits of diversification in favour of benefitting from the promising outlook of owning shares in a high-quality firm. Therefore, we assert that a price run-up followed by a sell down will in most cases be motivated by private information, thus implying a negative price reaction at the expiration date.

Furthermore, a cash-out mentality following a consistent price run-up might not only be prevalent for insiders, but rather a sentiment followed by the overall investor base. Field and Hanka (2001) find that investors in general are more inclined to sell after a greater price run-up. They argue that the motivation for a sell down stems from investor loss aversion and over emphasising insurance of a certain gain. This notion was termed by Kahneman and Tversky (1979), who called it the certainty effect as part of their prospect theory. Particularly, when comparing the weights that investors put on different decisions under uncertainty, investors assign overweight to outcomes obtained with certainty and underweight to outcomes that are slightly probable. That is, the certainty effect contributes to a greater degree of risk aversion in choices involving sure gains. Therefore, when investors consider the uncertainty surrounding the lockup expiration, they will be more likely to prefer a certain profit over the possible additional returns associated with holding on to the stock. If a large enough group of investors share this behavioural bias, a positive price run would be replaced by a bearish attitude towards the stock, thus creating the aforementioned contrarian investment cycle.

Lastly, the significantly negative relationship between price runs prior to the expiration and CARs at expiration date found in the Final Model is empirically backed up by previous research. Haggard and Xi (2017) find that larger price-runs prior to the event window are significantly associated with more negative CARs at lockup expiration. Taking starting point in the work of Purnanandam and Swaminathan (2004), Haggard and Xi (2017) suppose that when stocks with large price run-ups attract investors' attention, there will be a greater likelihood of investors determining that such stocks in fact are overvalued. When restrictions are relaxed at lockup expiration, they therefore expect that stocks with large price run-ups are more likely to be identified as overvalued, thus resulting in a negative price reaction at lockup expiration.

In conclusion, we find overwhelming evidence that there exists a non-zero relationship between PRICE_RAMP and CAR at lockup expiration. We therefore reject the following null hypothesis:

$$H_0: \phi_3 = 0$$

We reject the null hypothesis on PRICE_RAMP

However, we additionally conclude that the direction of the relationship is the opposite of what we hypothesised, namely a negative one. Based on the statistical results from the Final Model, the above standing theoretical and logical explanations, and the previous empirical findings by Haggard and Xi (2017), we revisit our initial hypothesis and argue that positive price-runs are associated with more negative abnormal returns at lockup expiration.

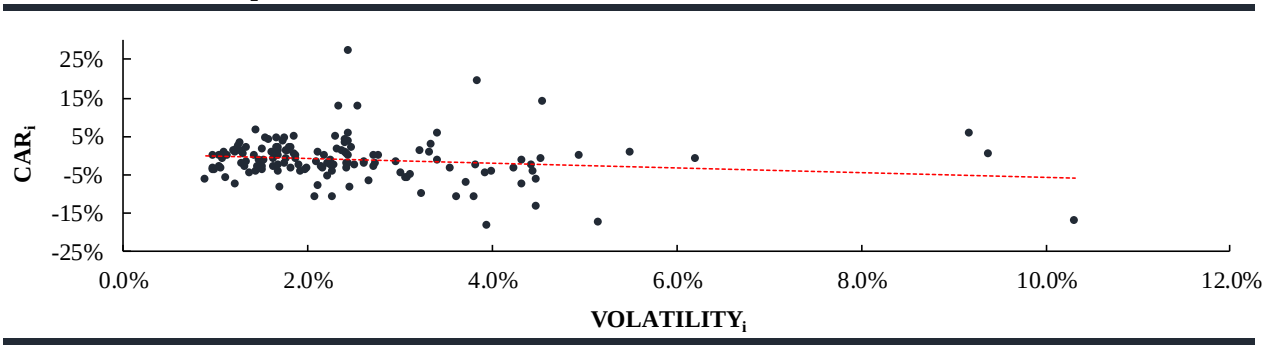
Lockup period volatility (VOLATILITY)

The relationship between volatility and abnormal returns at lockup expiration was initially addressed by Hypothesis 4A, in which we hypothesized a negative relationship. From a statistical point of view, Hypothesis 4A is tested in the Final Model according to the following null hypothesis:

$$H_0: \phi_2 = 0$$

The multivariate regression for the Final Model in Table 12 yielded a marginally significant coefficient for VOLATILITY ($p = 0.128$) with a negative coefficient ($\phi_2 \approx -0.479$). The coefficient implies that CAR decreases by 0.479 percentage points when volatility (*measured by standard deviation of stock returns*) increases by 1 percentage point. Although the coefficient is found to be statistically insignificant, its p-value suggests that it borderlines significance at the 10% level. Furthermore, we assert great economic significance to the sizeable magnitude of the coefficient's value. To establish a comprehensive understanding of this result, we construct a scatterplot as shown by Figure 11.

FIGURE 11: Scatterplot for CAR_i and $VOLATILITY_i$



When assessing the scatterplot in Figure 11, it is evident that high-volatility stocks are more inclined to have a more negative CAR at lockup expiration, as shown by the isolated setting of the scatterplot. One can thus argue that the coefficient for VOLATILITY in the multivariate regression only is marginally significant due to observations that are distant to the fitted line. But nevertheless, the scatterplot in Figure 11 indicates that there exists a clearly negative relationship between CAR and VOLATILITY.

From a purely mechanical point of view, we can attribute this finding to theory on the downward-sloping demand curve. Ofek and Richardson (2000) emphasize that high-volatility stocks imply that investors bear greater asset risk since their holdings possess substantial portfolio risk. In this sense, volatility becomes a vital proxy for the need of existing shareholders to diversify their asset risk. This notion is substantiated by the result in our expiration date analysis where we find a large and significantly negative relationship between VOLATILITY and ABNORMAL_VOL (*see Appendix 10*). In theory, share disposals that are motivated by diversification needs should not impact stock prices in the same sense as informative selling (Gao and Siddiqi, 2012). Thus, for our results to comply the theoretical notion of Ofek and Richardson (2000), one could argue

that outside investors fail to make timely and accurate predictions as otherwise suggested by the semi-strong form of the EMH.

Furthermore, we can add information asymmetry as a potential explanation for our findings on volatility. Here, Brav and Gompers (2003) suggest that abnormally negative price reactions at lockup expiration depend on firms' informational transparency. Here, they argue that an abnormally negative price reaction should be less negative for firms that have minor prevalence of information asymmetry, which is proxied by lower price volatility. This view suggests our observations of high-volatility stocks represent the uncertainty that stems from informational misalignment between inside and outside investors. When a great extent of information asymmetry prevails, investors become uncertain of the quality of the information that is known by insiders. Hence outside investors will expect a large degree of share disposals at lockup expiration, which not only are motivated by diversification needs but also by exploitation of an informational misalignment. One can thus infer that the yielded negative relationship between CAR and VOLATILITY from our multivariate regression is caused by an informational misalignment as proxied by volatility.

In addition, it is furthermore possible that investors are not only subject to an informational disadvantage but also possess heterogeneous and overconfident beliefs. Holding all else constant, such behavioural deficiencies among investors become highly impactful in a setting of short-selling constraints. Scheinkman and Xiong (2003) argue that speculative bubbles are accompanied by immense price volatility where overconfident investors engage in active trading, whereas conservative investors remain passive due to short-selling constraints.

As discussed in the hypothesis development for Hypothesis 4A, the heterogeneous beliefs of optimistic investors consequently generate fluctuations in the valuation of the firm, as the stock price will undergo large spikes according to the daily degree of overconfidence among speculative investors. This effect prevails due to the lack of counteracting short-selling transactions and asserts greater uncertainty regarding the true value of a stock. If investors in fact possess heterogeneous beliefs, our results will thus suggest that there is a high degree of variation in the probabilistic predictions among investors when a stock is highly volatile. Hence, the negative relationship between CAR and VOLATILITY would represent an overcorrection of those investors who have miscalculated the true value of the firm, due to overconfidence and heterogeneous predictions of the outcome at lockup expiration.

In summation, it is evident that the volatility of a stock is a vital characteristic to consider when analysing price reactions at lockup expiration. Due to the notable economic significance of volatility that is discussed above, we believe that the coefficient on VOLATILITY from the multivariate regression bears sufficient statistical significance to be included in our Final Model. Hence, although the coefficient for VOLATILITY merely is borderline significant at the 10% level ($p = 0.128$), we deem it to be satisfactory evidence to support our

hypothesized outcome of Hypothesis 4A. Ultimately, we believe there is sufficient statistical and economic significance for us to reject the null hypothesis.

$$H_0: \phi_1 = 0$$

We reject the null hypothesis on VOLATILITY

7 Implications

In the following section we will provide the most valuable insights obtained throughout the research process and dissect how these implicate the various stakeholders involved directly or indirectly in the lockup. We will start by addressing the company and the underwriter and explain how and why our research implicates them. Thereafter, we will turn our focus towards the outside investor and how she should interpret and act upon the information available in the market prior to the lockup expiration.

7.1 Implications for the company and the underwriter(s)

The implications for the company and its underwriters primarily revolve around how they should structure a lockup provision and which aspects they should focus on given different circumstances. Overall, our findings imply that expirations of lockups are on average associated with more negative abnormal returns when the locked up shareholder as well as the company in general are associated with more uncertainty. Thus, in order to avoid negative price reactions at expiration date and in turn loss of shareholder wealth, the company and its underwriters should 1) structure the lockup provision in a way that yields outmost transparency and minimum information asymmetry, and 2) focus on marketing and investor education throughout the lockup period. This has several implications for the different characteristics of the lockup provision, the IPO in general, and the subsequent release of information in the lockup period.

When looking at the characteristics of the lockup provision itself, our findings imply that duration should not be used as a signalling device. This implication contradicts conventional standards within lockup formulation. As pointed out by Sebastian Hougaard from Carnegie Investment Bank, underwriters usually set the duration of the lockup period to reflect the uncertainty surrounding the firm. When formulating a lockup provision, they factor in enough time for the market to accurately assess the fundamental value of the stock and the accompanying risk, thereby locking up firms with more uncertainty for a longer time, and vice versa (Hougaard, 2018). However, the prevalence of a non-existent relationship between duration and CAR suggests that this lockup characteristic does not affect abnormal returns at lockup expiration. We argue that the trend towards standardised lockup durations (*i.e. 180 and 360 days*) eradicates the potential signalling value of a

lockup period's duration, such that outside investors cannot recognize lockup duration as a signalling device for representing firm quality. Thus, duration should not by itself be used for alleviating issues that stem from information asymmetry.

Although, duration does solely constitute a viable instrument to reduce information asymmetry at lockup expiration, it can be used in conjunction with other aspects of the lockup provision to provide a lower degree of uncertainty for the investors. Specifically, lockups containing multiple shareholders of different types comprise conflicting insider motives, thus complicating the outside investors' attempt to decipher the overall price effect on the expiration date. All else equal, this would entail a high degree of uncertainty in the formulation of their expectation, which in turn would induce a higher probability of over- or under-estimating the supply shock. For example, setting the same release date for a short-term oriented PEVC-shareholder and a long-term oriented institutional-shareholder would yield offsetting motivations, thus making it increasingly difficult to anticipate the number of locked up shares coming to market at expiration. This can be mitigated by imposing different durations for each type of locked up shareholder. By using a staggered lockup setup, in which each type of shareholder has a unique lockup duration, the conflicting motives would be separated, thereby easing the expectations of the outside investor.

Furthermore, the company and their underwriters should draw up the lockup provision in a manner that limits the potential magnitude of the market's reaction upon lockup expiration. Our findings suggest that outside investors become more uncertain regarding the potential supply shock at lockup expiration when a greater proportion of shares are subject to a lockup. Therefore, the company and its underwriters should try to smoothen out the market overhang associated with each lockup. This could be done by only locking up part of a large shareholder's ownership or use a staged lockup for the same up shareholder, whereby the release of shares is allocated over multiple dates. For example, the lockup provision from the IPO of BONESUPPORT AB specifies that the principal shareholders are locked up for 180 calendar days after which a third of their shares will be released every 90^{th} calendar day (Bonesupport.com, 2018).

When looking at the characteristics of the IPO, neither underpricing nor underwriter quality are found to be useful predictors of what transpires on the expiration date. This implies that neither of the two aspects can be used as a signalling device to reduce uncertainty around expiration. Regarding underpricing, we assert that the information momentum of first-day returns is eroded by the time of lockup expiration and underpricing should therefore not be used with the sole purpose of mitigating abnormally negative price reactions at expiration. Considering underwriter quality, we primarily contribute the prevalence of a non-existing relationship with CAR to the fact that many of the small IPOs with less reputable underwriters had some of the highest CARs observed in the sample. As per construction of the UNDERWRITER_RANK variable, the highly ranked underwriters are associated with the largest IPOs in value terms, whereas the low ranked underwriters are associated with the small value IPOs. Our findings suggest that merely considering underwriter quality

according to IPO proceeds is insufficient when determining the true quality of the underwriter, especially in a Nordic setting. One must also consider the local expertise of the underwriter, as region-specific knowledge can more than offset the reputation disadvantage associated with smaller and less reputable underwriters.

Finally, when looking at the information content of the lockup period itself, the company should first and foremost focus on marketing and investor education in reducing the degree of uncertainty leading up to lockup expiration. As we find a negative effect of volatility and price-run on CAR, we recommend that the company should exert an immense effort in ensuring price stabilisation in the IPO aftermarket. This can be achieved by putting an emphasis on increased transparency during the lockup period, for example by issuing reminders about the forthcoming lockup expiration and the expected implications thereof. In turn, this will likely reduce uncertainty and normalise investor expectations around a unified indicator, namely the company guidance.

7.2 Implications for the rational investor

Our study's evidence of negative abnormal returns at lockup expiration asserts vital importance to discussing focal implications from the perspective of a rational outside investor. In the following, we will bifurcate the policy implications according to 1) investors that employ an exploitative strategy of risky arbitrage, and 2) investors that seek to make a short-term investment. In accordance with the scope of this thesis, we will not address implications that concern the long-term market development beyond lockup expiration.

7.2.1 Arbitrageurs

The expiration date analysis proved that the magnitude of CAR at lockup expiration is too small for investors to exploit when compared to concurrent transaction costs. In this sense, costly arbitrage implies that trading costs on average outweigh the prevalent abnormality in price reactions at lockup expiration. The fundamental trait of arbitrage is that one can attain an immediate profit that is relatively risk-free. As a simplified example, one could do so by constructing a portfolio that replicates the risk-exposure and expected payoff for a given stock (Ofek and Richardson, 2001). An arbitrageur could thus establish a short position in the stock and an equivalent long position in the replicative portfolio. Consequently, any abnormally negative mispricing of the stock price would yield an immediate profit to the arbitrageur.

In practice, replicative portfolios are seldomly exact replications of the targeted security. Therefore, in a lockup setting, outside investors can engage in "risky arbitrage" by shorting a stock prior to lockup expiration, with the underlying intention of closing out the position shortly after the predicted price drop. However, since transaction costs have been assessed to (*on average*) exceed abnormal return, such arbitrage opportunities are rendered insufficient to drive away abnormalities in a lockup setting. In addition, investors will also face

holding costs in the form of opportunity costs and risk factors that stem from time-specific uncertainty. For example, it may be the case that the expected supply shock remains absent and the stock price thereby fails to comply with one's predictions.

If we were to assume absence of transaction costs and related holding costs, one should infer from our findings that investors seeking a short-term profit should be highly aware of 1) the percentage of locked up shares relative to the free float, 2) the degree of volatility in the stock's underlying price, and 3) any notable run-ups in the stock price leading up to lockup expiration. With respect to the first notion, risky arbitrageurs should focus on stocks where a notably large proportion of shares are subject to lockup. This will assert an induced likelihood of shares flooding the market at lockup expiration, where risky arbitrage will yield a profit when market participants underestimate the magnitude of the supply shock. Furthermore, risky arbitrageurs should also focus on stocks that are highly volatile or have undergone persistently positive price-runs prior to lockup expiration. As discussed in the analysis, such stocks are on average expected to have more negative abnormal returns at lockup expiration, as they are potentially subject to immense uncertainty and have greater propensity to represent overconfident and heterogenous beliefs.

However, even if one were to assume that transaction costs are absent, risky arbitrage may still be a trivial strategy to employ due to a limited supply of lendable shares in a lockup setting. This substantiates the prevalence of short-selling constraints and complicates the feasibility of short-selling in the first place. It is thus evident that the significantly negative abnormal return at lockup expiration is non-exploitable due to trading costs, holding costs, and short-selling constraints.

7.2.2 Short-term investors

Although the magnitude of abnormal returns at lockup expiration is deemed too small for investors to exploit by costly arbitrage, our results still bear vital importance for the rational investor. Instead of exploiting price abnormalities at lockup expiration, such investors may intend to undertake investments in stocks where active lockups are yet to expire. For example, consider investors that intend to purchase shares either at the time of IPO or in the aftermarket. Given the scope of this thesis, such investors are assumed to have a short-term investment horizon, in the sense that they plan to realize their investment within the forthcoming year (*or at least shortly after lockup expiration*).

In accordance with our results (*and contrary to the proposed strategy for exploiting abnormal returns*) we advise such investors to avoid investing in stocks that 1) have a large percentage of shares subject to lockup, 2) possess a high degree of volatility in stock returns, and 3) have undergone notable run-ups in the stock price. Naturally, investors should assert most attention to the percentage of locked up shares if they intend to invest at the time of IPO, as they are yet to attain insight to the stock's degree of volatility and inclination toward

consecutive price-runs in the aftermarket. In this setting, firms that have a lower percentage of locked up shares relative to free float are on average expected to have a lessened (*or completely absent*) likelihood of negative abnormal returns at lockup expiration, which thereby would allow such investors to avoid being affected by a sudden abnormally negative stock return. Furthermore, if investors intend to purchase shares post-IPO, they can also account for the stock price's degree of volatility and inclination toward positive price-runs. Since one of the inherent purposes of lockup agreements is to stabilize initial trading according to market dynamics, any prevailing volatility should caution rational investors of excessive uncertainty. Combined with consecutive series of similar price movements, such observations have been found to represent a potential pervasiveness of overconfidence, heterogenous beliefs, or informational misalignments between insiders and outside investors. Rational investors must therefore be highly aware of such implications, as they otherwise may risk investing at a price that does not reflect the firm's true value.

In conjunction with these implications, we advise investors to seek out stocks where 1) active lockups only restrict one shareholder type, 2) active lockups incorporate staged unlocking of shares, and/or 3) notable efforts are made to induce transparency towards outside investors. In such scenarios, market participants are expected to have a greater possibility of establishing more certain predictions regarding the degree of share disposals by insiders at lockup expiration.

Firstly, we encourage investors to seek out stocks that employ simple lockups, where only one shareholder type is restricted from disposing of shares. In our analysis, we have observed that numerous IPOs have lockups that exert joint restrictions on several types of shareholders (*e.g. management, PEVC, and institutional shareholders*). This complicates investors' predictions since different types of shareholders have been theoretically and empirically demonstrated to possess conflicting underlying motivations. For example, PEVC-shareholders are suggested to have a more short-spanned investment horizon than long-term oriented institutional shareholders. Hence, outside investors must in such scenarios incorporate opposing probabilistic outcomes into their predictions on insiders' share disposals at lockup expiration. This issue was addressed when analysing Hypothesis 2C, as the true effect of PEVC-restrictive lockups was arguably distorted by the simultaneous restriction of other shareholders with dissimilar motives. The IPO for TCM is a great example of our recommendation, as the lockups are set to restrict a PEVC-shareholder and management for 180 and 360 days, respectively (Tcmgroup.dk, 2018).

Secondly, we advise investors to favour stocks where lockups are structured to expire over several stages. For example, the IPO of BONESUPPORT AB exerted a lockup on principal shareholders for 360 calendar days, whereas 33% of the restricted shares were set to unlock after 180 days and another 33% after the subsequent 90 days (Bonesupport.com, 2018). In this manner, the unlocking of shares is split into smaller fractions, which allows investors to construct their predictions according to a smaller potential supply shock. Hence, investors attain a greater possibility to estimate insiders' disposal of shares with greater certainty. This will dampen the

potential effect of shares unexpectedly flooding the market and thereby abnormally negative price reactions that stem from outside investors' underestimated predictions.

Lastly, investors should consider the degree of informational transparency that is provided for the stock. As emphasized by Sebastian Hougaard regarding the occurrence of abnormal returns at lockup expiration, "*a part of it might be [investors] remembering that the lockup actually expires*" (Hougaard, 2018, p. 4). As discussed throughout the analysis, it is highly probable that abnormal price reactions surrounding lockup expiration partly can be attributed to investors' untimely preparation for the expiration event. In such case, it is highly advisable for investors to prioritize firms that provide frequent public disclosures to minimize informational misalignment between insiders and outside investors. Especially, such disclosures should address the firm's lockups throughout the lockup period to assure that market participants make timely predictions regarding trading activity at lockup expiration.

8 Conclusion

The purpose of this thesis was to examine whether abnormal stock returns occur when lockup agreements of Nordic IPOs expire. Furthermore, our objective was also to assess potential *ex ante* cross-sectional predictors that may impact such abnormal returns. We structured our cross-sectional hypotheses according to three overall classifications of characteristics, namely 1) lockup characteristics, 2) IPO characteristics, and 3) lockup period characteristics.

Our analysis is bifurcated according to our hypotheses, in the sense that an event study approach is employed to investigate the abnormal returns at lockup expiration (*which is in accordance with Hypothesis 1*), whereas a cross-sectional analysis has been conducted to examine the potential influence of *ex ante* predictors (*which complies with the focus of hypotheses 2 through 4*).

When performing an event study on a sample of 141 Nordic IPOs that have taken place from 2009 to 2017, we find significant evidence of abnormally negative price reactions at lockup expiration. Specifically, our event study shows that Nordic IPOs on average experience a significantly negative cumulative abnormal return of -1.1% surrounding lockup expiration. This bears the highly noteworthy and focal implication of invalidating the semi-strong form of the efficient market hypothesis. With this finding, we contribute to the existing field of research by (*to our knowledge*) being one of the first European studies to observe significant evidence of abnormally negative stock returns when lockup agreements expire. We furthermore provide a thorough analysis and discussion that discredits any exploitative opportunities of risky arbitrage, as the magnitude of the yielded CAR does not surpass concurrent transaction costs.

In addition, when conducting a cross-sectional analysis of *ex ante* explanatory variables, we find evidence of three statistically and economically significant characteristics that have an influential impact on the cumulative abnormal returns at lockup expiration.

Firstly, with respect to lockup characteristics, our results suggest that the percentage of locked up shares relative to free float has a significantly negative impact on cumulative abnormal returns, as a larger overhang is believed to induce uncertainty, which in turn leads to greater estimation errors by outside investors. This result complies with the hypothesized outcome of Hypothesis 2B.

Secondly, with respect to lockup period characteristics, we find significant evidence of a negative relationship between stock price volatility prior to the expiration date and cumulative abnormal returns at lockup expiration. We attribute this negative relationship to the implications of a downward-sloping demand curve in conjunction with informational misalignments and investor overconfidence in a setting of selling constraints. This result complies with the hypothesized outcome of Hypothesis 4A.

Thirdly, once again with respect to lockup period characteristics, our results also suggest a significantly negative relationship between positive price ramps leading up to the expiration date (*i.e. substantially positive and consecutive stock price improvements*) and cumulative abnormal returns at lockup expiration. This finding contradicts the hypothesized outcome of Hypothesis 4C. We argue that one can attribute this finding to a possible prevalence of a contrarian investment strategy among insiders. In accordance with prospect theory, it can be supposed that such shareholders are inclined to realize successful investments too quickly, thus resulting in an unexpected disposal of shares at lockup expiration.

These findings have been discussed in accordance with imperative implications, which the company, the underwriters, and rational outside investors must take into consideration (*given the underlying intentions of such stakeholders*). To alleviate potential losses that will be caused by abnormal price reactions at lockup expiration, we consider it highly advisable that 1) active lockups should only restrict one shareholder type, 2) active lockups should incorporate staged unlocking of shares, and/or 3) notable efforts must be made to induce transparency and thus diminish informational misalignments between insiders and outside investors. When combined, these suggestive approaches will reduce uncertainty regarding the transpiring trading activity at lockup expiration, thus ensuring a greater propensity for outside investors to construct their predictions with optimal certainty.

9 Limitations and future research

It must be noted that this thesis has certain limitations that may substantiate potential relevance for future research. In the following, we will briefly elaborate upon limitations and focus areas for future research according to our sample selection, construction of cross-sectional variables, scope of analysis, as well as overarching implications.

Firstly, our sample is relatively small when compared to previous empirical research on IPOs in the US. Two focal reasons for this limitation is that our sample period is shorter and that the Nordic IPO market is notably smaller. The shortened sample period is mainly due to our intention of excluding the financial crisis of 2007/2009, as this could have distortive effects on our results. One could have compensated the Nordic market's relatively smaller size by expanding the sample period, however, we have prioritized to attain data that most optimally represents efficient market conditions.

Furthermore, when investigating impactful characteristics for stock price reactions, we acknowledge that numerous external factors may possess an explanatory power. Thus, our findings represent a simplified portrayal of reality. Our selection of cross-sectional variables is based on what has been deemed most relevant according to previous research, market professionals, and our own economic knowledge. However, our selection of cross-sectional variables is not exhaustive and may inevitably be impacted by omitted and discerned factors. It could therefore be of great relevance for future research to analyse alternative variables that previous research has not been attentive to. This could for example be disclosure frequency as an independent variable, or staged lock expirations as the dependent variable.

In addition, it was noted in the methodology-section that we assert focus on the earliest expiring lockup when multiple lockups are applied for an IPO. This was done according to the assumption that the earliest lockups generally are restrictive of the largest fraction of locked up shares and entail the largest potential realignment of information held by insiders and outside investors upon expiration. However, it could be of interest to construct a model that encompasses all lockup provisions that have been included in IPOs. In this manner, one would also attain a larger sample. It is thus suggested for future research to look further into possible solutions for expanding the sample selection, while mitigating the abovementioned distortive effects.

With respect to the construction of our cross-sectional variables, we suggest that further research should investigate how ambiguous effects can be eradicated when several types of shareholders are restricted by the same lockup. For example, this was an issue when addressing Hypothesis 2C on PEVC-restrictive lockups, as such lockups often include other shareholders that have different (*and potentially opposing*) motives. Furthermore, if deemed possible according to data availability and if feasibility allows, we also assert great interest in examining novel methods for optimally measuring the effect of underwriters' reputation and early

insider trades. Our measurement of these variables was inspired by best practices of previous research but have been considered to possess complicative traits that affect the overarching implications of one's inferences.

We also believe that there is vital empirical value for future research to expand the scope of our expiration date analysis. Our event study on abnormal returns was complemented by an assessment of abnormal volume and transaction costs that prevailed concurrently with lockup expiration. However, since we only used these findings to complement our results, we suggest further research to expand this focus by including a broadened and more in depth of alternative expiration date variables. For example, it would be highly interesting to consider the short interest that in fact prevails in the market when lockups expire.

Finally, from a broader perspective, we find it highly interesting for future research to assess whether our study's evidence of abnormal price reactions is applicable to all cases where a supply shock occurs, or if it solely is a unique phenomenon in a lockup context. Future research should therefore consider alternative cases of shifts in the supply curve. Such research could for example investigate whether our study's implications also hold for stock repurchases or seasoned equity offerings.

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Appendix 1: League table criteria

Rank item:	Manager
Rank Basis:	Number of Issues
Accumulate:	Proceeds Amount (USDm)
Accumulate:	Number of Tranches
Allocation Method:	Full to Each Manager
Credit to:	Surviving / Parent Firm
Count Level:	Number of Issues
Date based on:	Issue/Announcement Date
Exclude:	Callable/Putable Under One Year
Exclude:	Issues which are not Rank Eligible
Exclude:	Issues which are not Underwritten
Exclude:	Manager Not Available
Exclude:	Maturity Ineligible
Exclude:	Minimum Life Ineligible
Exclude:	Rights Issues
Exclude:	Self Funded Ineligible
Show overall ranking:	No
List top n Each Manager's Ultimate Parent:	25

Source: Thomson One

Appendix 2: League table ranks (1/2)

Overall rank	2008	2009	2010	2011	2012	2013	2014	2015	2016
ABG	9	2	11	4	1	3	7	4	7
ABN AMRO Bank	9	7	17	16	7	19	26	26	26
Arctic Securities	9	6	26	2	7	8	25	19	21
Avanza	9	7	25	16	7	19	26	25	22
Avenir Finance	8	7	26	16	7	19	26	26	26
BAML	9	7	7	16	7	9	26	12	18
Barclays	9	7	13	16	7	19	10	26	26
BNP	9	7	26	16	7	19	26	16	26
Bryan Garnier & Co	9	7	19	16	7	19	26	26	26
Carnegie	9	7	1	8	7	4	1	2	6
Citi	9	7	13	16	7	19	26	10	11
Cooperatieve Rabobank UA	9	7	26	16	7	19	26	26	11
Corporate Advice & Research AS	5	7	26	16	7	19	26	26	26
Credit Agricole CIB	9	7	15	16	7	19	26	26	26
Credit Suisse	9	7	15	16	7	19	15	26	26
Danske Bank	9	4	12	10	7	5	5	8	3
Deutsche Bank	9	7	26	16	7	9	26	9	9
DNB	9	7	9	3	1	12	12	6	10
E Ohman Jr Fondkommission	9	7	25	16	7	19	26	26	26
EFG Bank AB	9	7	26	12	7	19	26	26	26
equinet AG	9	7	26	16	7	19	26	20	26
Evli Bank Plc	9	7	26	16	7	17	26	26	26
Fearnley Fonds A/S	9	7	26	16	7	19	25	26	26
Finansieringsfonden af 1992	9	7	18	16	7	19	26	26	26
First Abu Dhabi Bank PJSC	9	2	26	16	7	19	26	26	26
First Securities AS	9	7	24	6	7	19	26	26	26

Source: Thomson One

Appendix 2: League table ranks (2/2)

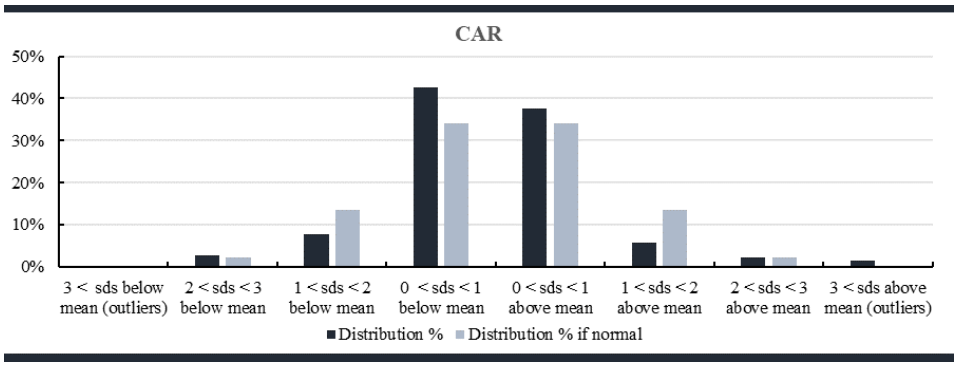
Overall rank	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fondsfinans AS	2	7	26	16	7	19	24	26	26
Goldman Sachs	9	7	2	16	7	14	6	15	17
Handelsbanken	1	7	26	9	3	7	11	5	20
ICF Kursmakler	9	7	26	16	7	19	26	20	26
ING	9	7	26	6	7	19	26	26	26
Jefferies	9	7	19	16	7	19	17	13	26
JMP Securities LLC	9	7	26	16	7	19	17	26	26
J.P. Morgan	9	7	5	16	7	19	13	17	2
Kempen and Co NV	9	7	26	12	7	19	14	26	26
Leerink Partners	9	7	26	16	7	19	17	23	26
Macquarie Group	6	7	26	16	7	19	26	26	26
Mid-Capital	9	7	26	16	7	19	26	20	26
Morgan Stanley	9	7	5	16	7	13	4	3	4
Nordea	9	7	3	10	7	1	2	7	1
Norne Securities AS	9	7	26	16	7	18	26	26	26
OP	9	7	26	16	7	19	26	14	14
Pareto	9	6	8	1	6	15	21	18	19
RBC	9	7	26	16	7	19	17	26	11
RBS	9	7	26	16	7	19	22	26	26
Redeye	9	7	26	16	7	19	26	26	23
RS Platou Securities AS	9	7	21	16	7	19	26	26	26
SEB	4	1	4	5	3	2	3	1	8
Shareholder	2	7	26	16	7	19	26	26	26
Singer Capital Markets Ltd	9	7	26	12	7	19	26	26	26
Spar Nord Holding A/S	9	5	26	16	7	19	26	26	26
Sparebank 1	9	7	21	16	7	19	26	26	15
Sparebanken Nord-Norge	9	7	21	16	7	19	26	26	26
Stifel/KBW	9	7	10	16	7	19	26	26	26
Swedbank	9	7	26	16	7	6	8	26	26
Sydbank A/S	7	7	26	16	7	19	26	26	16
UB Securities	9	7	26	16	7	16	23	26	25
UBS	9	7	26	15	3	11	9	11	5
Vastra Hamn	9	7	26	16	7	19	26	25	26
Vator	9	7	26	16	7	19	26	26	24
Wells Fargo & Co	9	7	26	16	7	19	26	23	26
Alexander Corporate Finance	9	7	26	16	7	19	26	26	26
Aqurat Fondkommission	9	7	26	16	7	19	26	26	26
Erik Penser Bank	9	7	26	16	7	19	26	26	26
G&W Kapitalforvaltning	9	7	26	16	7	19	26	26	26
G&W Fondskommission	9	7	26	16	7	19	26	26	26
Gazprombank	9	7	26	16	7	19	26	26	26
Other	9	7	26	16	7	19	26	26	26

Source: Thomson One

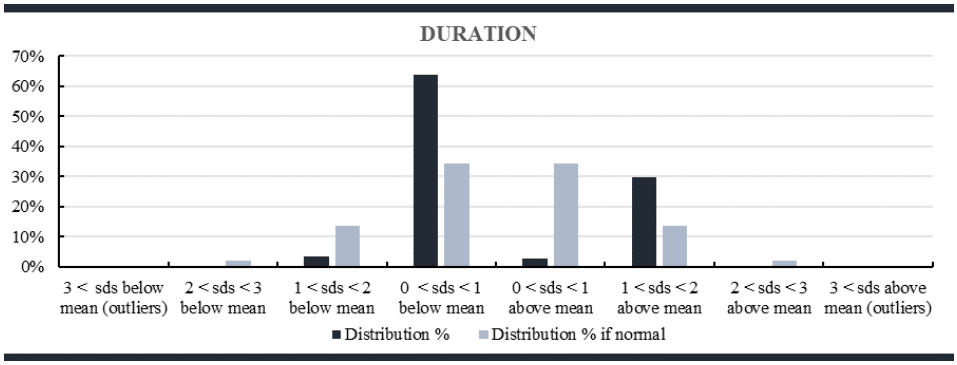
Appendix 3: Analysis of outliers (1/6)

In the following, we will assess the sample distribution of our dependent variable (CAR) and independent variables. Furthermore, we will apply two methods for identifying potential outliers. Firstly, we consider the rule-of-thumb where outliers are believed to reside more than 3 standard deviations away from the mean. Secondly, in line with the logic of Tukey's fences, we will identify outliers as those that reside k=1.5 times the interquartile range (IQR) away from the mean. These methods are applied in a combined manner.

The following figures show the initial distribution of our dependent and independent variables. We will not consider the distribution for PE_VC, and UNDERWRITER_RANK, as the construction of these variables does not enable the occurrence of outliers.

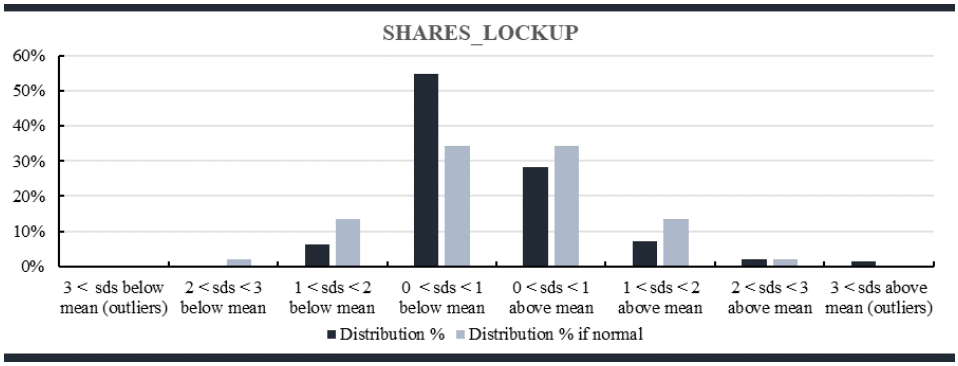


There are 2 observations for CAR that are larger than 3 standard deviations from the mean. However, there are not any outliers according to IQR, as the largest observation is k=1.45 away from the mean.

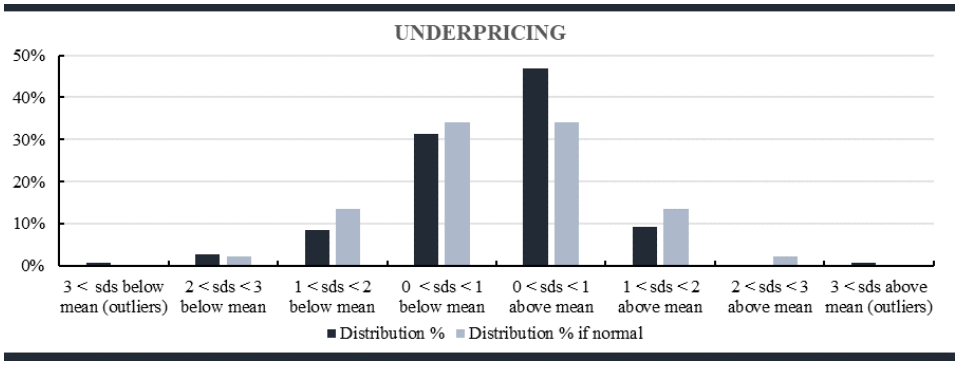


As expected, there are not any outliers that reside more than 3 standard deviations from the mean. The minimum and maximum observations have k=0.53 and k=0.49, respectively, thus also indicating that there are no outliers.

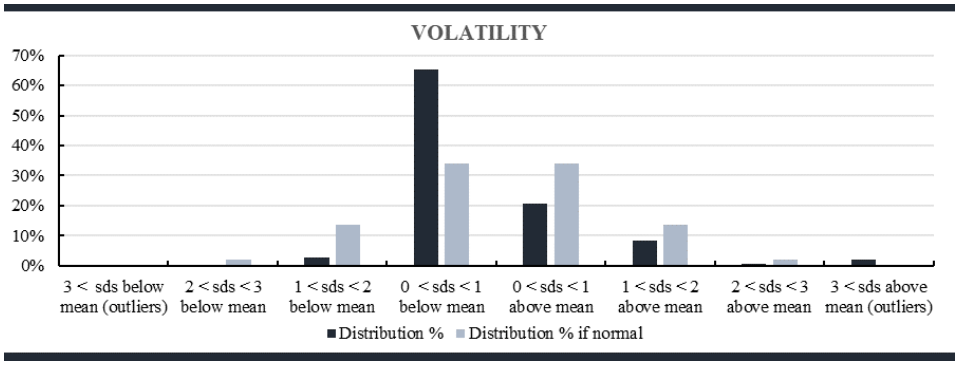
Appendix 3: Analysis of outliers (2/6)



There are 2 observations for SHARES_LOCKUP that are larger than 3 standard deviations from the mean. Furthermore, IQR suggests that there are 5 observations that have k>1.5.

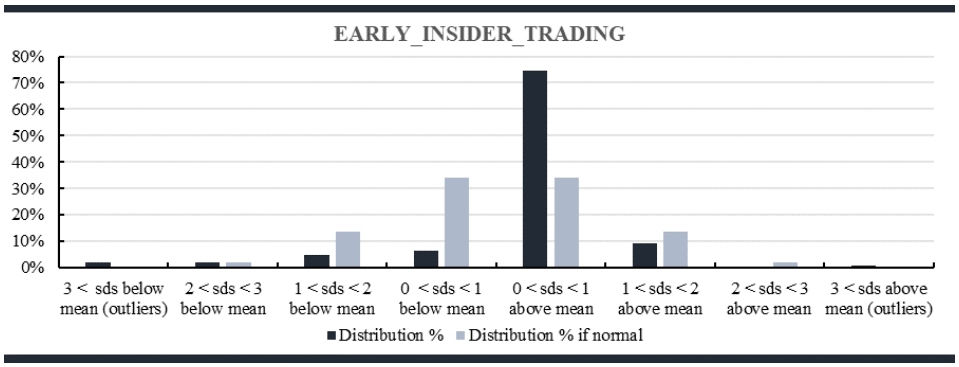


There are 2 observations for UNDERPRICING that are more than 3 standard deviations away from the mean (one above and one below). The IQR however suggests that these two observations only have k=0.75 and 0.91, respectively, thus suggesting an absence of outliers.

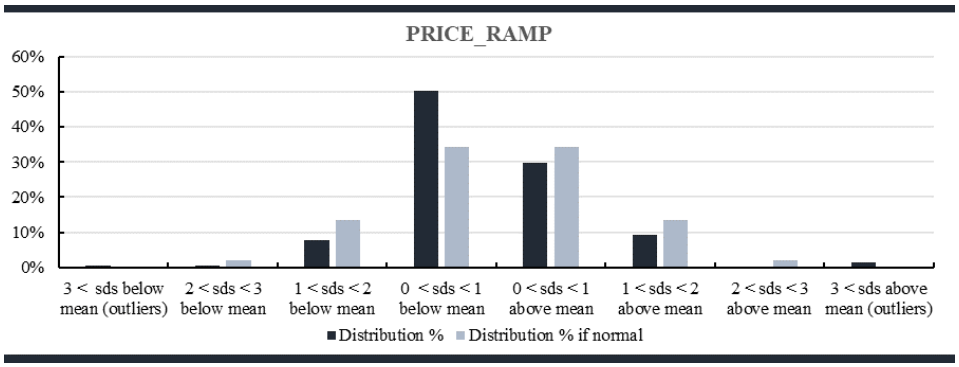


There are 3 observations for VOLATILITY that are larger than 3 standard deviations from the mean. Furthermore, the IQR suggests that there are 4 observations that have k<1.5.

Appendix 3: Analysis of outliers (3/6)



There are 4 observations for EARLY_INSIDER_TRADING that are more than 3 standard deviations from the mean (1 above and 3 below). However, the minimum and maximum have k=0.99 and k=0.89, respectively, thus suggesting an absence of outliers.



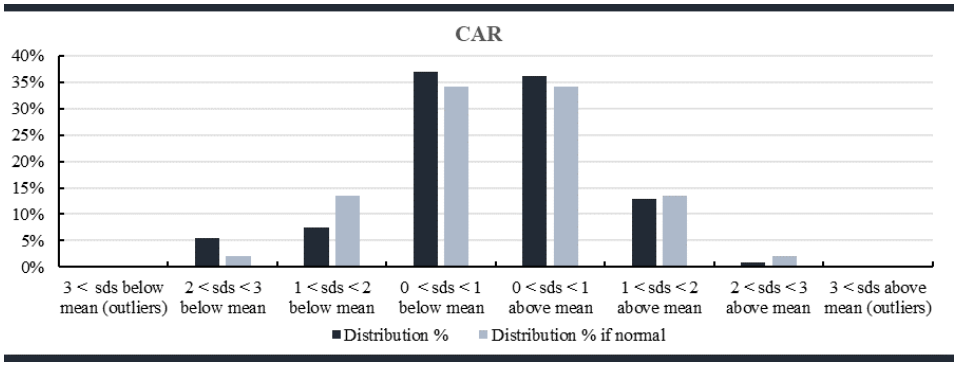
There are 3 observations for PRICE_RAMP that are more than 3 standard deviations away from the mean (2 above and 1 below). However, the minimum and maximum have k=0.93 and k=1.30, respectively, thus suggesting an absence of outliers.

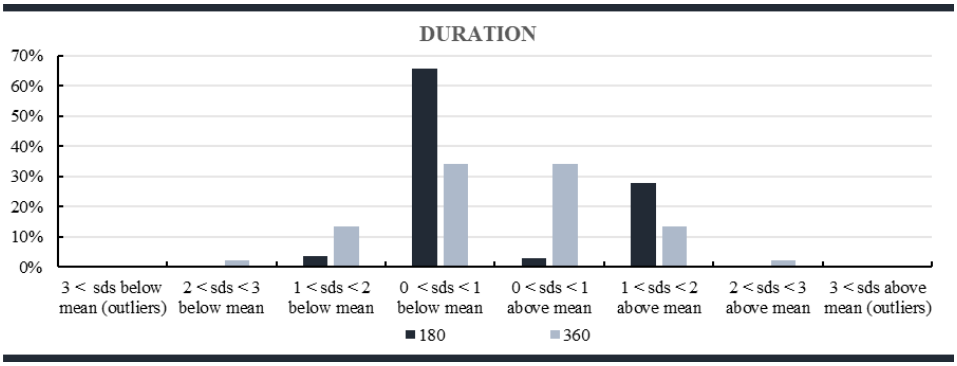
At a glance, it is highly evident that the sample distribution is affected by heavy tails. This complies with our emphasized notion when commenting on the summary statistics [(Section X)], where we argue that one should not discard outliers when observations are distributed with heavy tails. Instead, it is most optimal to keep outliers in the sample and be aware of their potential influence when making inferences. One can see that SHARES LOCKUP, VOLATILITY, and PRICE_RAMP have rightward tails, whereas UNDERPRICING has a leftward skew. DURATION and EARLY_INSIDER_TRADING possess a distribution where the observations are heavily concentrated within specific values.

Appendix 3: Analysis of outliers (4/6)

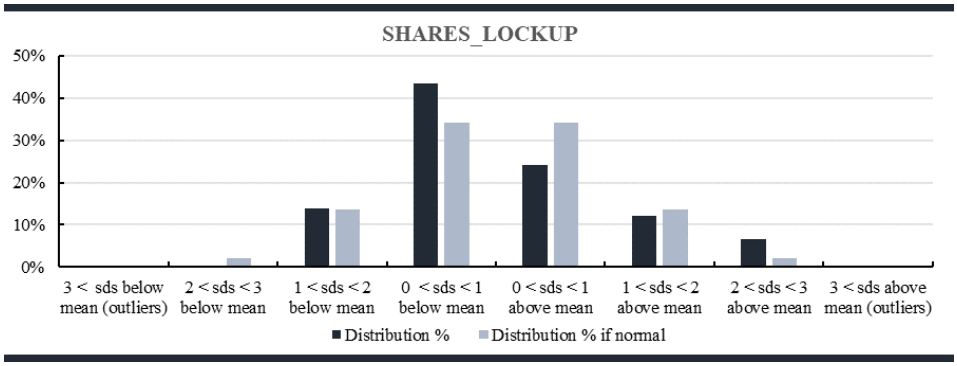
The sample distributions from the previous page suggest that there are few potential outliers for our variables, depending on which identification method is applied. Although we will not choose to exclude outliers, the following will show how our sample would appear if outliers in fact were excluded. When excluding outliers, one must employ an iterative process where the sample distributions are reconsidered once again after having removed outliers. When removing outliers, a new standard deviation and IQR will prevail, which therefore makes it possible for new outliers to occur. Therefore, the iterative procedure implies that one must continue to remove outliers until neither of the identification methods can observe outliers.

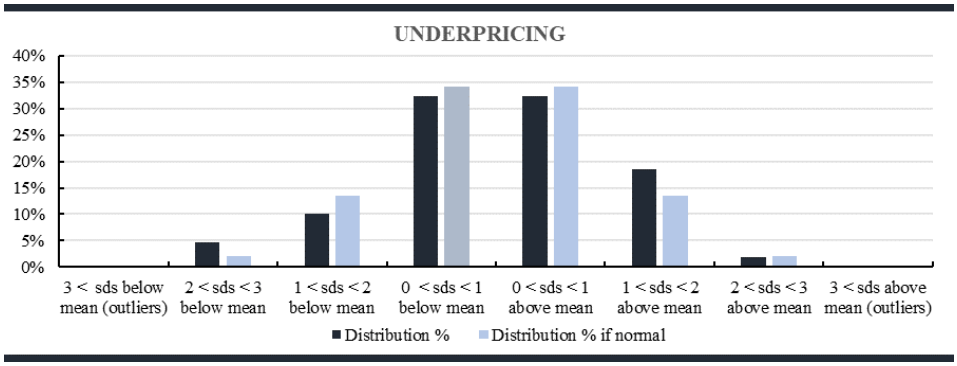
The following figures represent the 4th iterative stage of removing outliers. The first iterative stage removed 14 observations, the second stage removed 11 observations, the third stage removed 6 observations, whereas the fourth and final stage removed 2 observations. The final sample thus consists of 108 observations after having removed outliers. It is therefore evident that an immense disadvantage of this approach is that the sample is heavily diminished. Our sample is reduced by 23%, which can have a potential distortive effect on the statistical validity of our model. Furthermore, such distortive implications may offset any potential benefit of removing outliers. Hence we deem it far from optimal to commence an iterative procedure of removing outliers. Nevertheless, the following figures show how the sample distribution takes form after having removed outliers.

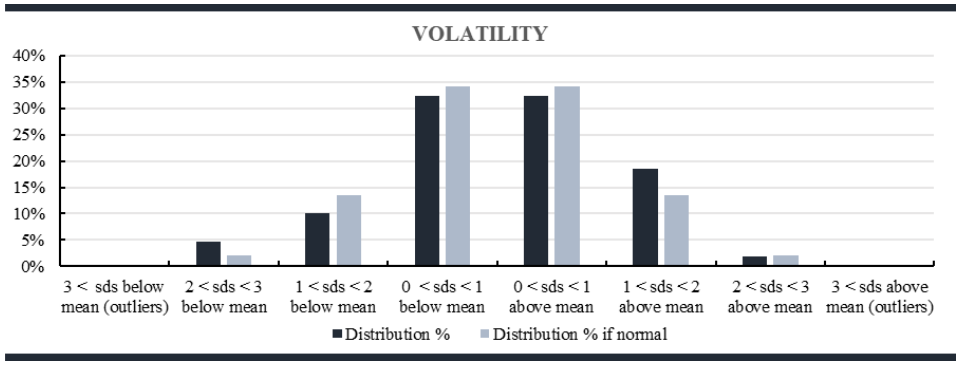


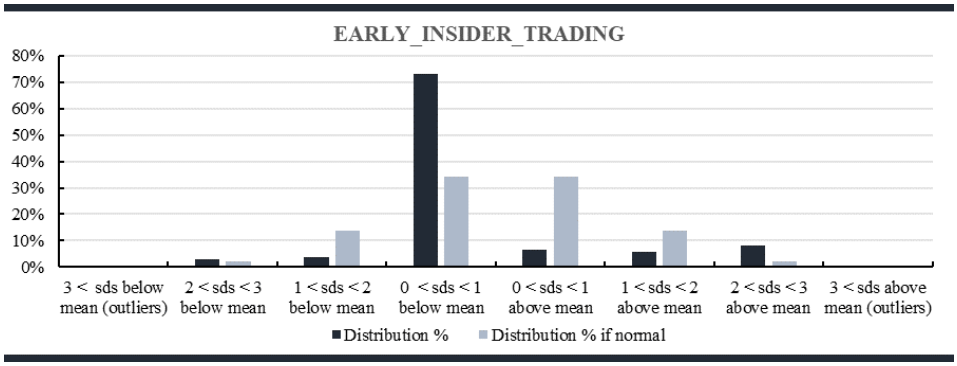


Appendix 3: Analysis of outliers (5/6)

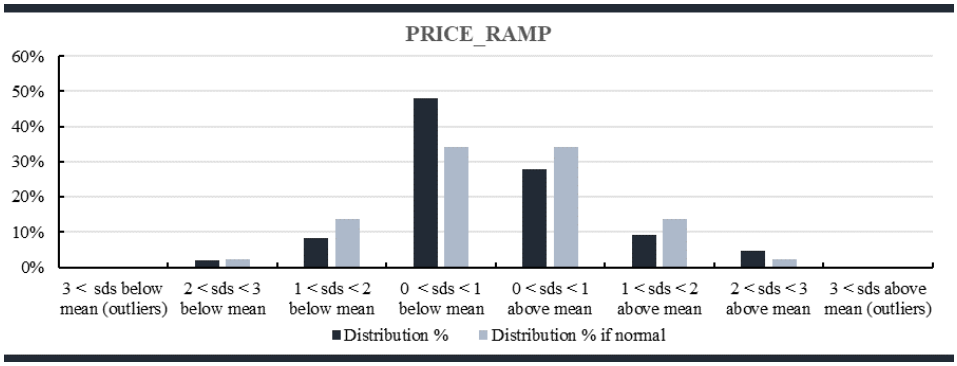






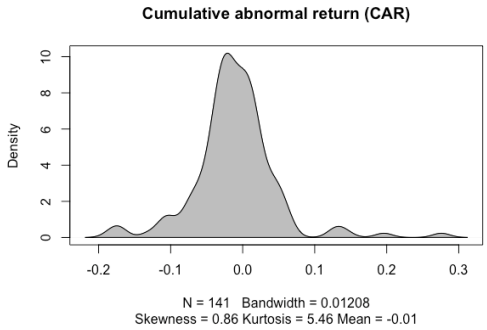


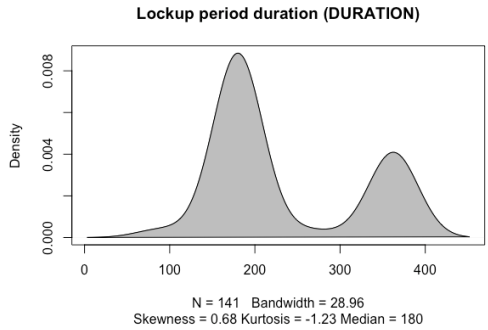
Appendix 3: Analysis of outliers (6/6)

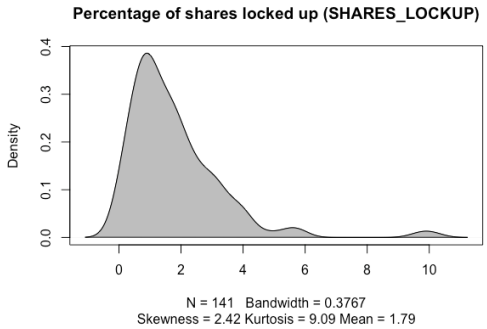


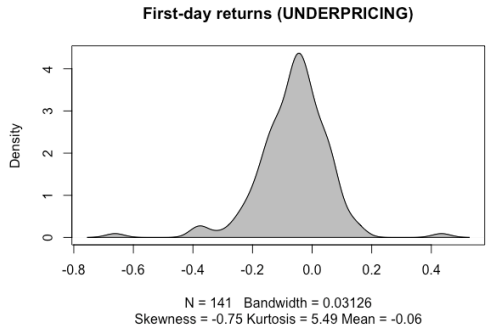
It is highly evident that all variables (arguably except CAR and VOLATILITY) possess a distribution with very heavy tails or a high concentration of observations. Hence, removing outliers has not improved upon the distribution of our observations, which consequently renders such an iterative procedure obsolete.

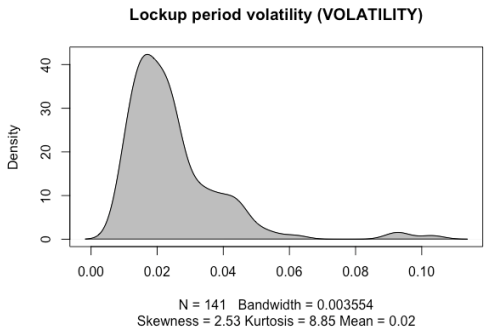
Appendix 4: Density plots for discrete and continuous variables

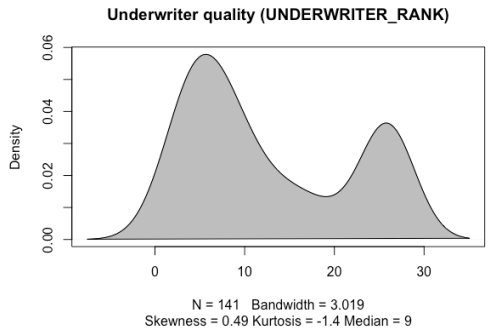


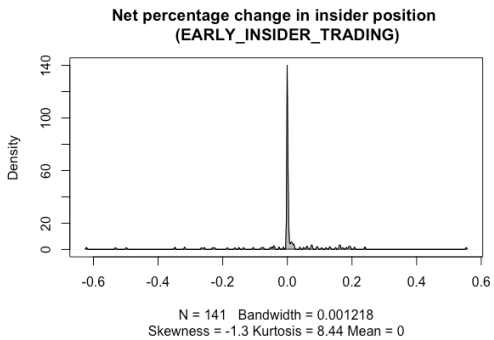


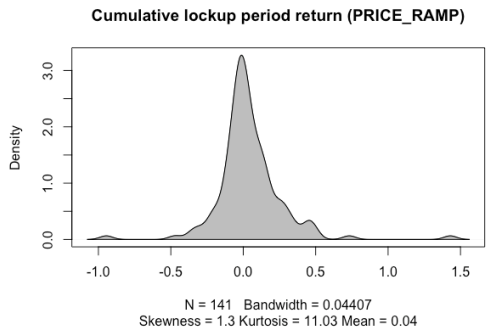






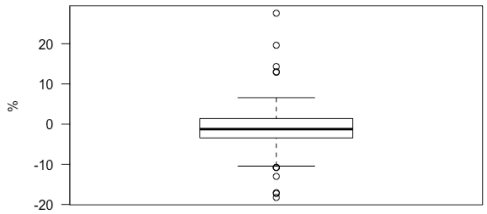




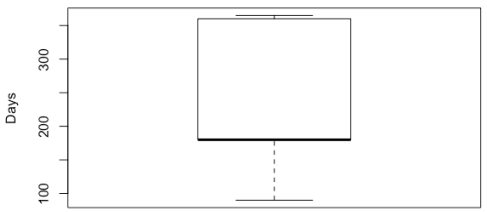


Source: Company prospectus, MergerMarket, CapitalIQ, FactSet
(data os of 22/03/2018)

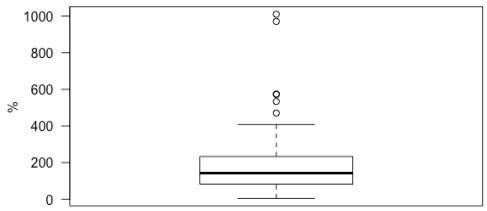
Appendix 5: Boxplots for discrete and continuous variables



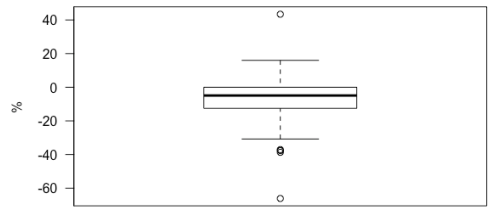
Cumulative abnormal return (CAR)



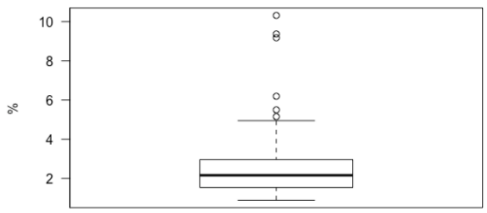
Lockup period duration (DURATION)



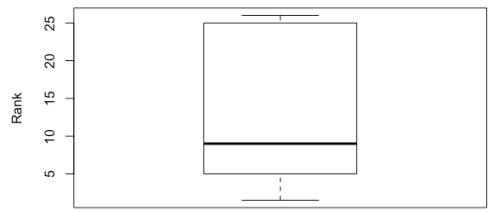
Percentage of shares locked up (SHARES_LOCKUP)



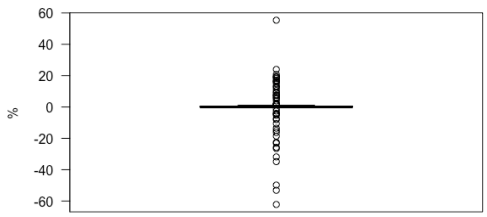
First-day returns (UNDERPRICING)



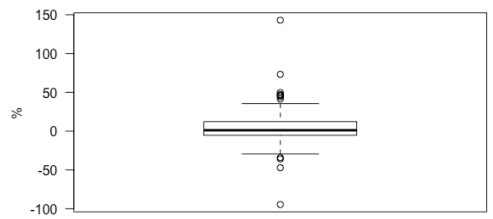
Lockup period volatility (VOLATILITY)



Underwriter quality (UNDERWRITER_RANK)



Net percentage change in insider position (EARLY_INSIDER_TRADING)



Cumulative lockup period return (PRICE_RAMP)

Source: Company prospectus, MergerMarket, CapitalIQ, FactSet
(data os of 22/03/2018)

Appendix 6: Statistical definitions

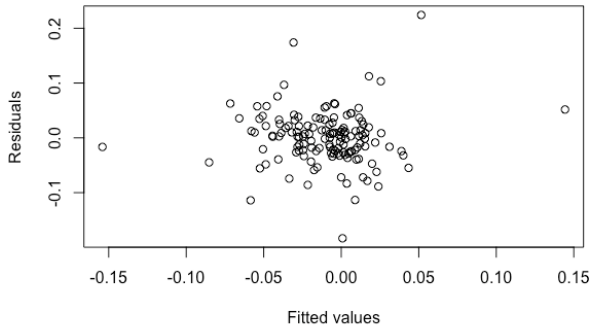
Term	Definition	Formula
R^2	Coefficient of determination (goodness of fit) captures the extent to which the fitted line fits the observations on the dependent and independent variables	$R^2 = \frac{ESS}{TSS} = \frac{\sum(\hat{Y} - \bar{Y})^2}{\sum(Y_i - \bar{Y})^2}$
Adjusted R^2	Adjusted R2 corrects for the "size" of the model by penalising the addition of variables	$\bar{R}^2 = 1 - [(1 - R^2) * \frac{n-1}{n-k-1}$
F-statistic	The F test of explanatory power tests the joint restriction that all estimated parameters are collectively equal to zero	$F = \frac{\frac{R^2}{k}}{\frac{1-R^2}{n-k-1}}$
Coefficient estimate	The slope of the best fitted line for the observations of Y and X_k	$\widehat{\beta_k} = \frac{cov(X_k, Y)}{var(X_k)}$

Appendix 7: Base Model compliance with OLS assumptions

OLS assumption	Test	Result	Inference
The error term follows a normal distribution with mean equal to zero; $E(\varepsilon_i) = 0$ for all i	Visual inspection of QQ plot Jarque-Bera test Sharpiro-Wille test	Residuals seem to follow a normal distribution with heavy tails 0.00 0.00	Reject null of normality Reject null of normality Reject null of normality
No autocorrelation; $cov(\varepsilon_i, \varepsilon_i) = 0$ for $i \neq j$	-	-	Assume no autocorrelation
Homoscedasticity; $\sigma_i^2 = \sigma_j^2 = \sigma^2$ for all i and j	Breusch Pagan's heteroscedasticity test White's general heteroscedasticity test	0.54 0.22	Cannot reject null of homoscedasticity Cannot reject null of homoscedasticity
Model is correctly specified; no omitted or surplus explanatory variables	-	-	-
Exogeneity; $cov(\varepsilon_i, X_i) = 0$	-	-	-
Linearity in the parameters	Visual inspection of "residuals vs fitted values" plot Visual inspection of "residuals vs predictors" plot	Vertical average of the residuals remains close to zero Vertical average of the residuals remains close to zero	Affirms the assumption of linearity in parameters Affirms the assumption of linearity in parameters
No perfect multicollinearity; no perfect linear association between explanatory variables	Correlation matrix Variance inflated factors (VIFs)	All pairwise correlation coefficients below 0.8 All VIFs below 10	No perfect multicollinearity No perfect multicollinearity

Appendix 8: Walkthrough of Base Model diagnostics (1/2)

A common starting point for econometric analysis is to look at the plot of the residuals and fitted values. This plot is used to investigate linearity, error variance, and outliers. The characteristics of a well-behaved residuals / fitted values plot are: 1) there is not any residual that stands out from basic random pattern of residuals, 2) the residuals lie randomly around a mean of zero, 3) the residuals fall within a constant band around the zero line (Wooldridge, 2009).



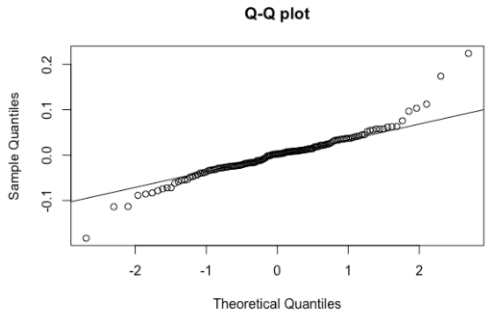
Firstly, there are not any easily identifiable observation which do not follow the basic random pattern. There are indeed outliers falling outside of the bandwidth, however these do not fall in any specific pattern. Moreover, we are cautious about falling into the trap of over-interpreting these types of plots, looking at every deviant as being potentially troublesome. Please see Appendix 3 for a thorough outlier analysis.

Secondly, we can observe from the plot that the vertical average of the residuals remains close to zero as look at the plot from left to right. This affirms the assumption of linearity in parameters (i.e. the relationship between CAR and explanatory variables is reasonably assumed linear).

Finally, the spread of the residuals remain approximately constant over the fitted values. This suggests that the variance of the error terms are constant over observations. To investigate the assumption of homoscedasticity further, we conduct White's general heteroscedasticity test and Breusch-Pagan heteroscedasticity test. Both of these confirm that the residuals are homoscedastic.

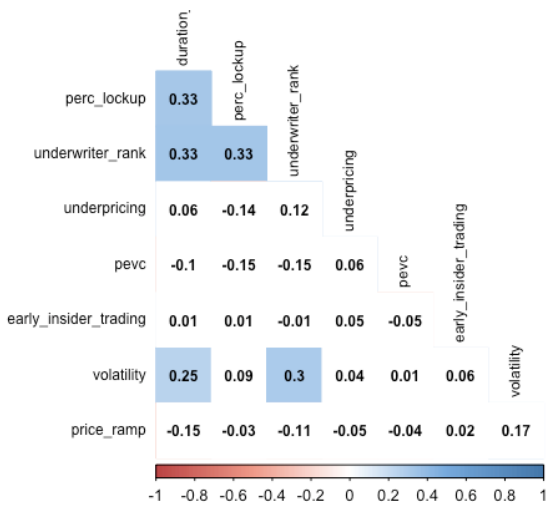
Appendix 8: Walkthrough of Base Model diagnostics (2/2)

Looking further into the residuals of the Base Model, we have some suspicion regarding the normality. Although the mean of the residuals is practically zero, it can be observed from the QQ plot that the residuals might not be normally distributed, but rather follow a heavy tailed distribution



To confirm this suspicion statistically, we perform a Jarque-Bera test and a Shapiro-Wilke test and both tests reject the null hypothesis of normality of the error term. Financial data is typically not normally distributed and as explained in our regression methodology OLS estimation does not require normal errors to estimate coefficients efficiently.

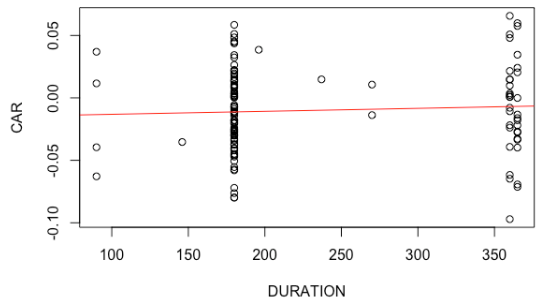
Since we investigate the relationship between CAR and multiple explanatory variables, we need to investigate the relationships among the explanatory variables to see if multicollinearity is present in our regression model.



As the correlation matrix above displays, there are not any notably high correlations between the explanatory variables. This is further emphasised by the fact that none of our explanatory variables have VIFs above 10:

Variable	DURA-TION	SHARES_ LOCKUP	UNDER-PRICING	UNDER-WRITER_ RANK	PE_VC	VOLA-TILITY	EARLY_ INSIDER_ TRADING	PRICE_ RAMP
VIF	1.6	18	1.5	1.9	1.4	1.6	1.4	1.4

Appendix 9: Scatterplot of CAR and DURATION with outliers removed



Appendix 10: Expiration date analysis

As a complimentary analysis to the event study and the cross-sectional regression analysis, we have performed an expiration date analysis, in which we investigate the relationship between our ex ante predictors (i.e. hypothesis variables) and abnormal volume trading around the expiration date as well as the relationship between abnormal volume trading around the expiration date and CAR around the expiration date. We perform this analysis to see if the ex ante predictors affect CAR implicitly through their affect on abnormal trading volume. Our expectation is that higher abnormal volume trading entails a higher supply shock which in turn will affect CAR negatively.

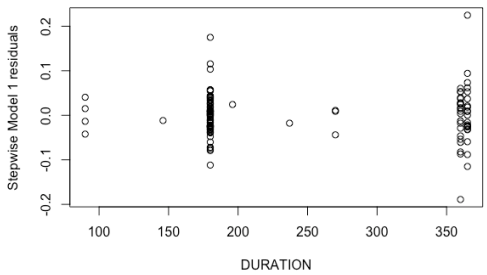
Therefore, we first regress our ex ante predictors on abnormal volume trading (ABNORMAL_VOL). As we only want to look at relevant and significant effects, we use the AIC stepwise regression procedure to narrow down the number of predictors (please see section 6.2.4 for a detailed explanation of stepwise model selection using AIC). The AIC stepwise regression tool specifies that we should only regress PE_VC and VOLATILITY on CAR.

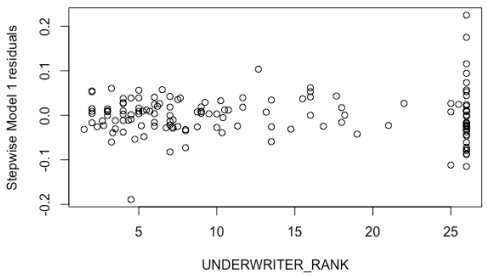
Thereafter, we regress PE_VC, VOLATILITY, and ABNORMAL_VOL on CAR to see if the two predictors effect on abnormal volume trading has a further indirect on CAR through abnormal volume trading. This gives the following regression output:

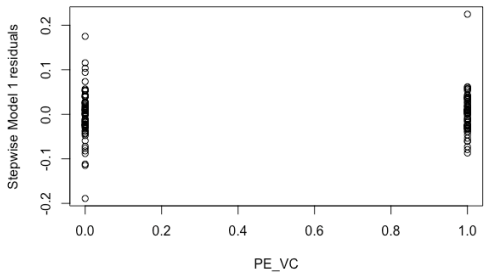
	Dependent variable	
	ABNORMAL_VOL	CAR
Independent variables	(1)	(2)
PE_VC	1.366*	0.006
	p = 0.094	*p = 0.509*
VOLATILITY	-53.355**	-0.574*
	p = 0.050	*p = 0.081*
ABNORMAL_VOL		0.0004
		p = 0.760
Constant	1.720*	0.0000
	p = 0.053	*p = 1.000*
Observations	141	141
R^2	0.0046	0.029
Adjusted R^2	0.032	0.008
Residual Std. Error	4.802 (df=138)	0.057 (df=137)
F Statistic	3.350** (df=2;138)	1.380 (df=3;137)
Note:		**p<0.1; **p<0.05; ***p<0.01*

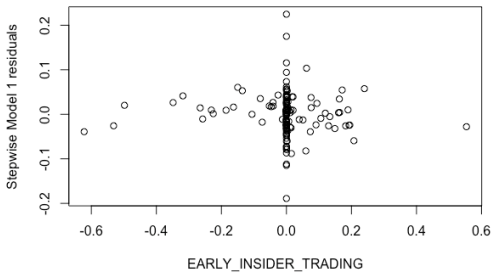
Looking at the first regression output, on can observe that PE_VC has a significantly positive effect on ABNORMAL_VOL whereas VOLATILITY has a significantly negative effect on ABNORMAL_VOL. Regarding the second regression output, ABNORMAL_VOL has a very insignificant effect on CAR. In addition, the constant term is zero with p-value equal to 1, which entails that CAR will not move unless there is trading in the market.

Appendix 11: Scatterplot of omitted variables and Stepwise Model 1 residuals









Appendix 12: Stepwise Model 1 with control variables shown

	Dependent variable		Dependent variable
Independent variables	CAR	Independent variables	CAR
SHARES_LOCKUP	-0.010***	OFFER_PRICE	0.019
	p = 0.007		*p = 0.525*
UNDERPRICING	-0.069	FACTOR.INDUSTRY1	-0.023
	p = 0.143		*p = 0.129*
VOLATILITY	-0.382	FACTOR.INDUSTRY2	0.001
	p = 0.319		*p = 0.973*
PRICE_RAMP	-0.079***	FACTOR.INDUSTRY3	-0.032
	p = 0.001		*p = 0.375*
SIZE	0	FACTOR.INDUSTRY4	-0.01
	p = 0.546		*p = 0.605*
M_B	0.0004**	FACTOR.INDUSTRY5	-0.01
	p = 0.012		*p = 0.802*
FACTOR.YEAR1	-0.069	FACTOR.INDUSTRY6	0.002
	p = 0.175		*p = 0.951*
FACTOR.YEAR2	-0.035	FACTOR.INDUSTRY7	0.016
	p = 0.579		*p = 0.704*
FACTOR.YEAR3	-0.041	FACTOR.INDUSTRY8	0.024
	p = 0.398		*p = 0.297*
FACTOR.YEAR4	-0.058	FACTOR.INDUSTRY9	0.002
	p = 0.227		*p = 0.936*
FACTOR.YEAR5	-0.04	FACTOR.INDUSTRY10	0.008
	p = 0.381		*p = 0.876*
FACTOR.YEAR6	-0.047	Constant	0.052
	p = 0.309		*p = 0.281*
FACTOR.YEAR7	-0.027		
	p = 0.573		
FACTOR.YEAR8	-0.058		
	p = 0.340		
FACTOR.EXCHANGE1	0.011		
	p = 0.471		
FACTOR.EXCHANGE2	0.004		
	p = 0.821		
FACTOR.EXCHANGE3	-0.005		
	p = 0.873		
FACTOR.EXCHANGE4	-0.076		
	p = 0.287		
Observations	141		
R^2	0.276		
Adjusted R^2	0.087		
Residual Std. Error	0.055 (df = 111)		
F Statistic	1.459* (df = 29; 111)		
Note:			**p<0.1; **p<0.05; ***p<0.01*

Appendix 13: Test for endogeneity due to observable omitted variable bias

	Dependent variable	
	CAR	
Independent variables	(1)	(2)
SHARES_LOCKUP	-0.007**	-0.007**
	p = 0.017	*p = 0.024*
UNDERPRICING	-0.036	-0.040
	p = 0.359	*p = 0.304*
VOLATILITY	-0.456	-0.391
	p = 0.149	*p = 0.204*
PRICE_RAMP	-0.070***	-0.071***
	p = 0.001	*p = 0.001*
M_B	0.0003***	0.0003***
	p = 0.010	*p = 0.010*
OFFER_PRICE	0.026	
	p = 0.353	
Constant	0.010	0.008
	p = 0.339	*p = 0.404*
Observations	141	141
R^2	0.177	0.171
Adjusted R^2	0.140	0.141
Residual Std. Error	0.053 (df=134)	0.035 (df=135)
F Statistic	4.788** (df=6;134)	5.578*** (df=5;135)
Note:		**p<0.1; **p<0.05; ***p<0.01*

Appendix 14: Final Model candidates

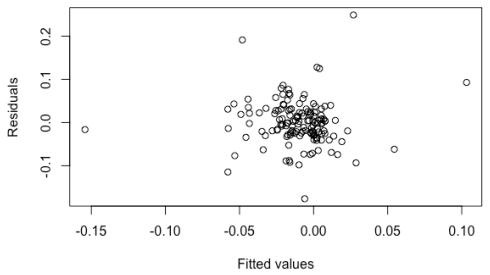
	Dependent variable			
	CAR			
Independent variables	(1)	(2)	(3)	(4)
SHARES_LOCKUP	-0.007**	-0.007**	-0.007**	-0.007**
	p = 0.022	*p = 0.019*	*p = 0.021*	*p = 0.024*
PRICE_RAMP	-0.070***	-0.075***	-0.069***	-0.074***
	p = 0.002	*p = 0.0005*	*p = 0.001*	*p = 0.0003*
UNDERPRICING	-0.065	-0.07		
	p = 0.141	*p = 0.108*		
VOLATILITY	-0.441		-0.479	
	p = 0.192		*p = 0.128*	
Constant	0.033	0.026	0.012	0.001
	p = 0.405	*p = 0.506*	*p = 0.236*	*p = 0.845*
Observations	141	141	141	141
R^2	0.212	0.201	0.171	0.154
Adjusted R^2	0.125	0.126	0.141	0.135
Residual Std. Error	0.054 (df=126)	0.054 (df=128)	0.053 (df=135)	0.054 (df=137)
F Statistic	2.428*** (df=14;126)	2.688*** (df=12;128)	5.583*** (df=5;135)	8.289*** (df=3;137)

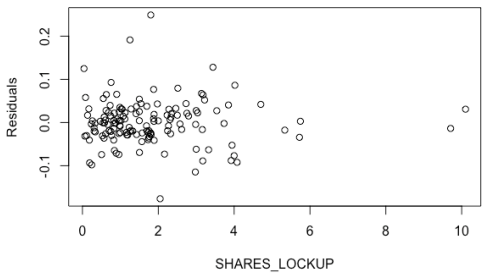
Note: **p<0.1; **p<0.05; ***p<0.01*

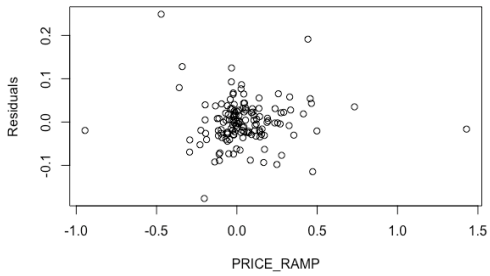
Appendix 15: Final Model compliance with OLS assumptions

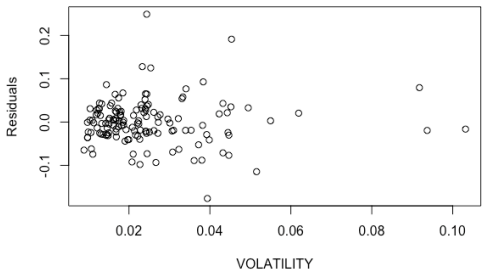
OLS assumption	Test	Result	Inference
The error term follows a normal distribution with mean equal to zero; $E(\varepsilon_i) = 0$ for all I	Visual inspection of QQ plot Jarque-Bera test Sharpiro-Wille test	Residuals seem to follow a normal distribution with heavy tails 0.00 0.00	Reject null of normality Reject null of normality Reject null of normality
No autocorrelation; $cov(\varepsilon_i, \varepsilon_i) = 0$ for $i \neq j$	-	-	Assume no autocorrelation
Homoscedasticity; $\sigma_i^2 = \sigma_j^2 = \sigma^2$ for all i and j	Breusch Pagan's heteroscedasticity test White's general heteroscedasticity test	0.19 0.29	Cannot reject null of homoscedasticity Cannot reject null of homoscedasticity
Model is correctly specified; no omitted or surplus explanatory variables	Stepwise regression procedure	-	The stepwise regression procedure should ensure that regression model is correctly specified
Exogeneity; $cov(\varepsilon_i, X_i) = 0$	Test for endogeneity due to observable omitted variable bias (see appendix 13 for further detail)	Correlation coefficient between VOLATILITY and OFFER_PRICE changes in the same direction as the coefficient for VOLATILITY when omitting OFFER_PRICE	VOLATILITY is endogenous on OFFER_PRCE – therefore we include OFFER_PRICE in the regression model to make VOLATILITY exogenous
Linearity in the parameters	Visual inspection of "residuals vs fitted values" plot Visual inspection of "residuals vs predictors" plot	Vertical average of the residuals remains close to zero Vertical average of the residuals remains close to zero	Affirms the assumption of linearity in parameters Affirms the assumption of linearity in parameters
No perfect multicollinearity; no perfect linear association between explanatory variables	Correlation matrix Variance inflated factors (VIFs)	All pairwise correlation coefficients below 0.8 All VIFs below 10	No perfect multicollinearity No perfect multicollinearity

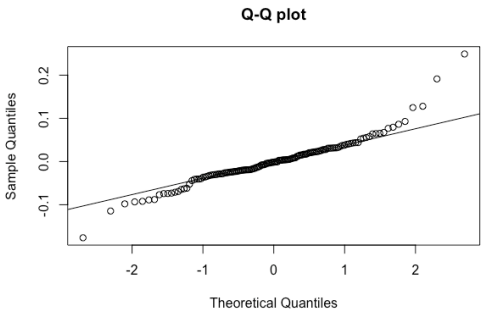
Appendix 16: Final Model visual inspection











Appendix 17: Transcript of interview with Sebastian Hougaard (1/9)

Peter Sommer

So as previously mentioned, we are writing our thesis based on the lockups that you see in conjunction with IPOs and more specifically the abnormal returns that previous research has observed at expiration and additionally we are interested in considering the TCM case that Carnegie was involved with and try to use this as a supporting real world example of how lockups actually can take form and the TCM case used two different lockups and I was considering if you want to elaborate on the specifically why choice landed on that structure of lockups and perhaps also compare that to that of Orphazyme why it perhaps did was that typical structure and then you can elaborate from there.

Sebastian Hougaard

Especially when considering the TCM case, then the lock-ups there, it served a purpose to just describe the background to why we have lock-ups and why we want lock-ups. It's not required by law or anything. Its specific the investments banks putting these companies to market that require it, i.e. us in those two instances you mentioned. The reason we want to do this is to give some certainty to the market that we are not just dumping shares, that there will actually be someone who is left with part of the responsibility, someone who will withstand for the company and the management at least an accounting cycle after the IPO, and for the sellers, which is typically half a year, so you get acquainted with the company before the owners are completely gone. And this was also the background for why we chose the model as we did in TCM. TCM was a bit different from many cases, since the management in the company had substantially larger share of the company than we normally see and thus the requirement on the selling shareholders, the private equity firm I gave, was less so, but still at some point some things are market practice and if you deviate from that you need to have a very good reason. There weren't any problems for IK having their lockup as well so that was easy to do.

When the lock-up expires for IK then TCM will have published their bank […] accounts, which they have done and also the first quarterly, which gives the market a few touch points […] as to the performance of the company. And after that they are comfortable with releasing the former owners. When you have someone who is even more insider into the strategy and the company itself and the management specifically, then you will require them to stay a bit longer. You would hate to see any management sell any shares, typically. This is to make sure that they won't do it. And once you've brought shares to the market, then you would rather not have the company issue new shares shortly after – because that would change the dynamics of the investment altogether.

Then again, this is an agreement done with the banks and you can't be released from reactively. Now you mentioned Orphazyme we did do a small release from the lock-up for Orphazyme as they needed to issue some new shares in order to pay part of an agreement they had with their partners. But they were actually prohibited

Appendix 17: Transcript of interview with Sebastian Hougaard (2/9)

from honouring their obligation because of the lockup. It was fairly ease to give, but nevertheless they formally had to ask us and ask to be released for that small amount of shares. But you can be released. Some years back with the rights issue for SparNord bank. They were actually under the lock-up when they did the merger with Spar bank. But you could do so, that would require […]

Joakim Helm

Do you include a specific clause if – in extreme circumstances such as the merger, in that case where you actually need to be released?

Sebastian Hougaard

We could just have said to Orphazyme, too bad you are under a lockup, we won't do it, but then we would have had other problems. It is a commercial view […] Does it make commercial sense, also for the market to digest? But it is a way to tell investors that at least the banks will assure that there will only be sell downs or new issues if there is a good reason to do so.

Peter Sommer

Is the lock up still considered as one of the more useful ways to signal this commitment to the market or do you see a trend to move towards other strategies?

Sebastian Hougaard

It would probably never go away, it's something that is market practice. It is more or less a requirement. In extreme circumstances, it can probably be left out, but then there would have to be good reason and then you will have a lot of questions around it. I think what we probably more see is refinement of the lock up or maybe even putting in more shield guards in conjunction with the lock up. The TCM case – we had the management having a large amount of the shares in the company, which is what they would want. They once closed execution of the strategy being tied up with a lot of their own wealth. That is a better signal than the lock up in itself. We didn't try, but we could probably have sold at least – we did sell almost all of IK shares in the IPO, didn't receive any questions as to the exit because we had management participating with their 8% of the company. So that goes a long way. The actual long-term commitment. That could also be – if you had long term holders, if you had family officers in for a substantial part of pre-IPO investors in generals, someone with

Appendix 17: Transcript of interview with Sebastian Hougaard (3/9)

a longer view, just blue stamping the investment. When you have a company as TCM, then the accounting quarterly, the accounting cycles are important, because then you will see the actual performance of the company, their kitchens being sold every day, do they deliver on their promises? In a case with Orphazyme it's completely different, because it doesn't really matter what's in the quarterly, they don't even issue quarterly, only half year results. When you have a company like Orphazyme it's important for the milestones that will come – as we did the IPO fairly close to a milestone which will come in the third quarter of this year, less than a year after the IPO. A lot of the investors were a bit hesitant because we did issue shares so close to a milestone, which will – if they meet the requirements will chance the valuation completely – most likely. In order to give them comfort that we didn't foresee any negative findings in the data published then, we have the structure of the lock-ups to have the former owners, which are currently still main owners, have them stay in at least until the data has been released. So if they take a hit, they take the same hit, effectively. That's why we did something different there, we wouldn't have done so in the TCM case, that wasn't considered because there you have actual daily observations but you only have those milestones in the Orphayme case.

Effectively, it's a way of trying to communicate to the market that we're actually after and we're trying to hold the sellers of the shares with an unproven track record and a public domain and were trying to hold them to their promises from the IPO. It's a way to do so.

Peter Sommer

Have you ever experienced that management or other people that have been locked up chooses to sell down their shares immediately after expiration or?

Sebastian Hougaard

Management less so, but it happens. Typically the longer date will be fairly close to a quarterly […]

And sometimes management would sell just for their own private wealth. What we see very often and I guess you also see in your data set is that if you have PE owners, they will sell at the first given instance they can. That's fairly common and anticipated by that market as well. For shares that have a larger overhang in the PE ownership after an IPO, that will probably also even suppress the market price a bit, because know there will be a fairly large sell down within short. It will probably not be the case for TCM, because since the overhang is less than we typically see, but in a case like HandiCare there's an overhang of more than 60%, so that's still a fairly large amount of the company that may come to market within short. So that suppresses the market price a bit there. That's also a dynamic to look at. The market is well aware of this, and they know when the lock ups expire, they know when to expect shares and then the price will be thereafter.

Appendix 17: Transcript of interview with Sebastian Hougaard (4/9)

Peter Sommer

What would you believe that when you in some cases observe an abnormal price reaction on the expiration day or surrounding it – but the market has clearly anticipated this day occurs – what would you believe is the main impacting factor that causes this?

Sebastian Hougaard

Part of it might be people remembering that the lock up actually expires then. Typically, especially when you have large ownership, then you're not allowed to sell until you are in the sell down window after quarterly has been published, so the lock up may well expire some weeks, even months in advance of an open window. So that shouldn't change anything, but it will probably change something in the coming window – but you would probably know so. It's a lot about psychology. It's a lot about people remembering, selling down, preparing themselves for a future sell down […] Probably the only logical explanation – it isn't as rational probably, but it's also difficult to know whether – a lot of things can happen in the company before the lock-up expires and that's why it happens.

Having the fair market price leading up to an expiration, because there might be other dynamics – will they, just before the expiration of the lock up, come with an update to the budget or downgrade even – then we would have to price that in when that comes and then we can price the lock up in afterwards.

Peter Sommer

People remember that the lock up occurs just before expiration – as you have noted the in the U.S. the lock up environment is quite different because there is a more standardized method of applying a lock up to an IPO. Do you think that there is more – previous research calls it "voluntary lock up environment" - in the Nordics, do you think this has an impact or there are any key differences between these two situations that can have an impact on the market's reaction?

Sebastian Hougaard

I think the Nordic model is more fitted to the Nordic market, and part of obtaining their trust in the lock up which you need when it is as voluntary as it is here, it so get the banks to actually adhere to what we promise in terms of the lock up. To my recollection it has always been done, so there hasn't been any […] to this unless

Appendix 17: Transcript of interview with Sebastian Hougaard (5/9)

a really good reason. And as long as that is the track record in all Nordic IPOs in the last 20 years, then it will carry almost as much weight as in the voluntary lock up. Also if there is an acquisition where you need to pay with shares and issue shares to acquire a company. If you're prohibited from that from the lock up that puts a lot of boundaries as to what you can do in the company – which isn't in the interest of the shareholders either. So it works both ways.

Joakim Helm

Going forward, you believe that the lock up market in the Nordics will still be more heterogenous than the standardized mandatory lockups in the U.S?

Sebastian Hougaard

Yes, unless people start violating your lock ups or take them too easy, you could see a lot of releases for no reason whatever, then it would probably shift towards something different. But as long as there is trust in we actually act professionally, then I'm sure we remain doing what we've done.

Peter Sommer

Are there other firm characteristics that you think are key when setting up the structure of the lock up or is it more the business model itself that determines the structure?

Sebastian Hougaard

If you can see a valuation triggers in either direction coming within a short or even longer, if you have a real estate development company, which takes a long time to actually develop the companies or the real estate, then you might want a longer lock up, because you want to see, can we actually and when we need to sell, what's the housing market like – it just needs to fit the risk of the company. It might be – if I have a real estate development company – it might be that I'm finishing real estate every quarter and the biggest one is just a few years ahead – then I might go for as six month lock up because that is just the course of the business. If you see something that can dramatically change the risk profile of the company, then you would try to encompass that in the lock up.

Appendix 17: Transcript of interview with Sebastian Hougaard (6/9)

Peter Sommer

Comparing the Swedish and Danish IPO markets where the Swedish market have perhaps a greater investment appetite for the small and mid-cap segment - do you believe that perhaps the Danish market opening up for this that we would e.g. observe lock ups taking on longer durations and so on to incorporate the risks that are associated with this?

Sebastian Hougaard

Definitely. And you will probably see some of the longer lock ups in the Swedish market, especially for the smaller companies. None of the companies are proven in terms of being publicly listed, but some of the companies – TCM for one – have a long history of actually proving themselves. If you have a company that's only 2-3-4 years old, 10 employees or so in the smaller startups, then the risk is definitely higher and this won't be a decent investment until they have proven themselves over a couple of years. Then you would probably want them being locked up for a longer time. Smaller companies with high growth, short track record, there you might risk having the management sell out fairly quickly when they have a chance, and just taking back the returns.

Definitely, when you look at the smaller companies, the more risky or the faster mover or younger companies, it would probably require a longer lock up. But again, it has to fit the business model.

Peter Sommer

When an IPO occurs, you say it's primarily the investment bank itself or the underwriter who sets the structure - do any of the other parties have a say in this or is it completely applied from one party.

Sebastian Hougaard

We will take input from the market as well, so when we speak to investors – in the case of Orphazyme – it was clearly important for them to have them locked up until after the data is published, which is also something we discussed with the company before but it means a lot what the investor says. So definitely we will listen to the investors – we should be the voice of the investors determining the lockup. But apart from that, that will be a negotiation between the sellers and the investment banks in the end.

Appendix 17: Transcript of interview with Sebastian Hougaard (7/9)

Peter Sommer

Do you ever experience that any of the locked up parties disagree to the extent of how they are restricted or is it in general well applied?

Sebastian Hougaard

When you apply fairly market conform lockups as TCM, there is no negotiation at all, that's just how its done. When you do as Orphazyme, it may require some dialog], but when there are good arguments, then we can actually overcome that. Some of the former selling shareholders invested in the IPO as well. But the shares they invested in the IPO are not subject to lock up because they are acquired at the same price as the rest of the market.

Joakim Helm

Would that be a way to escape to have your shares escape that lock up before for example a milestone – then you would be able to sell part of your ownership before…

Sebastian Hougaard

Yes, but you sell the part that you paid the IPO price for – so you'll get the same return as everyone else.

Then you will be locked up on the cheap shares you have. It's mixing hot and cold water but in the end you'll have the same exposure.

Peter Sommer

Are there any mitigating actions you can take post-IPO but pre-lockup to become more robust to such a negative reaction? Is it more just ensuring transparency and communicate to the market and so on or are there any early on signals?

Appendix 17: Transcript of interview with Sebastian Hougaard (8/9)

Sebastian Hougaard

It's probably difficult – what you maybe could do is to have a stage lock up where you reach part of what they owned at stages. So you smooth that out over time. You probably still has the same reaction but you might put a lid on it.Apart from that – you also see the same pattern when futures elapse and when you have warrants lapsing and there is a lot of psychology on those specific dates.

Joakim Helm

It is in general just uncertainty that is moved into the future from the IPO date to the future. You can't totally mitigate that kind of uncertainty for the outside investor.

Sebastian Hougaard

Exactly. Theoretically, there should be a gliding movement toward whatever the price is when the lockup expires. Don't see that in the everyday market. But that could also be a trigger strategy and I think that - pointing to that – if you have asked market participants where there is significant negative return on – they probably don't know it. If that's an investment strategy applied, that would of course alleviate profit. Volume's probably not high enough for that to matter for investors. They wanted to analyze that. That's what we've seen in previous work, where we did a derivative product around exactly the drop in share price on the day futures lapsed for certain reasons. As we sold more and more of those derivatives, then the movement became smaller and smaller, but that was fairly large companies that could actually do so.

Joakim Helm

Maybe just to elaborate more on the investor perspective. If you're standing as an outside investor and are aware of this, do you have any kind of predictors or indicators – in the pre lock up expiration market in the lock op period – what the outside investor should actually pay attention to before the lock up expires?

Appendix 17: Transcript of interview with Sebastian Hougaard (9/9)

Sebastian Hougaard

There are probably three, maybe more. The type of investor being released from lock up, it's probably more the case than not that the PE company would sell as soon as they can if the share price develops as anticipated. Will the company issue shares when to lock up expires? Probably not. There needs to be a reason for them to issue shares. Will management sell? There's a lot of attention around management sell downs, so might be at the first, if there's something in the prior financials that needs to be sorted out but that should have been handled at the IPO, so probably not. The type of lock up expiring, the share price development since the IPO. Then the number of shares being released from lock up should matter a lot.

Joakim Helm

What about the general volatility in the lock up period?

Sebastian Hougaard

If it is PE owners, they would probably just want to sell their shares as fast as possible. They're not in the business of being exposed to the stock market. So they would probably sell, even if it has had negative price development just getting the cash for the shares that's probably what they want to do. And that's probably also what you see in the data, that they sell out as fast as possible.

I don't know this, but, you probably won't see IK holding on to their shares in TCM for very long, because they're not a public equity investor and TCM might perform fantastically, but then you also have the general market sentiment – you have peers trading and a lot of other things you have to factor in to your risk assessment and that's not what they do so they will probably sell their shares fairly quickly. And that goes for the PE owners. So volatility shouldn't matter a lot. Volatility in the period just after a quarterly has been published might matter of the timing of the sell down within the window, but over the life time shouldn't matter.

[Outro]

Appendix 18: Transcript of interview with Chantal Patel (1/9)

[Intro]

Peter Sommer

Det, som tidligere forskning har peget på – at der forekommer et negativt abnormalt afkast, når lock ups løber ud. Derfor laver vi et event studie på nordiske børsnoteringer siden 2010, hvor vi prøver at se på dagene omkring udløbet af lock up og se, hvad der egentlig sker med aktiekursen for de forskellige selskaber.

Joakim Helm

Derudover, efter vi har analyseret afkastet omkring lock up'ens udløb, så prøver vi at lave nogle regressionsanalyser, hvor vi prøver at finde ud af nogle forskellige variabler, der rent faktisk kan forklare og forudsige, hvorvidt der kan forekomme et abnormalt negativt afkast ved udløb af disse lock up perioder.

Peter Sommer

Man kan sige, at det overordnede fokus for opgaven, det er at stå som udefrakommende investor og prøve at sige, hvad man før lock up udløb kan forvente i den forstand af vores output.

Chantal Patel

Er det så bare aktiekursen eller er det, hvad der rent faktisk er solgt til det afkast?

Peter Sommer

Det er i aktiekursen – lidt ud fra hvad tidligere empiriske studier har lavet. Hvor man laver et estimat af, hvad der forventes, med en typisk markedsmodel på, hvad der tidligere er set i markedet. Så laver man en estimering af, hvad burde kursen være omkring lock up udløb. Så det er selvfølgelig ikke et direkte mål, men det er overordnet set den prisreaktion, der sker.

Chantal Patel

Det er begrænset, hvad jeg har på kursudvikling, men det er jeg sikker på, at I har data på.

Appendix 18: Transcript of interview with Chantal Patel (2/9)

Peter Sommer

Det vi også tænker det er egentlig mere det at fokusere på det at inkludere en lockup i en børsnotering. Hvilke forbehold skal man tage sig når man laver restriktioner på insidere? Hvilke overvejelser gør man generelt når man laver et lock up for et selskab; hvorfor har den netop den form man har set hos TCM eller hvad spiller med i den forstand?

Chantal Patel

Der har ikke været vildt mange børsnoteringer, hvis man kigger på det sidste årti i Danmark. Lock ups er noget, der er markedspraksis. De er beskrevet i alle de prospekter, der er lavet i forbindelse med børsnoteringerne i Danmark. Min vinkel er meget dansk i øvrigt. Der vil I også kunne se, at det er stort set skåret over samme skabelon på de fleste. Så det er helt sædvanligt, at der er tre lock up typer: 1) en for det selskab, som skal på børsen, 2) en for de eventuelle aktionærer, der sælger med eller bliver tilbage af større aktionærer i selskabet, 3) en for bestyrelsesmedlemmer, direktionsmedlemmer og eventuelle nøglemedarbejdere, der sidder med aktier i selskabet eller får i forbindelse med børsnotering. Og det er helt sædvanligt. Jeg kan ikke engang huske et tilfælde, hvor der har været lock ups for disse grupper. Perioden er også ret sædvanlig, det er 180 dage for henholdsvis selskabet og aktionærerne. Og så er det 360 dage eller 365 dage (afviger en smule en gang imellem) for ledende medarbejdere og bestyrelse.

Joakim Helm

Det er fuldstændig I overensstemmelse med det vi observer i datasættet. Det er meget konsekvent hele vejen igennem også på tværs at landet at vi ser det er 180 dage for de sælgende aktionærer og firmaet selv og så den længere periode for management og bestyrelsesmedlemmerne.

Chantal Patel

Det er typisk noget, som også er drevet af de banker, der er involveret i forbindelse med udbuddet. Der er også en praksis dér. Det er som regel dét, der driver det og det er noget, der også sædvanligvis vil blive aftalt upfront inden man går i gang med sådan en proces. At man vil sige, at selskabet og aktionærerne og medarbejderne forventes at påtage sig sædvanlige lock up forpligtelser. Det er sjældent noget, der er specielt meget forhandling omkring. Det er mere justeringer og tilpasninger, som – jeg vil ikke sige påkrævet – der er blandt andet på dagene, hvornår du regner fra – for man vil som regel have det timet med, at lock up'en udløber på

Appendix 18: Transcript of interview with Chantal Patel (3/9)

et tidspunkt, hvor det rent faktisk er muligt at handle i aktien. Så det skal også ramme ind i et åbent handelsvindue. Og under de nye MAR regler, så kan man sige, at handelsvinduer eksisterer i princippet ikke mere, medmindre selskabet selv har indført det. […] Sådan at det ikke ligger i en blackout periode op til offentliggørelse af nogle regnskaber. Så du rent faktisk ikke kan bruge udløbet af lock upen til noget. Fordi der vil særligt ledelsen være begrænset hvis de ikke kan handle i de vinduer, som selskabet har lagt. Det er mere en justering på, om man lader dem regne fra den dag, du offentliggør prospektet eller den dag, hvor du gennemfører IPO eller hvornår. Man vil typisk se på en kalender og se, hvordan det hænger sammen med den finanskalender, som et selskab har.

Peter Sommer

[…] Så du ser stadig denne standardiserede brug af lock up'en, det er noget, man fortsat benytter sig af. Det er ikke fordi, at der er andre måder man kan signalere til markedet, at investorerne har tænkt sig at blive med selskabet og deres aktier.

Chantal Patel

Det bliver i hvert fald brugt. At afvige fra det ville nok sende et signal i sig selv. Derudover, så er der nogen, der går ud og siger, at hvis aktionær ejerkredsen har en forventning om at blive mere langsigtet. Det er der også eksempler på, at man går ud og italesætter det. Jeg tror man gjorde det med staten i DONG og jeg tror også, at man gjorde det med […] i ISS gik ud i forbindelse med nogle af meddelelserne og sagde, at de havde indikeret, at de ville holde deres aktieposter i en længere periode. Hvor mange af PE fondene, der ligger det lidt i kortene, at på et eller andet tidspunkt må man ofte sælge ned, afhængigt af, hvordan kursen udvikler sig. Men det ligger jo i den struktur, de er baseret på, at de skal ud af deres investering på et eller andet tidspunkt.

Peter Sommer

Grundlæggende er der ikke – som sådan – nedskrevne regler eller bredtfavnende forbehold, man skal tage sig, når man laver disse lock ups? Altså det er ikke noget, der er nævnt ved lovgivning eller noget som helst?

Appendix 18: Transcript of interview with Chantal Patel (4/9)

Chantal Patel

Nej. Det er frivilligt. Det er mere end forventning fra bankernes side. Og generelt også alle involverede, fordi det er med til at signalere, at de eksisterende aktionærer og ledelsen støtter op om børsnoteringen, og man ikke alle hopper fra borde lige så snart man har fået børsnoteret. Det er jo dét, der er signalværdien i det. At man bliver med i en periode efter en børsnotering og sørger for, at man kommer ordentligt i gang, og har samme risiko som øvrige investorer, der tegner i en IPO. I forhold til ledelsen, der er der også eksempler på, at man siger, at for at forhindre, at man har en væsentligt risiko for, at flere af ledelsens medlemmer vil sige op efter det når deres lock up udløber, der er eksempler på, at der er nogen, som er blevet tilbud nogle incitamentspakker, der gør at de kan få tildelt flere aktier eller en form for bonus eller skyggeaktier. Det kan tage alverdens varianter. De bliver honoreret for at fortsætte deres ansættelsesforhold, så en form for fastholdelsesengagement. [...] Hvis de sidder med disse aktieposter en periode efter, så kan det være, at der er dobbelt op (eller en eller anden bonus), der matcher det.

Joakim Helm

Lock up'en bliver brugt som den umiddelbare incitament-skaber, når den udløber, så skal der nogle nye instrumenter på bordet, som rent faktisk kan skabe samme form for incitament som denne lock up har gjort i de 180-360 dage lige efter IPO'en.

Chantal Patel

Ja, men på mere frivillig basis – med en økonomisk gulerod.

Peter Sommer

Givet, at der ikke er nogen lovgivning, der direkte går ind og omtaler lock ups, hvad med mere generelt om insider handel af aktier, hvis vi ser udover lock ups?

Appendix 18: Transcript of interview with Chantal Patel (5/9)

Chantal Patel

Den gælder uanset om du har en lock up eller ej (om lock up'en er udløbet). Det er netop derfor jeg nævnte det her med handelsvinduer, det er et element man prøver at få timet tingene i forhold til – der er en formodning for, at du ikke har noget intern viden, selvom – et selskab kan jo godt sige, at for nogle medarbejdere er de ikke åbne, fordi man konkret sidder med et eller andet. Det er en refleksion man har. I udgangspunktet skal selskaber offentliggøre al intern viden på det tidspunkt, hvor det opstår […]

Et element i forhold til lockups, det er - rigtig mange selskaber har man været på forkant og taget højde for, at en børsnotering på et tidspunkt kunne være en mulighed, enten som en exit eller som en funding vej for at få yderligere vækst. Så rigtig mange ejeraftaler tager højde for, at et selskab skal børsnoteres og vil allerede i forbindelse med en ejeraftale forpligte aktionærerne at påtage sig lock ups. I forbindelse med en IPO.

Joakim Helm

Så det er allerede noget, der er præ-aftalt inden det overhovedet kommer på bordet?

Chantal Patel

Ja. Rigtig mange ejeraftaler vil indeholde bestemmelser om det. Det er selvfølgelig ikke for at sige, at alle gør det. Men mange vil. Og det gør selvfølgelig også, at der ikke er så meget diskussion omkring det.

Joakim Helm

[…] Når I indfører disse aftaler […] Er det så bare en standardiseret skabelon, I lægger ned over firmaet? Hvis vi siger, at der er en større sælgende aktionær og deres residual af ejerskabet efter børsnoteringen, den bliver lock up i 180 dage og så er det noget bestyrelse og nogle nøglemedarbejde som også har nogle ejerandele. Er der noget mere diskussion omkring det?

Appendix 18: Transcript of interview with Chantal Patel (6/9)

Chantal Patel

Man tager altid udgangspunkt i standard og så bliver det tilpasset konkret. Der vil altid være konkrete forhold. […] Der vil være forskel. Det vil kun være – hvis vi taler om ledelsen, både bestyrelse og direktion og evt. ledende medarbejder, de sidder med tidspunktet for børsnoteringen Det er ikke aktier, de køber i forbindelse med en børsnotering, det er kun det de sidder med allerede eller får som led i oprulning af en eller andet form for gammel incitamentsprogram, der har ligget i selskabet. Og der kan det være afhængig af hvor store ejere. Én ting, der kan – hvor stor en pulje aktier ligger der i ledelsen og i medarbejderstaben? Dvs. hvor stor risiko er der for, at der er en stor gruppe, der går ud og sælger aktier, som kan påvirke aktiekursen negativt. Hvis ikke man har en eller anden form for lock up. I nogle selskaber kan det være rigtig mange mennesker, i andre er det en meget lille begrænset gruppe. Og hvis det er en lille gruppe, så er det kun dem, der som regel er omfattet af en lock up. Hvis det er rigtig mange, så vil man sige, så giver det kun mening at gøre det for bestyrelse, direktion og få nøglemedarbejdere, der har en ledende rolle, hvor man kan forvente det af. Så vil der også være forhandling på specifikke vilkår i forhold til hvad omfatter lock up'en. Planlægger man at selskabet skal ud og lave en form for restrukturering, eller regner man med, at de skal ud og rejse penge løbende, så dur det ikke, at de er begrænset i det i selve restriktioner- og undtagelsesbestemmelserne. Der er det ofte, at der er nogen der har behov for konkret at sælge nogen for at kunne betale noget skat. Fordi man bliver beskattet af det instrument, der nu engang ligger. Det kan være, at der er nogle incitamentsprogrammer, der gør, at der er en up front skattebetaling, så der er også behov for, at du laver nogle undtagelser der. Eller der kan være pantsætning af aktierne konkret, som man i udgangspunktet ikke må, men som eksisterer – som der også er behov for at undtage. Eller overdragelser til familiemedlemmer […]. Og så er der selvfølgelig også det, at disse lock up forpligtelser, det er jo en aftale med forpligtelser det er ikke en lovmæssig… Så de kan alle sammen – man kan i alle tilfælde, så vil dem der er lock'et up, de har mulighed for at bede bankerne om at give en waiver på at de alligevel vil kunne få lov at sælge. Og det er også set.

Joakim Helm

Det er bland andet også en af de ting vi undersøger, de her Early releases, som vi specielt ser fra bestyrelsesmedlemmer og nøglemedarbejdere, at de nogen gange får lov at komme ud af den her lockup tidligere end egentlig aftalt.

Peter Sommer

Hvad vil primært være nogle af årsagerne til, at de får lov at lave early release?

Appendix 18: Transcript of interview with Chantal Patel (7/9)

Chantal Patel

Det er for aktionærerne typisk været, at kursen har lagt sig på så godt et niveau tidligere, og på en stabil måde, så de vil gerne sælge yderligere ned hurtigere. Og hvor man fra bankerne siger, at man synes det ser fornuftigt ud. Og i forhold til ledelsen, der vil det mere ofte være på grund af at det er familiemæssige forhold, at man sælger noget. Oftest hvis der er familiemæssige transaktioner, så vil det familiemedlem blive bedt om at påtage sig samme forpligtelse. Det ligger i aftalerne, at der er nogle muligheder for, at man kan overdrage visse aktier, men så skal den, man overdrager til så påtage sig samme forpligtelse.

Peter Sommer

[…] Når lockup'en udløber, har du tidligere stiftet bekendtskab med denne pludselige prisreaktion, der sker ved lock up'ens udløb, eller er det mere noget, som gør sig gældende inden for tidligere teoretisk research?

Chantal Patel

Jeg vil ikke sige, at jeg har været opmærksom på det. Man er selvfølgelig opmærksom på, at især – ikke så meget for ledelsesmedlemmerne, fordi det er sjældent, at de bare går ud og dumper det hele. Vi har haft rigtig mange PE exits i forbindelse med de danske børsnoteringer, der tror jeg – jeg har ikke selv lavet undersøgelserne – men jeg vil tro, at markedet var opmærksom på, at nu udløber disse lock up perioder, og det er selvfølgelig rigtigt, at det kan sætte sig, da man forventer at der kan komme et salg lige efter. […] Men det lyder plausibelt.

Joakim Helm

Det er mere forventningerne om, at der vil ske et prisfald, end den faktiske mekaniske dumping, der sker fordi – det er lidt forventet i markedsprisen, det ved man, det er jo offentlig information. Så investorerne ved godt at der er stor risiko specielt med en PE involveret at der kommer til at blive en dump af shares i markedet så det er måske mere den psykologiske forventning omkring hvad der kommer til at ske og at man har set tidligere at der er nogen negative prisreaktion som måske kan være selve grunden til at det egentlig også kommer til at ske

Chantal Patel

Det lyder meget fornuftigt, at det er den markedsreaktion, der kan være. Fordi der er en forventning om, at det kommer til at ske. Men på den anden side, jeg vil ikke tro, at det nødvendigvis altid skete.

Appendix 18: Transcript of interview with Chantal Patel (8/9)

Joakim Helm

Det er bestemt heller ikke det vi observer i dataen at det ikke er noget der konsekvent sker men mere i gennemsnittet at vi ser et statistisk signifikant negative abnormalt afkast – ikke så stort at man kan trade og profitere på det men ikke desto mindre et signifikant forhold

Chantal Patel

Det har jo tit noget at gøre med – særligt fra aktionærkredsen – der vil de typisk vente til du kommer ind i et handelsvindue, til der er offentliggjort nogle regnskaber, netop for at eventuelle repræsentanter man har i bestyrelsen at man ikke siger, at de indirekte har noget intern viden. Det lyder sandsynligt, at der er nogen, der vil indregne hvornår de forventer, at der bliver solgt ud. Fordi du vil forvente at de først gør det på ryggen af en regnskabsmeddelelse. Og der er relativt meget transparens omkring disse salg, for større aktionærer vil det ofte have en virkning, hvor de ryger under en flagningsgrænse, og for ledelsesmedlemmerne, de skal indberette […] Men det er offentlig tilgængelig viden.

Peter Sommer

Når du siger større aktionærer, hvor går grænsen?

Chantal Patel

De hedder 5-10-15-20-25 og så er der vist 1/3 som den næste. Så der er en række storaktionærer grænse procenter, som let krydses ved de her større salg. Jeg synes, at den praksis man har set – det er jo ikke, at de større aktionærer går ud og sælger alt, hvad de har på bogen. Det sker jo i et par chunks.

Joakim Helm

Dine tanker omkring de nordiske marked i helhed og forskelle man ser der omkring lovgivning omkring insider trading og lock ups også. Har du nogle tanker om det – eller er det mere det danske marked, du fokuserer på?

Appendix 18: Transcript of interview with Chantal Patel (9/9)

Chantal Patel

Lovgivningsmæssigt, der er det de samme regler, vi har. Det er markedsmisbrugsordningen, som er EU-baseret og gælder direkte. Så derfor er det de samme reguleringer, man er underlagt. Lockups ved jeg ikke hvad de bruger i de nordiske markeder, men jeg vil tro, at det er markedspraksisbaseret. Jeg ville være overrasket over, hvis det var noget andet. Der er en krølle på halen her, at den der Cornerstone / anker investor, som har været meget udbredt i Sverige, og som Carnegie også har været med til at bringe her til landet på nogle af de senere. Der har man en struktur, hvor man placerer en stor del af aktierne up front hos nogle andre investorer, der siger, at de vil tage noget. Som jeg har forstået, i nordisk perspektiv, er det ret usædvanligt at lave en decideret lock up aftale med dem, der kommer ind og forpligter sig inden IPO'en. Men der er lidt en gentlemans agreement om, at de ikke går ud og sælger aktierne i en vis periode.

Peter Sommer

Og det er primært kun på gentlemans agreement basis – der er ikke noget nedskrevet?

Chantal Patel

Der er ingen bindinger, og årsagen til det er, at du stiller dem dårligere end almindelig institutionelle investorer, der tegner i forbindelse med udbuddet. Også fordi de sjældent får en discount, så der ville være for mange negative aspekter af det i forhold til de positive ved at få en allokering […]

Der er ikke en fast periode, hvor de udløber på en fast dato, som markedet er bekendt. Så vidt jeg har forstået, er der en form for gentlemans agreement om, at man i hvert fald sidder med det i en vis periode. Det vil jeg tro, at I har nogen hos Carnegie, der ved mere om.

[Outro]