IPO Lock-up expirations

An empirical study on the Nordic market during 2009-2016

By

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Abstract

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Purpose: The purpose of this study is to investigate whether abnormal returns can be observed in stock prices after the expiration of lock-up periods related to an IPO. In addition, the purpose is to analyse if private equity/venture capital (PEVC) ownership, the use of staggered lock-ups and the length of lock-up periods affect this return.

Methodology: This event study examines how the market reacts around the expiration of IPO lock-up periods by using the market model. A multiple regression analysis was conducted where the dependent variable (cumulative abnormal return) was regressed on IPO characteristics specific variables.

Theoretical perspectives: This dissertation is testing whether the semi-strong form of the efficient market hypothesis holds. In addition, theories regarding a downward sloping demand curve, costly arbitrage opportunities, information asymmetry and signalling theory are used to analyse the results.

Empirical foundation: The sample consists of companies completing IPOs on Nasdaq OMX Nordic and Oslo Børs during 2009-2016, on the main market lists. Data were obtained from the databases Zephyr, Bloomberg Terminal and DataStream.

Conclusions: The study provides new evidence for the Nordic market and concludes that abnormal returns exist around the expiration for lock-up periods with an observed significant abnormal return of -0.72%. The result shows evidence against the semi-strong form of the efficient market hypothesis and could potentially support a downward sloping demand curve and theories regarding information asymmetry between pre- and post-IPO owners and costly arbitrage opportunities. The study did not find any statistically significant evidence supporting that IPO characteristics in terms of PEVC-backing, staggered IPOs or the lock-up period length affects this abnormal return.

Key words: *IPO, Lock-up periods, abnormal returns, efficient market hypothesis, PEVC-ownership*

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1. Introduction

1.1. Problem background

When a company decides to offer its shares to the public for the first time, it is called an Initial Public Offering (IPO). Although IPOs are typically costly and time consuming, there are several reasons why a firm decides to go public; the company is given the opportunity to benefit from easy access to the capital markets and increased public awareness. Furthermore, the founders of the firm can benefit in the form of risk reduction in their personal portfolios by selling at least a portion of their ownership interest to the public. The diversification among public investors also leads to increased liquidity which results in a lower cost of capital for the firm, thereby increasing the profitability of future capital investment projects. (Ogden, Jen & O'Connor, 1966) Other reasons are that firms can use the proceeds from the IPO to reduce the firm's debt levels, motivate and retain management and employees through share based incentive schemes and exploit a perceived mispricing by investors. (Geddes, 2006)

If the founders and initial owners of the firm decide that they want to introduce the company's shares to the public markets, they need to determine the deal characteristics of the IPO. Key issues relate to which type and number of shares to issue as well as price and date of the initial offering. (Hiller, Grinblatt & Titman, 2008) In addition, the company needs to conclude if they want to impose a certain lock-up period for the shares (Geddes, 2006).

A lock-up period is an agreement that articulates a period in which insiders, i.e. management and majority shareholders are restricted from selling their shares. Although lock-up periods are not a legal requirement on most exchanges, it has become common practice to use them. (Goergen, Renneboog & Khurshed, 2006) However, if lock-up periods are implemented, the firm must disclose it in the prospectus (SEC, 2017). When insiders are holding a substantial portion of shares, it is typically seen as a positive signal on the firm's value. Consequently, by imposing lock-ups, underwriters try to mitigate the principal-agent problem. (Ogden et al., 1966)

The purpose with a lock-up agreement is often to retain some of the company's insider owners. It is easily forgotten that many of today's publicly traded firms used to be relatively small, privately owned companies. These start-ups began with a single individual or a group of individuals, that by various means obtained additional financing for expansion, and eventually sold equity shares to the public. One of the most favoured methods to get this additional financing is either through Venture Capital (VC) or Private Equity (PE). Private equity and venture capital firms, hereinafter referred to as PEVCs, are professional financing organisations that provide capital for ventures and generally assist the management of the firm with expertise and strategic guidance. (Ogden et al., 1966) A recent IPO which received a lot of media attention was the IPO of Snapchat in March 2017. In this case 25% of the shares are subject to a one year lock-up period, which is significantly longer than the standard one of 180 days (Hirch, 2017).

During the last decade, different reactions have been observed on the financial markets related to the expiration of lock-up periods. In December 2010, shares of the electric car maker Tesla dropped 15% after the lock-up period expired (Azam, 2010). On the contrary, in November 2012, shares of Facebook Inc. rose 13% after insiders were allowed to sell their shares (Oreskovic, 2012). Nevertheless, previous research has observed a negative abnormal return around the expiration of lock-ups on average (Bradley, Jordan, Yi & Roten, 2001; Brav & Gompers, 2003; Field & Hanka, 2001).

What is interesting about these reactions is that the lock-up periods for insiders are clearly stated in the prospectus, hence publicly available information. Since no new information is released, the market should already have priced in the lock-up expiration according to the efficient market hypothesis. Thus, theoretically, no abnormal returns should be observed at the end of the lock-up expiration.

1.2. Previous research and research gap

The returns around the expiration of IPO lock-up periods have puzzled researchers (Bradley et al., 2001; Ofek & Richardsson, 2000). As mentioned, the lock-up periods are stated in the prospectus, thus publicly available information. Despite that fact, a few previous studies conclude that the market reacts negatively to the expiration of lock-up periods. Field and Hanka (2001), Bradley et al. (2001) and Brav and Gompers (2003) all observed negative abnormal returns when examining IPOs in the U.S. during 1988-1997. Likewise, Ofek and Richardson (2000) found an abnormal negative return during 1996-1998 in the U.S. The same phenomenon has also been observed on the U.K. market during the period of 1992-1998 (Espenlaub, Goergen & Khurshed, 2001 & 2002) and in the Middle East and North Africa (MENA) region during 1999-2008 (Hakim, Lypny & Harjeet, 2012). However, unlike the U.S. research, these studies proofed little evidence of statistical significance of the results. Furthermore, Goergen et al., (2006) conducted a study on IPOs in France and Germany during 1996-2000 but did not observe any significant abnormal returns.

Taking this into account, it is noticeable that previous studies within the field are relatively scarce and have mainly focused on the U.S. market. The Nordic countries have different characteristics than previously researched equity markets. As La Porta, Lopez-De-Silanes, Shleifer and Vishny (1997) highlight, compared to the immense U.S. and U.K equity markets, IPOs are less frequent in the Nordic region, and the Nordic markets are less liquid. Moreover, the authors point out that both the US and the UK are classified as common law countries regarding their legal rights system and is known for its high level of shareholder rights and corporate governance, while France with its French civil law system is known for its low one. Germany, with its German civil law is classified as intermediate in terms of shareholder protection. The Nordic countries (excluding Iceland) are instead classified under a Scandinavian civil law system, which in accordance with Germany is known for intermediate shareholder protection. La Porta et al. (1997) also concluded in their study that the legal environment has large effects on the size and characteristics of capital markets across countries as well as the possibility to get external financing. Additionally, in line with previous findings by La Porta et al. (1997), the use of VCs and PEs has not been as common in the Nordics as in the U.S. or U.K. historically. In the last quarter of 2016, 75% of the IPOs were PE backed in the U.K., corresponding to 84% of the capital. (EY, 2017) Another distinguishing theme is that in Germany and France, lock-ups periods are compulsory, unlike the Nordics where it is optional (Goergen et al., 2006; Nasdaq, 2017).

Not only have previous studies mainly focused on the U.S. market, another key point is the fact that most of the previous studies were conducted over a decade ago. The financial markets are constantly changing; the IPO market has started to recover after the financial crisis in 2007-2008 and an increased IPO activity trend has been observed in recent years. In 2016, there were 1066 IPOs made worldwide and 94 of these were listed on Nasdaq Nordic. The year before, 2015 was the record year for IPOs on Nasdaq OMX Nordic (EY, 2017; Nasdaq OMX Nordic, 2017).

Accordingly, it would be relevant to study if previous empirical results coincide with the Nordic market. This is interesting for stakeholders such as investors, management, underwriters, and PEVCs, since it will help them make rational decisions. From an investor perspective, this may also create arbitrage opportunities unless this is prevented by large transaction costs. (Field & Hanka, 2001) It is also important for management within the firm to get a better knowledge about how strategic decisions such as getting listed and implementing lock-up restrictions affect the market value of the company. The PEVCs and underwriters will be able to get a better insight into how the financial markets react during the expiration of the lock-ups and the timing for liquidating their shares. (Brav & Gompers, 2003)

1.3. Purpose

The purpose of this study is to investigate whether abnormal returns can be observed in stock prices after the expiration of lock-up periods related to an IPO. Moreover, the purpose is to analyse if PEVC ownership, the use of staggered lock-ups and the length of lock-up period affect this return. Our defined research question is presented below:

- *Do abnormal stock returns exist around the expiration of lock-up periods related to IPOs on the Nordic main markets?*

1.4. Disposition

In this chapter, we explain how the dissertation is structured. In chapter 2, we develop the theoretical framework and discuss previous studies' results. We also construct our hypotheses in this chapter. In chapter 3, we motivate the chosen methodology and operationalise our hypotheses. In chapter 4, we present the empirical results from our event study. In this chapter, the result is analysed with help from the theoretical framework and compared with the findings of previous studies. In the fifth and last chapter, we summarise the findings, discuss the reliability and limitations of the study and provide suggestions for further studies.

2. Theoretical foundation

2.1. Theoretical framework

Based on the nature of our research question, the most relevant theory for our study is the efficient market hypothesis. In addition, we will cover theories regarding information asymmetry, arbitrage opportunities, signalling theory and a downward sloping demand curve. The efficient market hypothesis will be the main theory that is tested since if an abnormal return is observed, it will show evidence against the theory. If a positive abnormal return would be found, this could potentially support a liquidity effect while a negative abnormal return is more likely to support theories regarding downward sloping demand curves, costly arbitrage opportunities, information asymmetry and signalling theory.

2.1.1. The efficient market hypothesis

A well debated hypothesis within the financial framework is the efficient market hypothesis (EMH), framed by Euguene Fama in 1970. The hypothesis addresses the effects of competition in the financial markets on the market prices of securities. The EMH claims that the price of a security reflects the true rational value of the security. This means that a security is always fairly priced since the price reflects all available information. The theory assigns the market different types of information efficiencies. EMH exists in three forms: weak, semi-strong and strong. The weak form implies that current share prices reflect all historical publicly available information. The semi-strong form implies that prices incorporate and adjust for any published information, such as an IPO prospectus or a press release. The strong form states that in addition to the publicly available information, prices reflect all available information, e.g. including information held by insiders. (Fama, 1970). The EMH assumes that investors are rational and that overpriced and under-priced securities never would be sold or bought. Accordingly, all asset prices reflect a fair equilibrium price. (Pontiff, 2006). Applicable to this study, since the lock-up expiration is disclosed in the IPO prospectus, the semi-strong form of EMH states that this information is reflected in the share price.

2.1.2. Costly arbitrage opportunities

If the EMH would not hold, this implies that anomalies caused by mispricing in the market would create arbitrage opportunities. However, due to holding and trading costs, arbitrage can be costly, thus impeding investors from exploiting these inefficiencies. Trading costs include brokerage fees and commission while holding costs include opportunity costs of capital and idiosyncratic risk exposure. (Pontiff, 2006). Arbitrage trading strategies also assume that it is possible to short-sell stocks, which is not always easy for newly-public stocks (Ofek & Richardsson, 2000).

2.1.3. Information asymmetry

Assuming the semi-strong form of the efficient market hypothesis, asset prices are always accurately valued since the information is symmetric (Fama, 1970). The implications of information asymmetry were first analysed by Akerlof (1970). Akerlof metaphorically compares the financial markets with the U.S. market for used cars. Akerlof argues that an individual who sells a car has full knowledge of the condition of the car, whereas the individual who purchases a car is experiencing an information disadvantage. Therefore, the buyer will only be willing to pay a price for the car below its true value because the buyer does not possess all the information necessary to verify the quality of the car. This is widely known as the "bad lemons problem", where the old and defective cars are referred to as lemons. This could lead to a situation where sellers who possess high quality cars are withdrawing their cars from the market because they could receive a price below their vehicles' actual value. This information asymmetry problem is often present in IPOs, since the initial owners possess information that prospective investors do not have (Leland & Pyle, 1977).

2.1.4. Signalling theory

Signalling theory is based on the view that certain signals from the firm affect investors' view of the firm's value. The signalling theory, with information asymmetry as its underlying driver has been used to explain different IPO characteristics. (Park, Borah & Kotha, 2016) For example, if insiders are retaining higher percentages of equity in an IPO, it creates a positive signal (Leland & Pyle, 1977). Accordingly, imposing lock-up periods can be seen as a positive signal for value (Hoque, 2011). Although most research regarding signalling theory has focused on positive signals, it can also be argued that the expiration of lock-up periods can be seen as a negative signal (Connelly, Certo, Ireland & Reutzel, 2011).

2.1.5. Downward-sloping demand curves

The main implication with a downward-sloping demand curve is the assumption that the quantity demanded increases when price decreases (Black, Hashimzade & Myles, 2017). When the lock-up periods expire, the public gets access to an increased supply of shares.

Thus, if there is a downward sloping demand curve, the share price would then drop permanently. This is also known as a "scarcity premium", regarding IPOs with a smaller amount of free float. The downward sloping demand curve hypothesis suggests that increases in the supply affects the abnormal return negatively (Field & Hanka, 2001).

2.1.6. Liquidity effect

A contractionary theory to the downward sloping demand curve is the liquidity effect. Many investors require a liquidity premium for assets. This implicates that when liquidity increases the price is more likely to rise than fall. When the lock-up period expires, more shares become available to the public, leading to increased liquidity. Accordingly, since the shares are more easily converted to cash, less extra return is required from investors. (Damodaran, 2006)

2.2. Literature review

The literature review section below introduces the key concepts and previous findings which lead to the construction of our hypotheses.

2.2.1. IPOs

An IPO is when a private firm decides to offer its shares to the public for the first time. In general, approximately a third of the firm's shares are offered to the market. (Ogden et al., 1966) As mentioned above, there are several reasons for why a firm may choose to go public. Firstly, the founders and early investors of the firm can sell off some of their ownership interest to the public and use the proceeds to invest in other securities. At the same time, the firm can use the proceeds to pay back their debt. By reducing leverage, the firm's entrepreneurs and original owners decrease the risk of their own portfolios even if they do not sell their shares in the IPO. Secondly, the firm's entrepreneurs and initial owners can dilute the voting power of other pre-IPO shareholders by issuing new shares in the IPO. Thirdly, post-IPO, when the shares of the firm are "seasoned", the firm can introduce stock option plans for its management and employees. Lastly, the firms can issue new shares to finance an acquisition instead of paying cash. (Ogden et al., 1966) The share price performance surrounding IPOs has been a commonly examined and debated topic. Gomper and Lerner (2001) studied the performance of the listing of 3,661 IPOs during 1935-1972 in the U.S, and found evidence for a significant buy and hold return underperformance. Likewise, Espenlaub, Gregory and Tonks (2000) studied the performance of U.K. IPOs during 1985-1992 and found a sizable IPO underperformance after the first three years. However, five years after the IPO no underperformance could be observed anymore.

2.2.2. Private Equity/Venture Capital (PEVC)

Although VCs and PEs bear a lot of resemblance, in general PEs focus on mature companies that are already established while VCs focus on start-ups with high growth potential (Ogden et al., 1966). PEVCs use IPOs to exit the firms they are invested in and monetize on their initial investments. Other exit routes include mergers and acquisitions (M&A), or selling to another private buyer. Espenlaub, Khurshed & Mohamed (2011) studied the exit behaviour of VCs and concluded that in the U.K. an IPO is the most preferred exit channel followed by M&A. They explain that the IPO option is popular among VCs since the IPO route provides a faster way to exit their portfolio firm in comparison with other exit channels such as M&As or liquidations.

Since 2010, on average, approximately 200 VC deals have been made annually in the Nordics, with its peak in 2014 with almost 250. However, the aggregate deal value of these has seen a positive trend with the highest value in 2016 of approximately €1.7bn. (Prequin, 2017)

2.2.3. Lock-up periods

The determinants of lock-up length and lock-up volume are based on the firm's and shareholders' characteristics. Goergen et al. (2006) studied shareholder lock-up agreements on the German and French equity markets during 1996-2000. The study concluded that firms with higher uncertainty, e.g. young and small firms with a relatively high portion of intangible assets, often have longer lock-up agreements subject to a larger proportion of their shares. In addition, they concluded that VCs prefer a quick exit, thus VC backed IPOs often have shorter lock-up agreements.

Brav and Gompers (2003) argue that lock-up periods exist because outsiders usually have little information about the firm at the time of flotation. In contrast, the firm's insiders tend to have a better view about the prospects of the company. Accordingly, lock-up periods aim to protect outside investors from being exploited by insiders acting on private information. Bray and Gompers' (2003) results support three different explanations for the existence of lock-up periods; firstly, lock-up periods serve as signal for the quality of the firm. Secondly, lock-up periods serve as a tool to avoid moral hazard problems. Lastly, lock-up periods help underwriters to extract additional compensation from the issuing firm.

In the U.S. market, it is common practice to have a relatively short standardized lock-up period of 180 days. However, this trend has evolved over time. Field and Hanka (2001) noticed that in 1988, only 43% of their investigated lockup periods were exactly 180 days while in 1996, more than 90% of lock-up periods were 180 days. In Europe on the other hand, longer and more varied lock-up periods are common with the U.K. being known for an average lock-up duration of 561 days. (Espenlaub et al., 2002) In some exchanges in Europe, lock-up periods are mandatory; in the Netherlands and Italy a minimum lock-up period of 1 year is required (Hoque, 2011). In Germany and France, they also have compulsory lock-ups. However, in France only insiders such as directors and founders are subject to these while in Germany, all the pre-IPO shareholders are affected by the lock-up. (Goergen et al., 2006) As with the US and UK exchanges, lock-up periods are voluntary on the Nordic exchanges (Nasdaq, 2017).

2.2.3.1. Lock-up periods and information asymmetry

Prospective investors do typically not have many resources to rely on except for the prospectus which usually provides one to three years of financial information. (Nam, Park & Arthurs, 2014) On average only one third of the firm’s shares are offered to the public, while the firm’s managers and initial financiers retain substantial ownership (Ogden et al., 1966). Thus, lock-up periods can be a necessary signal of insiders’ assessment of value, a bonding mechanism, which mitigates the information asymmetry problem. Consequently, there is also a downside to the lock-up provision. Since only a minority of the firm’s shares are freely floating in the secondary market in the critical first six months after the offering, it limits the liquidity of the firm’s stock (Ogden et al., 1966). In line with Brav and Gompers (2003) explanations for lock-up periods, Hoque (2014) and Espenlaub et al. (2001) conclude that information asymmetry and moral hazard are the main drivers for imposing lock-up periods in the UK.

2.2.4. Previous findings

2.2.4.1. Abnormal returns around IPO lock-up expirations

An abnormal return is a term used to describe the difference between the actual return and the expected return of a security. Abnormal return is sometimes triggered by events like mergers and acquisitions or unexpected dividend announcements since these events are not yet reflected in the stock price. However, since the period of the lock-up for insiders is public information, any price reactions should already be anticipated according to the semi-strong form of the efficient market hypothesis. Nevertheless, Field and Hanka (2001) examined 1,948 IPOs during 1988-1997 in the U.S. and found a 40% increase in trading volume and a negative abnormal return of -1.5% around the lock-up expiration, which partly could be explained by a downward sloping demand curve. For their sample, 63% of the IPOs showed a negative cumulative abnormal return during a 3-day event window. A comparable result was found by Bradley et al. (2001) who examined the behaviour of the share price in the period surrounding the lock-up agreement expiration. Their sample included 2,529 U.S. IPOs during the same time period of 1988-1997. Brav and Gompers (2003) also focused on the U.S. market and observed the same phenomena during 1988-1997. Brav and Compers (2003) concluded that their result supports that IPOs are subject to information asymmetries and that it also is consistent with a downward-sloping demand curve and costly arbitrage opportunities. Brau, Carter, Christophe and Key (2004), did also observe a negative abnormal return on their sample of IPOs made during 1988-1998 in the US, and explain the phenomenon with information asymmetry based theories. Moreover, they state that an explanation more related to financial biases would be that investors are getting nervous when the expiration dates are approaching. Ofek and Richardson (2000) found an abnormal negative return during 1996-1998 in the U.S. but concluded that it would be very difficult to exploit the anomaly due to investors' trading costs. Moreover, they noticed that the price drop was permanent, thus supporting a downward sloping demand curve.

A similar study has been conducted on the U.K. market (Espenlaub et al., 2001). The study examined abnormal returns around lock-up expirations and found marginally significant results for their whole sample consisting of 188 IPOs during 1992-1998. The observed cumulative average abnormal returns ranged from 0.5% to 2.5% depending on the sub sample and event windows used. For their total sample, the average 2 and 3-day abnormal return was -0.96 and -1.21% respectively, with only the former result being significant at a 10% significance level.

In addition to studies focusing on the U.K. and U.S. market, Hakim et al. (2012) examined the stock market reaction to lock-up expirations in the Middle East and North Africa region. The authors mentioned that the region has a unique environment since lock-up agreements are set by regulators instead of being negotiated between firms and underwriters. Their study consisted of a sample of 60 companies and they also observed negative abnormal returns around the expiration. Goergen et al. (2006) conducted a European study in Germany and France during 1996-2009 but could not find any significant abnormal return around the lock-up expiration, which unlike previous studies is consistent with the EMH.

2.2.4.2. PEVC- backed IPOs

A significant proportion of IPOs made worldwide are backed by private equity firms. A possible reason for this is that these firms have the knowledge and scale to introduce their holdings quickly to the market when they experience a suitable market timing. (EY, 2017) In 2015, 18% of the global IPO volume was PEVC-backed, corresponding to 34% of the proceeds. Bradley et al. (2001) found in their study of the US market that during 1988-1977, on average, a significant negative abnormal return is associated with the expiration of lock-up periods and that the negative returns were concentrated in firms being venture capital backed. They explained this by the hypothesis that VCs liquidate their ownership directly after the lock-up period, which gives support for a downward sloping demand curve. This is in line with the result of Field and Hanka (2001) which found that the 3-day abnormal return was almost three times larger for VC-backed IPOs, with -2.3% versus -0.8% for non-VC-backed IPOs. They also concluded that it can be explained by the fact that VCs tend to sell their shares more aggressively than other pre-IPO owners and that information asymmetry is increasing when insiders are allowed to sell their shares.

Similarly, Espenlaub et al. (2002) conducted a similar study on 186 U.K. companies during the time period of 1992-1998. They found that a similar trend could be observed in U.K., with negative abnormal returns ranges of -1.2% to -1.6% and -0.2% to -0.8% for VC-backed IPOs and non-VC-backed IPOs respectively. However, the result was not statistically significant when using an 11-day event window, but they found evidence for that the abnormal return for VC-backed IPOs are statistically significant different from 0 during a 3-day event window. The authors state that this can potentially be related to differences in the informational contents of the lock-up expiration. Nam et al., (2014) also observed a larger negative market reaction in VC-backed IPOs. They came up with the possible explanation that management and VC investors have an information advantage compared to less informed investors and that the expiration of the lock-up period is perceived as a negative signal in terms of signalling theory. However, they found that the relationship was weakened when a reputable VC was involved.

2.2.4.3. The length of the lock-up period

Ahmad (2012) agrees with the explanation that lock-up periods serve as a signal for the quality of the firm. His study's results suggest that the length of the lock-up agreement positively affects the survival of the firm. The fact that IPO firms with longer lock-ups show better survival rates support the view that lock-ups signal the quality of the firm. The longer the lock-up periods, the more information is likely to get to the investors, hence the expected positive relationship with the return (Brau et al., 2004). Field and Hanka (2001) noticed that the cumulative abnormal returns for IPOs with lock-up periods equal to or less than 180 days was -1.3% compared to -0.8% for lock-ups longer than 180 days. However, only the result for the shorter period was statistically significant on the 1%-level while the longer one is just marginally significant. Likewise, Hakim et al. (2012) found an abnormal return that only was significant for lock-up periods equal or less than 180 days but not for longer ones.

2.2.4.4. Staggered lock-up periods

It is also possible to impose several lock-up periods. For example, in 2004, Google imposed 5 different IPO lock-up dates ranging from 15 to 180 days subject to different shares. (Rivlin, 2004) Although staggered lock-up periods are not very common in the US, they are frequently used in Europe. (Goergen et al., 2006). Hogue (2011) concluded in his study of 831 IPOs made during 1999-2006 on the London Stock Exchange, that single lock-ups have larger price drops than staggered lock-ups. The author states that this result supports the view that staggered lock-up periods are also used as a signal for quality and that firms with higher information asymmetry are more likely to use single lock-ups rather than staggered ones.

2.3. Hypotheses

As highlighted in the literature review above, a negative abnormal return has been observed related to the expiration of IPO lock-up periods in the U.S. and to some extent in the U.K. Previous research has also found evidence of that the abnormal return is affected by IPO characteristics such as if the IPO is VC-backed, lock-up length and if it is a single or a staggered lock-up. However, since we are researching another market and time period than previous studies, we have constructed the following research question to help us achieve our purpose:

- *Do abnormal stock returns exist around the expiration of lock-up periods related to IPOs on the Nordic main markets?*

Accordingly, the first step is to investigate whether abnormal returns can be observed to see if we can support the semi-strong form of the EMH. Our main null hypothesis is therefore the following:

Hypothesis 1 *– There is no abnormal return around the expiration of lock-up periods related to IPOs.*

We also aim to investigate whether the factors PEVC ownership, length of lock-up and staggered lock-ups moderate any abnormal return. PEVCs are often liquidating their positions after lock-up expirations, thus increasing the supply of free float. We therefore expect that the increased supply especially related to PEVC-backed IPOs, in combination with a downward sloping demand curve, will cause an abnormal price decline. Our second hypothesis is therefore the following:

Hypothesis 2 *– PEVC-backed IPOs have a larger negative abnormal return than non PEVC-backed IPOs.*

In line with the signalling theory, lock-up periods are seen as a signal of the quality of the firm Ahmad (2012). This is also supported by theories regarding information asymmetry, since more information is likely to reach investors during a longer lock-up period (Brau et al., 2004). We therefore expect the length of the lock-up period to have a positive relationship with any abnormal return.

Hypothesis 3 *– IPOs with longer lock-up periods have a smaller negative abnormal return than shorter ones.*

A hypothetical supply chock is less concentrated in staggered lock-up periods. Thus, in line with the downward sloping demand curve, we expect staggered lock-up periods to have a less negative abnormal return. Furthermore, firms with higher information asymmetry are more likely to use single lock-ups rather than staggered ones (Hoque, 2011).

Hypothesis 4 *– IPOs with staggered lock-up periods have a smaller negative abnormal return than single ones.*

Expected variable relationships

H1: ACAR	**=**	**Normal return (0)**
H2: PEVC-backed	=	Negative
H3: Lock-up Length	=	Positive
H4: Staggered Lock-ups	=	Positive

Table 1. Summary of expected variable relationships

3. Methodology

3.1. Introduction to methodology

This study is using a quantitative method, in the form of an event study where we have used an Ordinary Least Squares (OLS) regression to explain the relationship between dependent and independent variables (Brooks, 2014). The benefit with a quantitative study instead of a qualitative is the reduced risk for biases affecting the result and a better possibility to generalise the results (Saunders, Lewis & Thornhill, 2009). The variables are analysed through the statistics programme SPSS. Data is collected from the databases Zephyr, Bloomberg Terminal and Datastream. The data have also been compared with lists of all IPOs from Nasdaq OMX Nordics main market lists and Oslo Børs as well as with prospectus of the firms obtained from the firms' own webpages. The study has a deductive structured research method, meaning that data is analysed by using a theoretical framework. Thus, the data collecting is not done until a clear and defined question is stated, which will increase the reliability of the study. (Saunders et al., 2009)

3.2. Event study methodology

An event study aims to measure the effect of a specific event on the value of a company, presuming rationality in the market. This is useful since the event immediately will be reflected in the share price. (MacKinlay, 1997) Accordingly, an event study is a suitable approach to investigate how the market reacts to a lock-up period expiration and if any abnormal return can be observed. Since this study focuses on the market reaction around lock-up period expirations, which is public information, we will assume that the semi-strong form of the EMH is applicable. According to Fama (1991), event studies are well suited to test the semi-strong form of the EMH. Furthermore, previous studies within the field (Bradley et al, 2001; Brav & Gompers, 2003; Espenlaub et al., 2002; Field & Hanka, 2001) have used event studies, which facilitate the comparison with these. Daily returns were used in the study as proposed by Brown and Warner (1985). Regarding the event study, we have chosen to follow the seven-step process proposed by Campbell, Lo and MacKinlay (1997):

- Definition of event and event window (chapter 3.2.1.)
- Data and sample selection (chapter 3.2.2.)
- Estimation window (chapter 3.2.3.)
- Calculation of normal and abnormal return (chapter 3.2.4.-3.2.8.)

- Hypothesis testing (chapter 3.3.)
- Empirical results (chapter 4.)
- Conclusion (chapter 5.)

3.2.1. Definition of event and event window

The first step in an event study is to define the event of interest and identify the period for when the stock's price should be investigated, i.e. the event window (MacKinlay, 1997). This study's event is the expiration of the lock-up period after an IPO. In cases where multiple lock-up periods were given, we have used the earliest expiry date for the analysis, which is typically the one when the largest quantities of shares were locked up. This method of dealing with staggered lock-ups was also used by Espenlaub et al. (2002)

It is common practice to include the day before the event as well as the day after since it captures a potential abnormal return around the event, caused by information leakage or any additional information. (MacKinlay, 1997) In previous studies in the field, a variation of different event windows have been used; Field and Hanka (2001) used a 7-day event window (-5,+1). Nam et al. (2014) also used a 7-day event window but with different days (−3,+3). Espenlaub et al. (2002) used event windows of 1, 3 and 11 days. Bradley et al. (2001) instead used event windows of (-1,+1) and (-2,+2). Brav and Gompers (2003) used an event window of 21 days (-10, +10), but noticed that the largest abnormal returns were observed from day -1 to +2. However, if the event itself is easy to determine, shorter event windows are recommended since it will capture any abnormal return better (Armitage, 1995). Supported by Armitage and MacKinlay's recommendations, we have used an event window of 5 days which starts 2 days before the event, which is in line with the method of Bradley et al. (2001).

3.2.2. Data and sample selection

In this study, our sample consists of companies completing IPOs on Nasdaq OMX Nordic (OMX Stockholm, OMX Copenhagen, OMX Helsinki and OMX Iceland) and Oslo Børs during the period of 2009-2016. The sample aims to get a relatively complete picture since it represents differently sized companies on the main market lists. To get a sufficient number of observations a research period of eight years was chosen. Previous studies were conducted a decade ago; thus, we aim to fulfil a research gap by conducting a study with more recent data, to our knowledge, on an unexplored sample region. The reason for why the period starts in 2009 is to avoid including the financial crisis in the investigated time period. Since the financial crisis caused large fluctuations in stock prices, this could potentially cause a skewness of the abnormal return.

The study consists of secondary data accessed from the databases Zephyr, Bloomberg Terminal and Datastream. From the database Zephyr, we retrieved a list of all IPOs as well as information regarding if the IPO was PEVC-backed. To get access to the lock-up periods, we used the Bloomberg Terminal. In cases where we could not find a lock-up period, we manually downloaded the prospectus from the company's webpage to see if any lock-up period was stated. We also compared the data accessed from Zephyr and Bloomberg Terminal with the prospectus and the lists of all IPOs available on Nasdaq OMX webpage to ensure that the information was accurate.

To get access to historical stock prices, data were collected from Datastream. In cases where a company had several share classes, the most liquid one was used since it can be assumed to reflect the market's reaction best. Thereafter, the collected data have been processed and calculated to the event study's variables.

3.2.2.1. Data loss

Initially we identified 132 number of IPOs made on the main markets of Nasdaq OMX Nordic and Oslo Børs between 2009 and 2016. Of these, 29 IPOs were excluded since they did not have a stated lock-up period. In addition, 14 IPOs where excluded where we could not get access to any information or prospectus. Since our investigated time horizon includes 2016, we had to exclude 7 IPOs made in late 2016 where the lock-up periods had not expired yet. We also had to exclude 2 IPOs with a shorter lock-up period than our estimation window. The final sample consists of 80 IPOs (Appendix A) that met our qualifications for the event study.

Sample critera

Deal type:	Initial Public Offering (IPO)
Deal status:	Completed
Time period:	IPOs completed between 01-01-2009 and 31-12-2016
Deal stock exchanges:	Nasdaq OMX - Copenhagen, Nasdaq OMX - Helsinki, Nasdaq OMX - Iceland, Nasdaq OMX - Stockholm, Oslo Børs (main markets)
Lock-up agreement:	Identifiable
Lock-up period:	Longer than the estimation window (100 days)
Lock-up expiration:	Before May 2017

Table 2. Sample criteria

3.2.3. Estimation window

An estimation window is used to predict how the share price should have moved if the event did not happen. Thus, the event itself should not be included in the estimation window to prevent that the event affects the estimate of the normal return parameters. (MacKinlay, 1997) An estimation window between 100 and 300 days is proposed by Armitage (1995) when daily returns are used which is consistent with MacKinlay's (1997) recommendation of approximately 120 days. Previous studies within the field have used different estimation windows; Brau et al., (2004) used (-90, -11) Bradley et al. (2001) used (-80, -10) and Field and Hanka (2001) used a 101-day window. Comparatively, we are using an estimation window of 100 days before the event to 10 days before. This will allow us to get a sufficient estimate for the stock price relative to the market. To prevent an overlap of the event and estimation windows, our estimation window ends 10 days before the event. The reason for why we are not able to have a longer estimation window is because there are IPOs with short lock-up periods, preventing us from starting the estimation window earlier, a dilemma that was present in previous studies as well (Bradley et al., 2001; Brau et al., 2004; Field & Hanka, 2001).

Event window	t-2, t+2 from the expiration date 0
Estimation window	t-100, t-10, from the expiration date 0

Table 3. Summary of event window and estimation window period

3.2.4. The normal return

MacKinlay (1997) describes two different ways of calculating the normal return for a stock: the constant mean model and the market model. The constant mean model assumes that a stock's mean return is constant over time. The market model on the other hand assumes a stable linear relationship between the return of the market and the stock's. Brown & Warner (1985) and MacKinlay (1997) promote the market model since it excludes the return that is related to the variance in the market return. This method reduces the variance of the abnormal return (MacKinlay, 1997). This is desirable since it allows us to discover a potential event effect which is the purpose of our study. Accordingly, we have chosen to use the market model with the following indices: OMX Stockholm Index (OMXS), OMX Copenhagen Index (OMXC), OMX Helsinki (OMXH), OMX Iceland (OMXI), and Oslo Exchange (OSEAX) for companies listed in Sweden, Denmark, Finland, Iceland and Norway respectively, since they are broad indices covering the Nordic markets. The market model is calculated with the following formula: (MacKinlay, 1997):

$$\mathbf{R}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \mathbf{R}_{m,t} + \boldsymbol{\varepsilon}_{i,t} \qquad (1)$$

$\mathbf{R}_{i,t}$ = Normal return for share *i* during the time period *t*

$\boldsymbol{\alpha}_i$ = Idiosyncratic risk for share *i*

$\boldsymbol{\beta}_i$ = Systematic risk for share *i*

$\mathbf{R}_{m,t}$ = Return of the market portfolio during the time period *t*

$\boldsymbol{\varepsilon}_{i,t}$ = Error term assumed to have a mean of 0

3.2.5. Abnormal return (AR)

By using the estimates for the normal return, we can calculate the abnormal return. The next step is how the framework for the abnormal return should be constructed. (MacKinlay, 1997) The abnormal return is calculated by using the formula below, where the expected return is subtracted from the actual return for the stock (Brown & Warner, 1985).

$$\mathbf{AR}_{i,t} = \mathbf{R}_{i,t} - (\boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \mathbf{R}_{m,t}) \qquad (2)$$

$\mathbf{AR}_{i,t}$= Abnormal return for share *i* during the time period *t*

$\mathbf{R}_{i,t}$= Actual return for share *i* during the time period *t*

$\boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \mathbf{R}_{m,t}$= Expected return for share *i* during the time period *t*

3.2.6. Average abnormal return (AAR)

To calculate the average abnormal return for all observations during each given day of the event window, all abnormal returns are summated and divided by the number of observed events. (MacKinlay, 1997)

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

$\mathbf{AAR}_t$= Average abnormal return during the time period *t*

N= Number of events

$\mathbf{AR}_{i,t}$= Abnormal return for share *i* during the time period *t*

3.2.7. Cumulative abnormal return (CAR)

The cumulative abnormal return is needed to be able to use an event window which extends over more than one period, in this case, days. CAR is the sum of the abnormal returns during a time period for a share (MacKinlay, 1997).

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t} \quad (4)$$

$CAR_i(t1,t2)$= Cumulative abnormal return for share i between day t1 and day t2, where t1 and t2 are days included in the event window.

$AR_{i,t}$= Abnormal return for share *i* during the time period *t*

3.2.8. Average cumulative abnormal return (ACAR)

The average cumulative abnormal return is calculated with the same method as CAR above, by adding up abnormal returns during a time period. In this case, the cumulative abnormal returns are summated. This results in an aggregated measure over the average abnormal returns in an event window. (MacKinlay, 1997) The formula can be seen below:

$$ACAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AAR_t \quad (5)$$

$ACAR(t_1,t_2)$= Average cumulative abnormal return for share *i* between day t_1 and day t_2, where t_1 and t_2 are days included in the event window

AAR_t= Average abnormal return during the time period *t*

3.3. Statistical testing

To investigate whether the observed average abnormal return is statistically significant, t-tests are performed. These tests require the variance of the abnormal return for each stock during the estimation period. (MacKinlay, 1997) The formula to aggregate these individual variances is shown below:

$$var(AAR_t) = \frac{1}{N^2} \sum_{i=1}^{N} \sigma_{\varepsilon_i}^2 \quad (6)$$

$var(AAR_t)$= Variance of average abnormal return during the time period *t*

N= Number of events

σ^2= The variance of the average abnormal return during the estimation period for the share *i*

Thereafter, the variance of the average cumulative abnormal return from day t_1 to t_2 is calculated using the formula below (MacKinlay, 1997).

$$var(ACAR(t_1, t_2)) = \sum_{t=t_1}^{t_2} var(AAR_t) \quad (7)$$

var(ACAR(t_1,t_2))= The variance of the average cumulative abnormal return for share *i* between day t_1 and day t_2, where t_1 and t_2 are days included in the event window

var(AAR$_t$)= The variance of the average abnormal return during the time period *t*

The two formulas above are needed in order to conduct the actual hypothesis testing. To investigate whether the deduced null hypothesis can be rejected, i.e., if the average cumulative abnormal return is different from zero, the below formula is used (MacKinlay, 1997):

$$\theta_1 = \frac{ACAR(t_1,t_2)}{var(ACAR(t_1,t_2))^{1/2}} \sim N(0,1) \quad (8)$$

ACAR(t_1,t_2)= Average cumulative abnormal return for share *i* between day t_1 and day t_2, where t_1 and t_2 are days included in the event window

var(ACAR(t_1,t_2))= The variance of the average cumulative abnormal return for share *i* between day t_1 and day t_2, where t_1 and t_2 are days included in the event window

3.4. Operationalising hypotheses

To fulfil the purpose of the study, the hypotheses presented in the theoretical framework are operationalised before testing. Two-tailed t-tests are used to investigate whether the abnormal return during the event window is statistically significantly different from 0. In addition, a multiple regression analysis is conducted to explain the relationship between dependent and independent variables (Brooks, 2014).

3.4.1. Non-normality

Financial data is typically not normally distributed, which regression analyses assume test variables to be. To see to which extent a variable is normally distributed, the variable's kurtosis and skewness can be tested. Skewness refers to if the data is skewed in one direction. A perfect normal distribution has a skewness of 0, and the variable is deemed to be normally distributed if the skewness is between -0.5 and 0.5. Kurtosis is measuring the height or flatness of the normal distribution curve. A perfect normal distribution has a kurtosis value of

3 and a variable should preferably have a value between -1 and 1, for non-dummy variables. (Ho & Yu, 2015) For small samples, non-normality may be problematic and some different methods can be used for dealing with non-normality (Brooks, 2014). For certain independent variables, the use of the natural logarithm of the variable can correct for the non-normality (Nath, Das & Mukhopadhyay, 2017). If outliers cause non-normality for the dependent variable, trimming and winsorizing can be used. Trimming is when you remove the outliers from the sample while winsorizing is the method of replacing the extreme variables with a suitable value such as the median or the mean (Hoo, Tvarlapati, Piovoso & Hajare, 2002). Due to the nature of our relatively small sample, we did not want to remove any valuable observations and used the method of winsorizing instead. We have therefore replaced four outliers identified in SPSS by a boxplot, with ACAR values lower than the 1st and higher than the 99th percentile, with the sample median in line with Brav and Gompers methodology (2003). After removing outliers, we use the Kolmogorov-Smirnova and Shapiro-Wilk tests to test for the assumption of normality statistically with improved results.

3.4.2. Multicollinearity

Since we are looking at the correlation between one dependent variable and several independent variables, there is also a potential risk that the independent variables are highly correlated. This phenomenon is called multicollinearity and can result in uncertain parameter estimates. To measure multicollinearity, a variance inflation factor (VIF) is used. If the VIF is higher than 10, it indicates that there is multicollinearity between the independent variables. (Andersson, Jorner & Ågren, 2007)

3.4.3. Heteroscedasticity

It is also important to be aware of any issues regarding heteroscedasticity since the OLS-regression requires the variables to be homoscedastic, i.e. that the error variances are constant, in order to generate the best linear unbiased estimators. (Brooks, 2012) When dummy variables are used to create pooled groups and the error variances for the groups are significantly different, heteroscedasticity is present. This could lead to incorrect standard errors and inference. (Hardy, 1993) In order to test the assumption of homoscedasticity, we plotted the residuals on the y-axis and the predictors on the x-axis. Furthermore, we conducted Breusch-Pagan and Koenker tests to ensure that the assumption of homoscedasticity holds for our sample.

None of our variables in the sample had problematic values when testing for skewness, kurtosis, heteroscedasticity and multicollinearity which can be seen in our empirical results and Appendix B.

3.4.4. IPOs lock-up expiration

Hypothesis 1 *– There is no abnormal return around the expiration of lock-up periods related to IPOs.*

Hypothesis 1, stating that there is no abnormal return after the expiration of a lock-up period after an IPO is tested by investigating if ACAR during our 5-day long event window is statistically significant different from zero for the IPOs in our sample. ACAR is used for this hypothesis since CAR is calculated per stock and is not an aggregated measure for the whole sample. Hypotheses 2, 3, and 4 relate to how specific characteristics are affecting the size of the abnormal return. Thus, these are investigating the test variables' correlations with CAR.

3.4.5. IPOs backed by PEVCs

Hypothesis 2 *– PEVC-backed IPOs have a larger negative abnormal return than non PEVC-backed IPOs.*

To test whether an IPO is PEVC-backed or not affects the abnormal return we are measuring if CAR is different from 0 when the IPO is PEVC-backed. In line with (Brau et al., 2004; Field & Hanka, 2001; Hoque, 2011) we distinguish between PEVC-backed companies and non PEVC-backed, by using dummy variables. Companies that are non PEVC-backed have been assigned the value 0 while the PEVC-backed ones received the value 1. However, unlike previous findings which have solely focused on VC-backed IPOs, we do not make any distinction of the stage of financing for the broader definition private equity and venture capital backed IPOs. The logic behind this choice is that there is no clear commonly known distinction on the definition for venture capital and private equity firms since venture capital can be defined as an investment strategy within private equity (Nordic Capital, 2017). In addition, we did not have access to the same databases, such as Thomson One, which previous studies have used to define and identify venture capital backed IPOs only.

3.4.6. The length of the lock-up period

Hypothesis 3 *– IPOs with longer lock-up periods have a smaller negative abnormal return than shorter ones.*

We also investigate whether the length of the lock-up period is influencing the abnormal return. To construct the variable, we look at the lock-up periods in calendar days. Just as Bradley et al. (2001 and Field & Hanka (2001) we have divided our data into groups. One group was created with lock-up periods less than or equal to 180 days and one for lock-up periods longer than 180 days. When an IPO was subject to staggered lock-up periods, we have used the earliest expiry date for the analysis, in line with Espenlaub et al. (2002)

3.4.7. Staggered lock-up periods

***Hypothesis 4** – IPOs with staggered lock-up periods have a smaller negative abnormal return than single ones.*

To research whether staggered lock-up periods are affecting the abnormal return we construct dummy variables. Single lock-ups are assigned value 0 and staggered lock-ups value 1. This dummy method is in line with Hoque (2011) way of measuring staggered lock-ups.

3.4.8. Control variables

3.4.8.1. Size

We also want to investigate whether the firm size affects the return, since larger firms are expected to provide greater information to the public, thereby reducing the information asymmetry and complexity of valuing a company. (Brau et al., 2004) We are using the market value in Euro at the time of the IPO, in accordance with the methodology used by Brav and Gompers (2003). To get the variable more normally distributed, we have logarithmized the IPO value (Appendix C) as proposed by Nath Das and Mukhopadhyay (2017).

3.4.8.2. Fixed effects: Exchange (FE(Exchange))

Although a data collection seems to have independent variables, there is a risk that fixed effects are present and causing a dependency between variables. This is also known as unit-specific heterogeneity or omitted variable bias at the unit level. (Andress, Golsch & Schmidt, 2013) The Nordic markets may have different characteristics. Thus, to control for country-specific effects we are using dummy variables for the different exchanges in Sweden, Denmark, Norway, Finland and Iceland.

3.4.8.3. Fixed effects: Year (FE(Year))

To eliminate possible fixed year effects, implying that the year is influencing any abnormal return, dummy variables for each year are used in the study, a methodology that is also used by Brav and Gompers (2003). This means that each one of the sample years is getting an individual dummy variable.

3.5. Regression model

The different variables' effect on CAR is analysed in a multiple regression analysis. When choosing variables, it is important so choose a suitable number of variables that are the most relevant and together can explain the variation in the dependent variable (Körner & Wahlgren, 2006). Accordingly, our model consists of CAR as the dependent variable and 3 independent variables: PEVC-backed IPOs (PEVC), staggered lock-up periods (Staggered) and lock-up length (Length). Moreover, our model consists of the control variables IPO size (MV), FE(Exchange) and FE(Year), to make sure that potential size, exchange/country and year effects are eliminated. FE(Exchange) and FE(Year) consist of several dummy variables but are stated as one separate variable in the formula below to facilitate the lucidity. The regression model is illustrated below:

$$\mathbf{CAR_i = \beta_1 * PEVC_i + \beta_2 * Length_i + \beta_3 * Staggered_i + \beta_4 * Size_i + \beta_5 * FE(Exchange) + \beta_6 * FE(Year)_i + \varepsilon_i}$$

CAR_i= Cumulative abnormal return for share I

ε_i= Error term assumed to be 0

4. Empirical results and analysis

4.1. Descriptive statistics

Table 4 and 5 provide descriptive statistics for the 80 IPOs. Table 4 displays the sample and its characteristics in terms of the number of IPOs during each investigated year as well as if the IPO was PEVC-backed, staggered and the lock-up period length. Table 5 describes characteristics of the data, such as the variables distribution. For the logarithmized size value, we are presenting both the pre- and post-logarithmization variable in order to provide a fair picture of the logarithmizing effect on the variable as well as the size characteristics of the firms.

Overview

Year	2009	2010	2011	2012	2013	2014	2015	2016	Total
Observations	0	8	4	2	4	21	26	15	80
Backing									
PEVC	0	4	2	1	3	11	17	10	48
Non-PEVC	0	4	2	1	1	10	9	5	32
									80
Lock-up type									
Staggered	0	1	1	0	2	11	23	13	51
Non-staggered	0	7	3	2	2	10	3	2	29
									80
Lock-up length									
<= 180 days	0	7	3	2	4	17	23	13	69
> 180 days	0	1	1	0	0	4	3	2	11
									80

Table 4. Sample characteristics.

	N	Min	Max	Mean	Median	Std. Dev.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
CAR	80	-.0837	.0689	-.0072	-.0091	.0300	.1542	.2689	-.0515	.5318
PEVC	80	.0000	1.0000	.6000	1.0000	.4930	-.4161	.2689	-1.8744	.5318
Staggered	80	.0000	1.0000	.6375	1.0000	.4838	-.5830	.2689	-1.7033	.5318
Length >180d	80	.0000	1.0000	.1375	.0000	.3465	2.1457	.2689	2.6702	.5318
Size	80	21	13,228	832	340	1,653	5.7438	.2689	40.6628	.5318
Size (log)	80	4.3233	7.1215	5.5747	5.5316	.5169	.4063	.2689	.2117	.5318
Valid N (listwise)	80									

Table 5. Table with descriptive statistics for the sample. CAR is the cumulative abnormal return during the event window. PEVC-backed is a dummy variable with value 1 for PEVC-backed IPOs. Staggered is a dummy variable with value 1 for staggered IPOs. Length>180d is a dummy variable with value 1 for lock-up periods longer than 180 days. Size is the firm market value in Euro (millions) at the time for the IPO. Size log is the logharitmized market value. Std. dev. is the standard deviation. Min is the variable's minimum value and Max the maximum value. Kurtosis and Skewness are the height and the skewness of the normal distribution.

As table 4 above displays, no IPOs were made in 2009 with a lock-up period. This may derive from the fact that it was during the aftermath of the financial crisis and firms were reluctant to go ahead with new public listings. We can also observe a trend of increased amounts of IPOs with lock-up periods during the last few years. In our sample, 60% of the IPOs were PEVC-backed. Although not the exact same definition was used, this can be compared to Field and Hanka's (2001) sample where 48% of the IPOs were venture capital backed and U.K data implying that 75% of the IPOs are private equity backed (EY, 2017). Unlike the U.K. where the length of the lock-up period varies a lot (Espenlaub et al., 2002), our sample has a relatively homogenous length where only 11 out of 80 IPOs had a longer lock-up period than 180 days, which is similar to the U.S. market where the majority of the IPOs have a 180-day lock-up period. Noteworthy for this comparison, is our relatively small sample size.

Table 5 above exhibits that the maximum CAR value for our sample is 6.9% while the minimum value is -8.4%. Although the mean and median are -0.7% and -0.9% respectively, this implies that some strong reactions, around the lock-up expiration are present, both positive and negative. Applicable to non-dummy variables, as noticed in table 5 above, the logharitmizing of the size variable result in acceptable skewness and kurtosis values of 0.406 and 0.212 respectively compared to the 5.74 and 40.66 for the non-logharitmized one.

4.2. IPO Lock-up expiration

Event window (days)	**-2**	**-1**	**0**	**1**	**2**
AAR	-.0009	.0008	-.0023	-.0037	-.0012
ACAR	-.0009	-.0001	-.0023	-.0061	-.0072**
T-value	-.4286	-.0194	-.6223	-1.3965	-2.1520
Significance ACAR					.034
Fraction with negative CAR for days -2 to +2					47%

*Table 6. Average abnormal return and t-tests for average cumulative abnormal return. ***, ** and * represent significance at 1% 5, and 10% level respectively (2-tailed).*

Research question *– Do abnormal stock returns exist around the expiration of lock-up periods related to IPOs on the Nordic main markets?*

Hypothesis 1 *– There is no abnormal return around the expiration of lock-up periods related to IPOs.*

As table 6 above displays, there is a negative average cumulative abnormal return (ACAR) of -0.23%, -0.61% and –0.72% during the event day and the two following days respectively.

The 5-day ACAR result of 0.72% is significant on a 5% significance level. Thus, the null hypothesis that there is no abnormal return around the expiration of lock-up periods related to IPOs can be rejected, showing evidence for that the EMH does not hold. The abnormal return of -0.7% is lower than the -1.5% observed by Field and Hanka (2001) in the U.S. and the --1.2% observed in the U.K by Espenlaub et al. (2001). However, the latter result in the U.K was not statistically significant. What the negative abnormal return derives from cannot be fully decided from the results but is compatible with theories such as a downward sloping demand curve as Field and Hanka (2004), points out. Since we do not have any negative abnormal returns the day before the lock-up expiration, and the largest negative abnormal returns during our event window are observed after the actual expiration at day 0, this further supports a downward sloping demand curve since it could be attributed to the new shares entering the public market. For some reason, investors seem to underestimate the amount of shares that are being sold at the expiration, thus the abnormal returns.

Furthermore, it is in line with theories regarding information asymmetries as highlighted by previous findings (Brau et al., 2004; Brav & Gompers, 2003; Field & Hanka, 2001). Since insiders are permitted to sell the shares after the lock-up period expires, it could potentially increase the information asymmetry between investors as pointed out by Field and Hanka (2001). Due to the information disadvantage, it is possible that investors are getting nervous when the expiration dates are approaching, as discussed by (Brau et al., 2004). It is also possible that investors perceive the expiration as a negative signal in line with signalling theory as concluded by Nam et al. (2014) The result is interesting since Goergen et al. (2006) who conducted a European study in Germany and France during 1996-2009 could not find any significant abnormal return around the lock-up expiration and Espenlaub et al. (2001) did only observe marginally significant results in the U.K.

To summarise, an anticipated permanent price decline at the lock-up expiration is contradictory against the semi-strong form of the efficient market hypothesis. However, it is not obvious that it will create any arbitrage opportunities since bid and ask prices may not fall enough to be able to utilise this strategy as discussed by Ofek and Richardsson (2000). The result is compatible with theories regarding costly arbitrage opportunities, preventing investors to exploit market inefficiencies (Pontiff, 2006). However, since our study does not include data regarding transaction costs, we cannot make any conclusions regarding if this result would imply that arbitrage opportunities exist on the Nordic markets. Our results indicate that the question to our research question is yes; abnormal returns exist around the expiration of lock-up periods related to IPOs on the Nordic main markets.

4.3. Cross-sectional determinants of the abnormal return

4.3.1. Correlation matrix

Correlations

		CAR	PEVC	Staggered	Length >180d	Size (log)
CAR	Pearson Correlation	1	-.0113	-.0543	.0085	-.1599
	Sig. (2-tailed)		.9210	.6322	.9405	.1565
	N	80	80	80	80	80
PEVC	Pearson Correlation	-.0113	1	,499***	-.1926	.1248
	Sig. (2-tailed)	.9210		.0000	.0869	.2700
	N	80	80	80	80	80
Staggered	Pearson Correlation	-.0543	,499***	1	-,378***	,321***
	Sig. (2-tailed)	.6322	.0000		.0005	.0037
	N	80	80	80	80	80
Length >180d	Pearson Correlation	.0085	-.1926	-,378***	1	-,347***
	Sig. (2-tailed)	.9405	.0869	.0005		.0016
	N	80	80	80	80	80
Size (log)	Pearson Correlation	-.1599	.1248	,321***	-,347***	1
	Sig. (2-tailed)	.1565	.2700	.0037	.0016	
	N	80	80	80	80	80

*Table 7. Correlation matrix with Pearson's Correlation Coefficient. ***, ** and * represent significance at 1% 5, and 10% level* respectively *(2-tailed).*

As table 7 above displays, there are no noticeable high correlations between the independent variables to be concerned about. The only noteworthy correlation may be the moderate correlation for PEVC-backed and staggered IPOs of 0.499 which may imply that PEVCs often tend to use staggered lock-ups when helping the firms to go public. To ensure that all the other variables combined are not highly correlated with each other, we also conducted a VIF-test which is presented in our model below. Although not statistically significant, the negative correlation between long lock-up periods and PEVC-backed IPOs is interesting and is compatible with Goergen et al. (2006) findings that PEVC-firms tend to have shorter lock-up periods.

4.3.2. Multiple regression analysis and univariate subsample tests

Table 8 presents the mean cumulative abnormal return for different subsamples, and Table 9 presents our multiple regression model of the abnormal return, as functions of our independent and control variables.

Event window (days)	N	-2	-1	0	1	2
AAR	80	-.0009	.0008	-.0023	-.0037	-.0012
ACAR	80	-.0009	-.0001	-.0023	-.0061	-.0072**
PEVC ACAR	48	.0000	-.0018	-.0036	-.0049	-.0075
Non PEVC ACAR	32	-.0022	.0026	-.0005	-.0079	-.0068
Staggered ACAR	51	-.0012	.0009	-.0028	-.0043	-.0085
Non Staggered ACAR	29	-.0002	-.0017	-.0016	-.0093	-.0051
Lock-up <=180d ACAR	69	.0009	-.0004	-.0018	-.0028	-.0073
Lock-up >180d ACAR	11	-.0119	.0019	-.0060	-.0264	-.0066

*Table 8. Average cumulative abnormal return for different subsamples. ***, ** and * represent significance at 1% 5, and 10% level respectively (2-tailed).*

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.0795	.0557		1.4265	.1585		
	PEVC	-.0004	.0091	-.0061	-.0411	.9674	.5993	1.6687
	Staggered	.0014	.0129	.0232	.1123	.9109	.3127	3.1983
	Length >180d	-.0031	.0121	-.0354	-.2527	.8013	.6819	1.4666
	Size (log)	-.0132	.0087	-.2268	-1.5208	.1332	.6020	1.6610
	FE (Exchange)	YES	YES	YES	YES	YES	YES	YES
	FE (Year)	YES	YES	YES	YES	YES	YES	YES

a. Dependent Variable: CAR

*Table 9. Multiple regression analysis with chosen test variables. ***, ** and * represent significance at 1% 5, and 10% level respectively (2-tailed). YES for the fixed effects variables imply that we have controlled for fixed effects, without absorbing any significant values.*

As table 9 above displays, all the VIF-variances are lower than 10, thus we do not have any concerns regarding multicollinearity for our variables. Neither did our model show that we had any fixed effects regarding the country specific stock exchange or year for the IPO.

Table 9 also displays that all our independent variables have negative coefficient signs, although it was only expected for the PEVC-backed variable. Notwithstanding, none of the independent variables are statistically significant in our multiple regression. Accordingly, none of the variables coefficients can be used to help explain the differences in CAR. We have also conducted univariate tests for the independent variables, where the different independent variables' effect on CAR are analysed in isolation. The univariate tests did not provide any significant variables either and can be found in Appendix H.

4.3.3. PEVC-backed IPOs

Event window (days)	-2	-1	0	1	2
Full Sample ACAR	-.0009	-.0001	-.0023	-.0061	-.0072
PEVC-backed ACAR	.0000	-.0018	-.0036	-.0049	-.0075
Non PEVC-backed ACAR	-.0022	.0026	-.0005	-.0079	-.0068

Table 10. ACAR for PEVC-backed IPOs and non PEVC-backed IPOs.

Our second hypothesis aimed to prove if PEVC-backed IPOs have a larger negative abnormal return in comparison with non PEVC-backed IPOs. Hence, our hypothesis was formulated as:

Hypothesis 2 – *PEVC-backed IPOs have a larger negative abnormal return than non PEVC-backed IPOs.*

As table 10 above displays, the abnormal return during our 5-day event window for our subsample of PEVC-backed IPOs is -0.75% compared to -0.68% for non PEVC-backed. Thus, our PEVC variables have the expected negative relationship with CAR as our hypothesis, which is in line with the findings from previous studies in the field (Espenlaub et al., 2002; Field & Hanka, 2004; Bradley et al., 2001). However, as shown from our multiple regression model in table 9 earlier, the variable is not statistically significant. Accordingly, hypothesis 2 implying that if a company is PEVC-backed, it affects any abnormal return negatively, cannot be accepted.

Our negative abnormal return is slightly less negative than what Espenlaub et al., 2002 observed on the U.K market with negative abnormal return of -1.2% to -1.6% for VC-backed IPOs, while the corresponding abnormal returns without VC backing ranged between -0.2% to -0.8%. Nevertheless, due to lack of statistical significance, the result cannot support the hypothesis that PEVCs tend to liquidate their shares more aggressively around the lock-up period expiration than other owners, which would have given further strength for a downward sloping demand curve as discussed by Field and Hanka (2001) and Bradley et al., (2001). Although we cannot draw any conclusions from the result, the observed negative relationship is also compatible with information asymmetry theories implying that VC investors have an information advantage compared to less informed investors and that the expiration of the lock-up period is perceived as a negative signal in terms of signalling theory as concluded by Nam et al. (2014)

4.3.4. Length of lock-up period

Event window (days)	-2	-1	0	1	2
Full Sample ACAR	-.0009	-.0001	-.0023	-.0061	-.0072
Lock-up <=180d ACAR	.0009	-.0004	-.0018	-.0028	-.0073
Lock-up >180d ACAR	-.0119	.0019	-.0060	-.0264	-.0066

Table 11. ACAR for IPOs with lock-up periods shorter or equal to 180 days and lock-up periods longer than 180 days.

Our third hypothesis sought to prove if the length of the lock-up period has a positive impact on the abnormal return. Hence, our hypothesis was formulated as:

Hypothesis 3 *– IPOs with longer lock-up periods have a smaller negative abnormal return than shorter ones.*

As table 11 above displays, the abnormal return is slightly less negative for the longer lock-up periods, -0.66% compared to -0.73% for shorter periods, but the results are not significant. The observed relationship is consistent with previous findings within the field and our hypothesis. Field and Hanka (2001) noticed that the cumulative abnormal negative return for lock-up agreements equal or less than 180 days was -1.3% compared to -0.8% for lock-up agreements longer than 180 days. Likewise, Hakim et al. (2012) found an abnormal return that only was significant for lock-up periods equal to or less than 180 days but not for the longer ones. However, since the lock-up length variable was not significant in neither the multiple nor the univariate regression analysis, hypothesis 3 asserting that the length of the lock-up period does have a positive impact on any abnormal return is rejected. Consequently, our results do not give any support to the hypothesis that more information is released under a longer period which facilitates the valuation of the company as Brau et al. (2014) pointed out or that longer lock-up periods are perceived as a positive signal as discussed by Ahmad (2012).

4.3.5. Staggered lock-up periods

Event window (days)	-2	-1	0	1	2
Full Sample ACAR	-.0009	-.0001	-.0023	-.0061	-.0072
Staggered ACAR	-.0012	.0009	-.0028	-.0043	-.0085
Non-Staggered ACAR	-.0002	-.0017	-.0016	-.0093	-.0051

Table 12. ACAR for IPOs with a staggered lock-up period and non-staggered lock-up periods.

Our fourth hypothesis implied that IPOs with staggered lock-up periods have a smaller negative abnormal return than single ones. Therefore, our hypothesis was stated as:

Hypothesis 4 *– IPOs with staggered lock-up periods have a smaller negative abnormal return than single ones.*

51 of the 80 IPOs were staggered, meaning that more than one lock-up period was stated in the prospectus. As table 12 displays, the staggered lock-up expirations are subject to a more negative ACAR of -0.85% as opposed to a negative ACAR of -0.51% for non-staggered lock-up expirations. This is interesting since it is an unexpected relationship with CAR compared to previous findings and our hypothesis. Hogue (2011) concluded in his study on IPOs made during 1999-2006 on the London Stock Exchange, that single lock-ups have larger price drops than staggered ones and argued that the result supports the view that staggered lock-up periods are also used as a signal for quality. Since neither our multiple or univariate regression analysis provide any evidence of a significant relationship between the staggered dummy-variable and CAR, hypothesis 4, stating that IPOs with staggered lock-up periods have a smaller negative abnormal return than single ones is therefore rejected.

Due to the fact that none of our variables were significant in our multiple regression model and the staggered variable had an acceptable but still a relatively high VIF-value of 3.2, compared to the rest of the variables and a moderate correlation of 0.499 with the PEVC variable, we conducted a model where we excluded the staggered variable from our model to see if the variables coefficients wold become more stable. (Appendix F) However, this did not improve our model and did only change the t-values and beta coefficients marginally. In addition, we constructed a model where only the PEVC-backed variable and control variables where included but without any substantial improvements (Appendix G).

5. Conclusion

The purpose of this study was to investigate whether abnormal returns can be observed in stock prices after the expiration of lock-up periods related to IPOs on the Nordic markets. Furthermore, the purpose was to analyse if PEVC ownership, the use of staggered lock-ups and the length of lock-up period affect this return. Consequently, we examined how the market reacts around the expiration of lock-up periods related to IPOs made on the Nordic main markets during 2009-2016. We concluded that for the 80 IPOs made with a lock-up period, we found a statistically significant abnormal return of -0.73%. Although observed differences in the CAR between subsamples, we did not find any statistically significant evidence for a negative relationship between abnormal returns and IPOs backed by private equity/venture capital firms. Neither did we find any statistical evidence that the lock-up length or the use of staggered lock-up periods affect this abnormal return.

The significant result for our whole sample is puzzling since it shows evidence against the efficient market hypothesis. Since the lock-up period is clearly defined in the prospectus this violates the semi-strong form of the EMH implying that the market is incorporating all publicly available information. The results could instead potentially support a downward sloping demand curve since the market is facing an increased supply of shared at the time of the expiration. However, for some reason, investors seem to underestimate the expected amount to be sold. Whether the observed market anomaly would be possible to exploit cannot be determined from this study but in accordance with costly arbitrage theories, transaction cost may be a reason for why this phenomenon is not arbitraged away. The result is also compatible with theories regarding information asymmetry and signalling theory.

The results are in line with previous older studies made in the US (Bradley et al., 2001; Brav & Gompers, 2003; Field & Hanka, 2001; Ofek & Richardsson, 2000). This implies that this phenomenon is also applicable on the Nordic main markets. This is interesting since another study conducted on European markets in Germany and France (Georgen et al., 2006) did not observe any significant abnormal returns around expiration. The studies conducted by Espenlaub et al., (2001&2002) in the U.K did also proof little evidence of statistical significance of the results. Worth mentioning is that the investigated time periods for these European studies were 1996-2000 for Georgen et al. (2006) and 1992-1998 for Espenlaub et al. (2011&2002) which is before our investigated time horizon. In conclusion, to our knowledge, we have contributed to the research within the field and filled the research gap of findings of IPO expirations on the Nordic markets.

5.1. The reliability and validity of the study

Validity is defined as the absence of systematic errors and that the study is measuring what is meant to be tested (Esaiasson, Gilljam, Oscarsson & Wängnerud, 2012). The purpose of this dissertation was to investigate whether abnormal return can be observed in stock prices after the expiration of lock-up periods related to an IPO as well as how specific IPO characteristics affect this return. To only investigate the change related to the IPO lock-up expiration and not how the stock market is behaving in general, we have used an abnormal return as a measurement. This is the change in return that cannot be related to general changes on the stock market. (Brigham & Daves, 2007) Accordingly, we believe that we have been measuring what we intended to measure and that we have included relevant test variables in regard to the purpose of the study, supported by previous research within the field. The event study methodology we have used is a well-known methodology used in many research studies. We have used the market model to calculate the normal return which is deemed to be more accurate than more simple versions. (Brown & Warner, 1985; MacKinlay, 1997) Thus, we believe our choice of methodology is strengthening the validity.

In addition to the validity of the study, it is of importance to consider the reliability of the study. This means that besides from measuring what is intended to be investigated we want to ensure that the study is thoroughly conducted and that the random error term will be as tenuous as possible. (Körner & Wahlgren, 2012) Our study is based on secondary data accessed from well-known databases. The use of secondary data is associated with quality risks since we do not have the full control over the collected material (Saunders et al., 2009). We have therefore conducted a spot check where we have compared the data from the databases with other databases as well as from collected prospectuses and webpages. Some parts of the collecting and processing have been made manually, which increases the risk for human factors affecting the result. However, we believe that we have been very careful, used reliable sources and ensured that the collected data is accurate. Since the study relies on market data and the used formula are detailed described, we consider the study to have a high reliability since the study could be replicated and provide the same results. In summary, we consider the validity and reliability of the study to be satisfactory.

5.2. Limitations of the study

This study has some possible limitations. An important aspect is that our sample is relatively small compared to previous research within the field in the U.S. However, the main reason for this is related to characteristics of the Nordic market compared to the U.S. Since statistical significance partly depends on the size of the sample, this limits the possibility of obtaining significant results. Although our whole sample provided us with statistically significant results for the abnormal return, none of the independent variables were significant and could help us explain the phenomenon. Since our sample only consisted of 80 observations, there were very few observations for each independent variable, limiting the results significantly (Saunders et al., 2009). There is also a risk for an omitted variables bias, which could be related to the insignificant results in the multiple regression model. This means that there may be other potential factors than the included ones in the study, influencing the abnormal return. When multiple lock-up periods were given, we used the earliest expiry date for the analysis in line with previous studies (Espenlaub et al., 2002). Although we have spot-checked the data and noticed that the first lock-up is when the largest quantity of shares were locked up, it is not completely certain that this was applicable to all IPOs. Accordingly, we have not been able to capture any potential abnormal return after the second lock-up expiration. Another factor which makes the comparison with previous studies more difficult is that our PEVC variable do not distinguish between private equity and venture capital since we did not have access to the same databases which separate these.

5.3. Suggestions for further research

When controlling for staggered lock-ups, we defined staggered lock-ups as all IPOs where there was more than one lock-up date, typically a longer one for management. However, it would be interesting to see if we would get another result if we took into consideration the amount of shares that were subject to the second lock-up. Furthermore, to more accurately control for the downward sloping demand curve, it would be relevant to see if the fraction of shares locked up is affecting the abnormal return as well. A contradicting theory to the downward sloping demand curve and information asymmetry is the liquidity effect which states that with increased liquidity, the share price would increase due to a liquidity premium. Our sample did only include IPOs on the main markets, where all stocks tend to have a relatively high liquidity. Therefore, it would be interesting to see if the same phenomenon is applicable on secondary markets such as First North and Oslo Access, or in these cases, a positive abnormal return could be seen due to the increased liquidity. It would also be relevant to conduct a similar larger study with an extended investigated time period in the Nordics to see if any differences and trends can be observed. Furthermore, it would be interesting to dig deeper into the lock-up expiration topic and investigate what fraction of insiders that sell their shares immediately after the lock-up expires.

6. References

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Appendix

Appendix A. List of total sample

	Company Name	Target exchange	IPO date
1	DONG ENERGY A/S	Nasdaq OMX - Copenhagen	2016-06-09
2	NETS A/S	Nasdaq OMX - Copenhagen	2016-09-23
3	PANDORA A/S	Nasdaq OMX - Copenhagen	2010-10-05
4	GJENSIDIGE FORSIKRING ASA	Oslo Bors	2010-12-10
5	ISS A/S	Nasdaq OMX - Copenhagen	2014-03-13
6	CHR HANSEN HOLDING A/S	Nasdaq OMX - Copenhagen	2010-06-03
7	ENTRA ASA	Oslo Bors	2014-10-17
8	COM HEM HOLDING AB	Nasdaq OMX - Stockholm	2014-06-17
9	PANDOX AB	Nasdaq OMX - Stockholm	2015-06-18
10	STATOIL FUEL & RETAIL ASA	Oslo Bors	2010-10-22
11	AHLSELL AB	Nasdaq OMX - Stockholm	2016-10-28
12	DOMETIC GROUP AB	Nasdaq OMX - Stockholm	2015-11-25
13	EPH II AS	Oslo Bors	2015-06-19
14	OW BUNKER A/S	Nasdaq OMX - Copenhagen	2014-03-28
15	SKANDIABANKEN ASA	Oslo Bors	2015-11-02
16	XXL ASA	Oslo Bors	2014-10-03
17	RESURS HOLDING AB	Nasdaq OMX - Stockholm	2016-04-29
18	LIFCO AB	Nasdaq OMX - Stockholm	2014-11-17
19	MATAS A/S	Nasdaq OMX - Copenhagen	2013-06-28
20	HEMFOSA FASTIGHETER AB	Nasdaq OMX - Stockholm	2014-03-21
21	SCANDIC HOTELS GROUP AB	Nasdaq OMX - Stockholm	2015-12-02
22	BRAVIDA HOLDING AB	Nasdaq OMX - Stockholm	2015-10-16
23	INWIDO AB	Nasdaq OMX - Stockholm	2014-09-26
24	HOIST FINANCE AB	Nasdaq OMX - Stockholm	2015-03-25
25	ELTEL AB	Nasdaq OMX - Stockholm	2015-02-06
26	COOR SERVICE MANAGEMENT HOLDING AB	Nasdaq OMX - Stockholm	2015-06-16
27	GRANGES AB	Nasdaq OMX - Stockholm	2014-10-10
28	BORREGAARD ASA	Oslo Bors	2012-10-18
29	THULE GROUP AB	Nasdaq OMX - Stockholm	2014-11-26
30	NOBINA AB	Nasdaq OMX - Stockholm	2015-06-18
31	ALIMAK GROUP AB	Nasdaq OMX - Stockholm	2015-06-17
32	NNIT A/S	Nasdaq OMX - Copenhagen	2015-03-06
33	RECIPHARM AB	Nasdaq OMX - Stockholm	2014-04-03
34	DUSTIN AB	Nasdaq OMX - Stockholm	2015-02-13
35	ASIAKASTIETO GROUP OYJ	Nasdaq OMX - Helsinki	2015-03-27
36	SCANDI STANDARD AB	Nasdaq OMX - Stockholm	2014-06-27
37	MORPOL ASA	Oslo Bors	2010-06-30
38	TOKMANNI GROUP OYJ	Nasdaq OMX - Helsinki	2016-04-29
39	BUFAB HOLDING AB	Nasdaq OMX - Stockholm	2014-02-21
40	OCEAN YIELD ASA	Oslo Bors	2013-07-05
41	NORDIC WATERPROOFING HOLDING A/S	Nasdaq OMX - Stockholm	2016-06-10
42	COLLECTOR AB	Nasdaq OMX - Stockholm	2015-06-10
43	ACADEMEDIA AB	Nasdaq OMX - Stockholm	2016-06-15
44	RENONORDEN ASA	Oslo Bors	2014-12-16
45	WESTERN BULK ASA	Oslo Bors	2013-10-25
46	HOEGH LNG HOLDINGS LTD	Oslo Bors	2011-07-05
47	BAKKAFROST P/F	Oslo Bors	2010-03-26
48	SCATEC SOLAR ASA	Oslo Bors	2014-10-02
49	HUMANA AB	Nasdaq OMX - Stockholm	2016-03-22
50	CLX COMMUNICATIONS AB	Nasdaq OMX - Stockholm	2015-10-08

51	KID ASA	Oslo Bors	2015-11-02
52	TROAX GROUP AB	Nasdaq OMX - Stockholm	2015-03-27
53	B2HOLDING ASA	Oslo Bors	2016-06-08
54	LEHTO GROUP OYJ	Nasdaq OMX - Helsinki	2016-04-28
55	CAMURUS AB	Nasdaq OMX - Stockholm	2015-12-03
56	FINNVEDENBULTEN AB	Nasdaq OMX - Stockholm	2011-05-20
57	NORDIC NANOVECTOR ASA	Oslo Bors	2015-03-23
58	PIHLAJALINNA OYJ	Nasdaq OMX - Helsinki	2015-06-04
59	MQ HOLDING AB	Nasdaq OMX - Stockholm	2010-06-18
60	TOBII AB	Nasdaq OMX - Stockholm	2015-04-24
61	INTERNATIONELLA ENGELSKA SKOLAN I SVERIGE HOLDINGS II AB	Nasdaq OMX - Stockholm	2016-09-29
62	TRANSMODE HOLDING AB	Nasdaq OMX - Stockholm	2011-05-27
63	WILSON THERAPEUTICS AB	Nasdaq OMX - Stockholm	2016-05-12
64	ZEALAND PHARMA A/S	Nasdaq OMX - Copenhagen	2010-11-23
65	BACTIGUARD HOLDING AB	Nasdaq OMX - Stockholm	2014-06-19
66	BESQAB AB	Nasdaq OMX - Stockholm	2014-06-12
67	CONSTI YHTIOT OYJ	Nasdaq OMX - Helsinki	2015-12-11
68	GARO AB	Nasdaq OMX - Stockholm	2016-03-16
69	ASETEK A/S	Oslo Bors	2013-03-20
70	ZALARIS ASA	Oslo Bors	2014-06-20
71	NP3 FASTIGHETER AB	Nasdaq OMX - Stockholm	2014-12-04
72	HAVYARD GROUP ASA	Oslo Bors	2014-07-01
73	EVLI PANKKI OYJ	Nasdaq OMX - Helsinki	2015-12-02
74	SIILI SOLUTIONS OYJ	Nasdaq OMX - Helsinki	2016-04-20
75	RAK PETROLEUM PLC	Oslo Bors	2014-11-07
76	BOULE DIAGNOSTICS AB	Nasdaq OMX - Stockholm	2011-06-23
77	SCANFIL OYJ	Nasdaq OMX - Helsinki	2012-01-02
78	SPORTAMORE AB	Nasdaq OMX - Stockholm	2015-05-18
79	ATTENDO AB	Nasdaq OMX - Stockholm	2015-11-30
80	SCANDINAVIAN TOBACCO GROUP A/S	Nasdaq OMX - Copenhagen	2016-02-10

Appendix B. Tests for OLS assumptions

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CAR	.0606	80	.200*	.9910	80	.8562

*. This is a lower bound of the true significance.

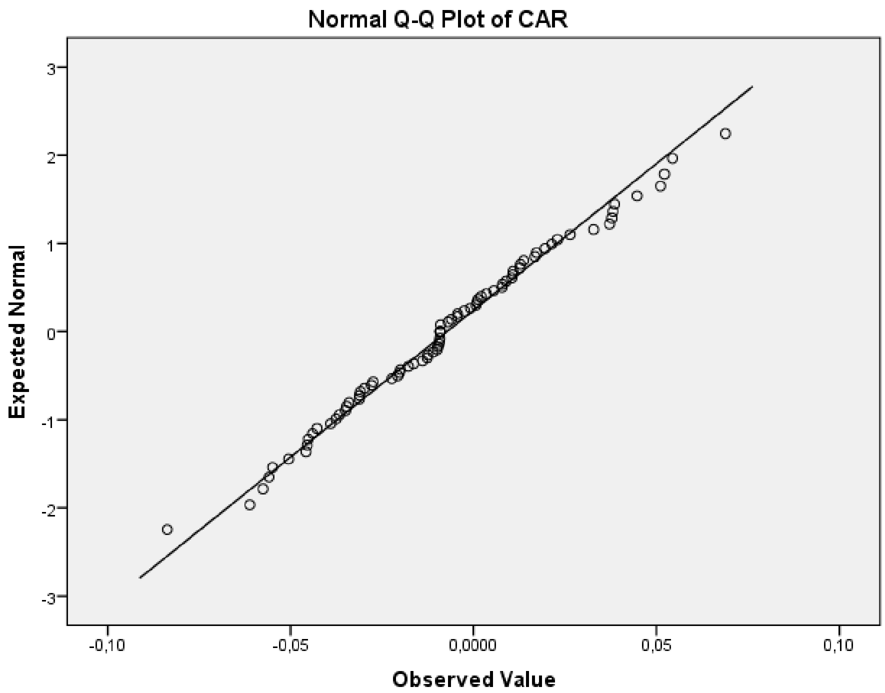
a. Lilliefors Significance Correction

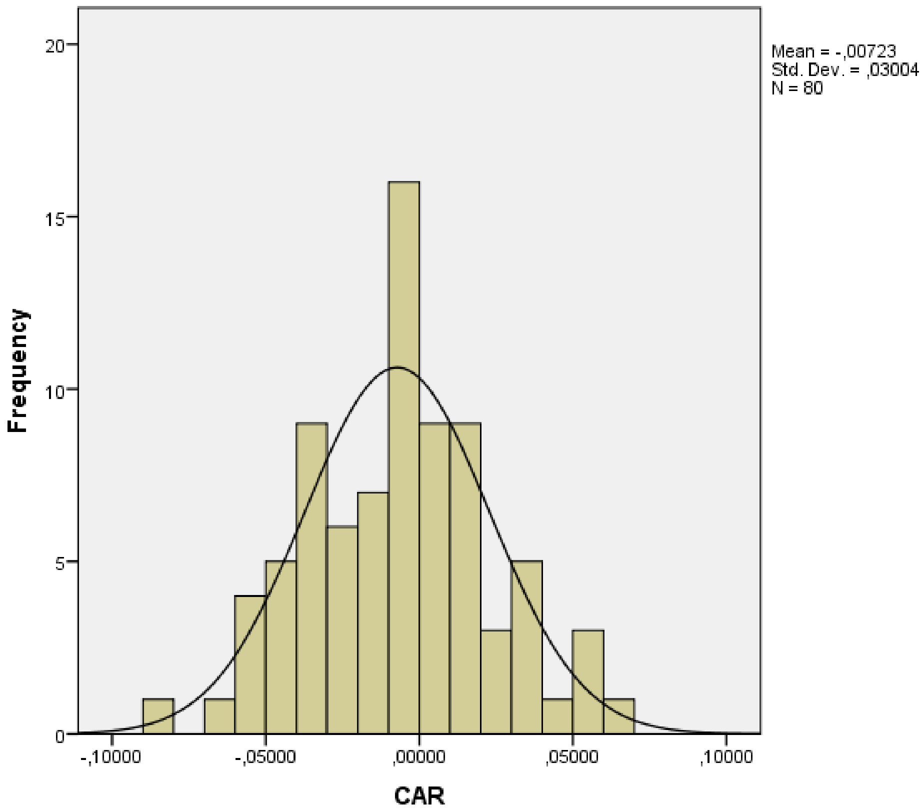
Tests of Heteroskedasticity

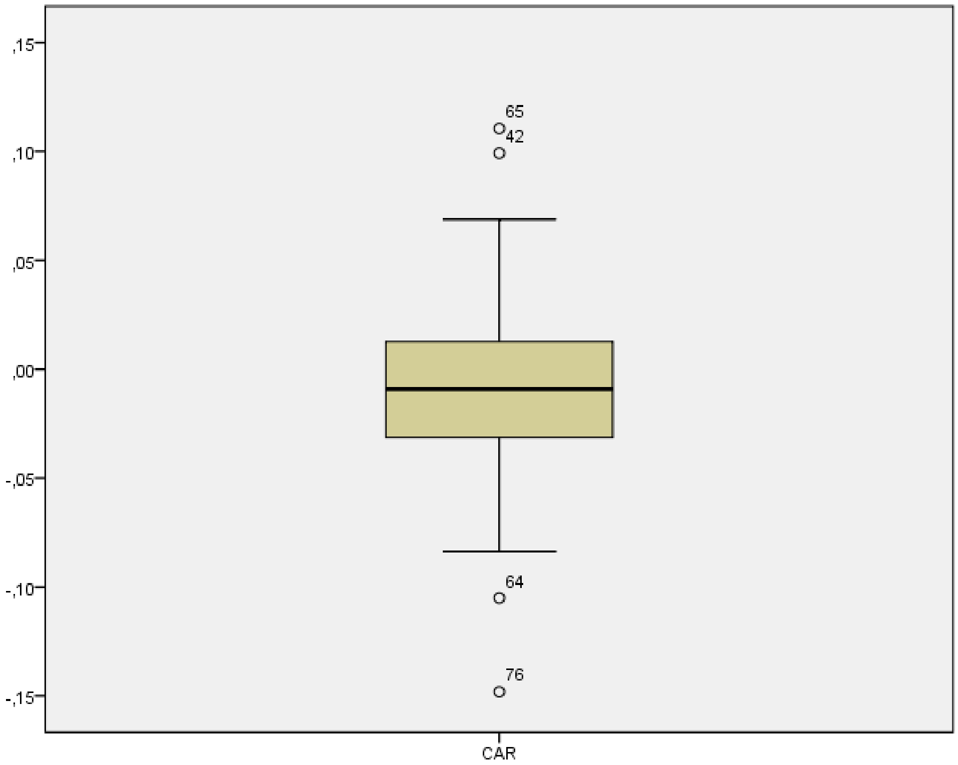
	LM	Sig.*
Breusch-Pagan	2.8100	.5900
Koenker	2.9770	.5620

*Null hypothesis: heteroskedasticity not present (homoskedasticity)

*if sig-value less than 0.05, reject the null hypothesis

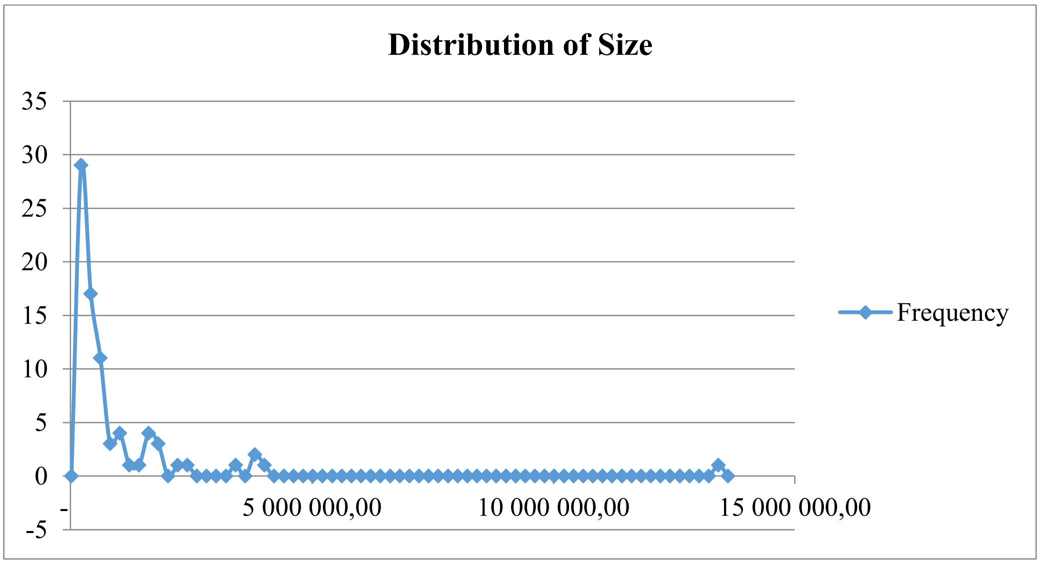

Normal Q-Q Plot of CAR
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
-0,10
-0,05
0,0000
0,05
0,10

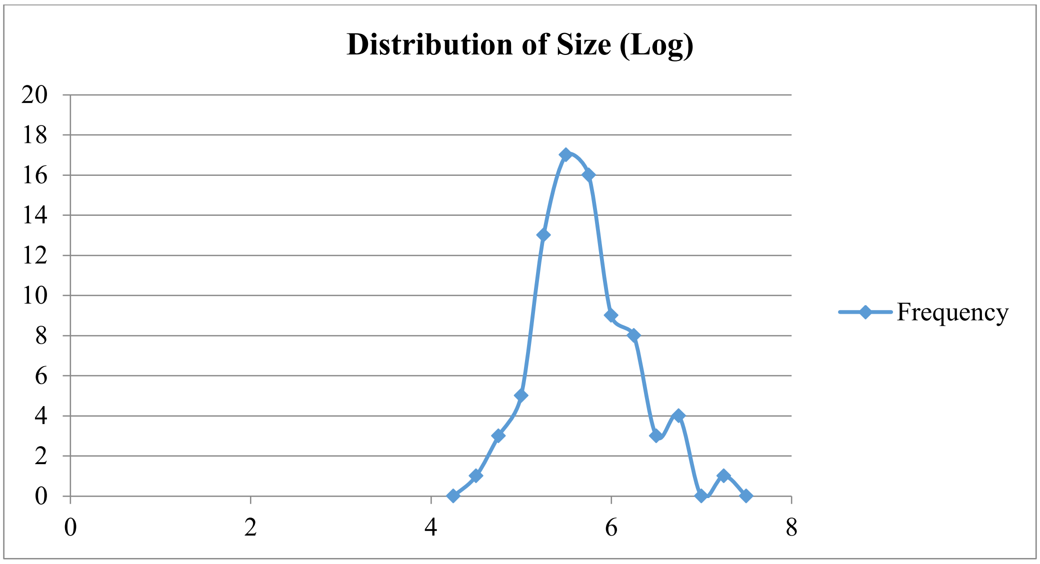

Mean = -,00723
Std. Dev. = ,03004
N = 80
Frequency
CAR
20
15
10
5
0
-,10000
-,05000
,00000
,05000
,10000



Descriptive analysis, boxplot with outliers. Observations 65, 42, 64 and 76 have been replaced with the sample median (-0,0091).

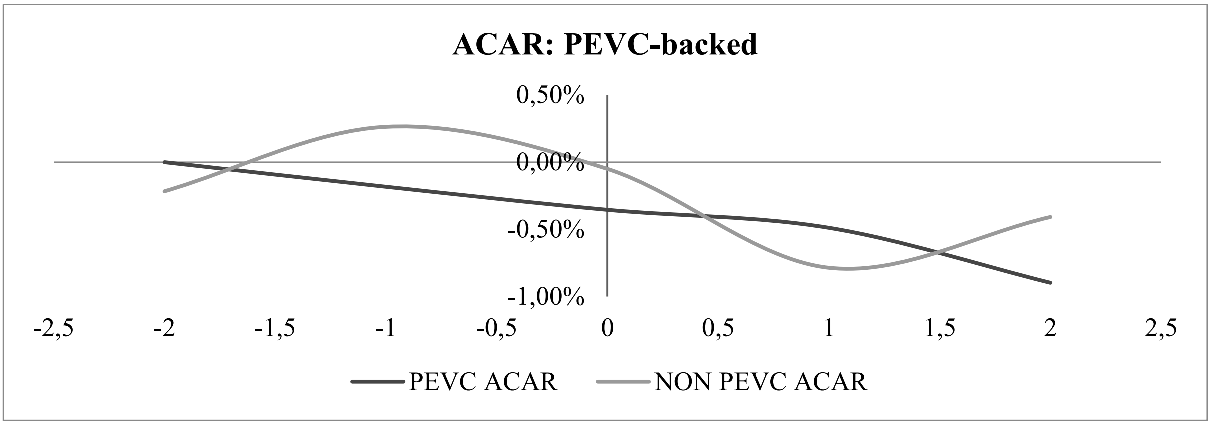
Appendix C. Pre and post logharitmized size variable

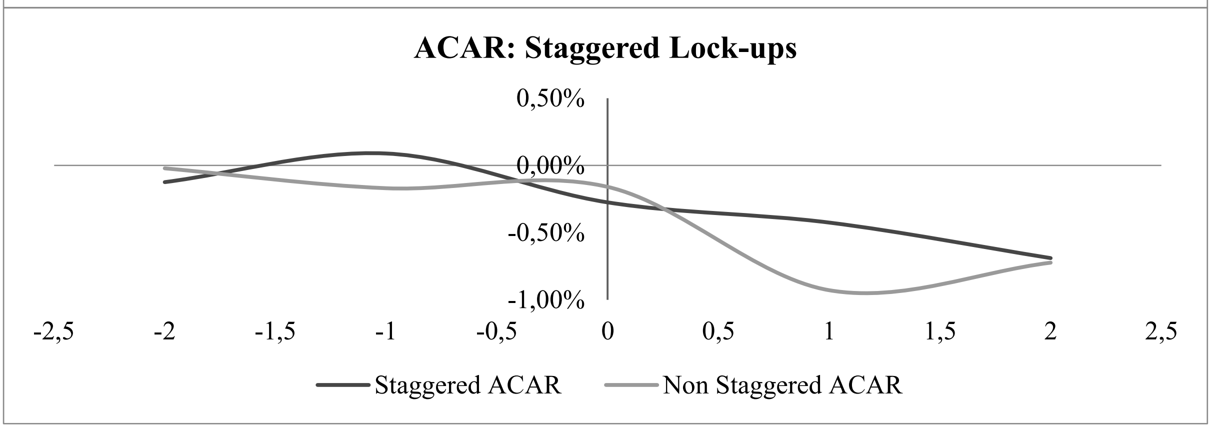


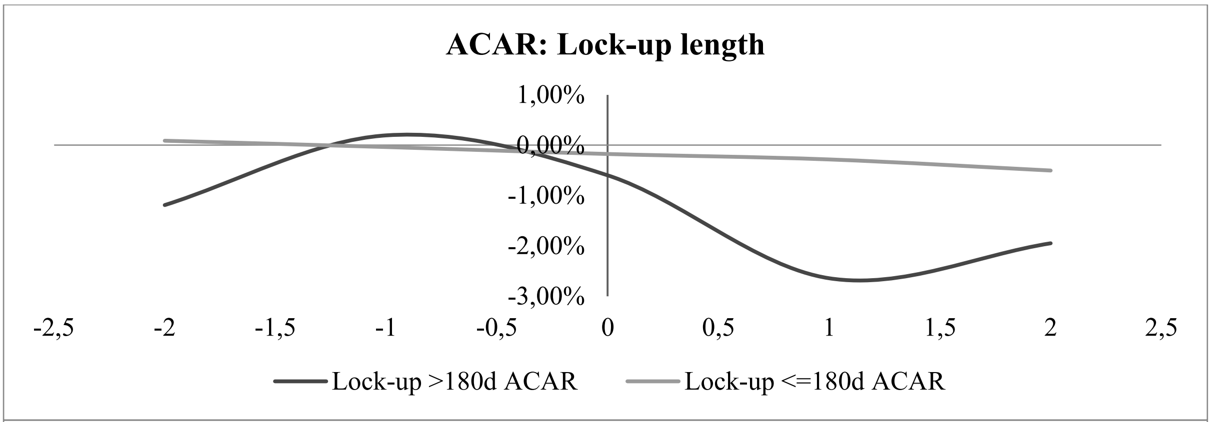


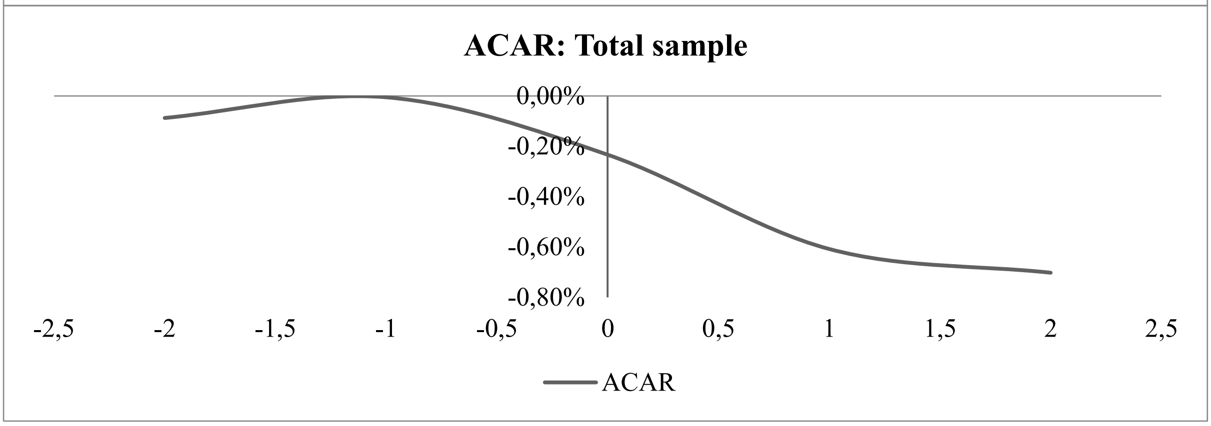
Pre log		Post log	
Kurtosis	Skewness	Kurtosis	Skewness
40.66278486	5.74375977	0.211688053	0.406338739

Appendix D. ACAR Scatter plot diagrams









The Y-axes are displaying ACAR in% while the X-axes are showing the days around the lock-up expiration (the event-day)

Appendix E. Multiple regression analysis, model 1 (main regression)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.360[a]	.1297	-.0577	.0309	1.9721

a. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Length >180d, Helsinki, Y2016, Copenhagen, Staggered, Stockholm
b. Dependent Variable: CAR

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.0092	14.0000	.0007	.6922	.774[b]
	Residual	.0620	65.0000	.0010		
	Total	.0713	79.0000			

a. Dependent Variable: CAR

b. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Length >180d, Helsinki, Y2016, Copenhagen, Staggered, Stockholm

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.0795	.0557		1.4265	.1585					
	PEVC	-.0004	.0091	-.0061	-.0411	.9674	-.0113	-.0051	-.0048	.5993	1.6687
	Staggered	.0014	.0129	.0232	.1123	.9109	-.0543	.0139	.0130	.3127	3.1983
	Length >180d	-.0031	.0121	-.0354	-.2527	.8013	.0085	-.0313	-.0292	.6819	1.4666
	Size (log)	-.0132	.0087	-.2268	-1.5208	.1332	-.1599	-.1854	-.1760	.6020	1.6610
	Y2010	.0247	.0153	.2483	1.6155	.1111	.0914	.1965	.1869	.5668	1.7644
	Y2011	-.0008	.0184	-.0060	-.0445	.9646	.0289	-.0055	-.0051	.7404	1.3505
	Y2012	-.0126	.0252	-.0659	-.4994	.6192	-.1029	-.0618	-.0578	.7688	1.3007
	Y2013	.0344	.0185	.2511	1.8581	.0677	.1771	.2246	.2150	.7333	1.3637
	Y2015	.0088	.0103	.1375	.8505	.3982	-.0038	.1049	.0984	.5119	1.9536
	Y2016	.0157	.0117	.2056	1.3397	.1850	.0593	.1639	.1550	.5687	1.7585
	Stockholm	-.0209	.0249	-.3501	-.8379	.4051	.0005	-.1034	-.0970	.0767	13.0396
	Copenhagen	-.0278	.0271	-.3441	-1.0288	.3074	-.0098	-.1266	-.1190	.1197	8.3571
	Helsinki	-.0269	.0282	-.2704	-.9534	.3439	.0110	-.1174	-.1103	.1664	6.0096
	Oslo	-.0257	.0265	-.3525	-.9722	.3346	-.0264	-.1197	-.1125	.1018	9.8215

a. Dependent Variable: CAR

Appendix F. Multiple regression analysis, model 2 (without Staggered)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
2	.360[a]	.1296	-.0419	.0307	1.9711

a. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Length >180d, Helsinki, Y2016, Copenhagen, Stockholm
b. Dependent Variable: CAR

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	.0092	13.0000	.0007	.7558	.702[b]
	Residual	.0621	66.0000	.0009		
	Total	.0713	79.0000			

a. Dependent Variable: CAR

b. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Length >180d, Helsinki, Y2016, Copenhagen, Stockholm

Coefficients[a]

Model		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
2	(Constant)	.0784	.0545		1.4394	.1548					
	PEVC	.0002	.0076	.0030	.0238	.9811	-.0113	.0029	.0027	.8492	1.1776
	Length >180d	-.0036	.0111	-.0414	-.3226	.7480	.0085	-.0397	-.0370	.7993	1.2512
	Size (log)	-.0130	.0084	-.2234	-1.5413	.1280	-.1599	-.1864	-.1770	.6278	1.5929
	Y2010	.0240	.0137	.2409	1.7458	.0855	.0914	.2101	.2005	.6924	1.4443
	Y2011	-.0008	.0183	-.0062	-.0462	.9633	.0289	-.0057	-.0053	.7406	1.3503
	Y2012	-.0134	.0240	-.0702	-.5595	.5777	-.1029	-.0687	-.0643	.8385	1.1927
	Y2013	.0340	.0181	.2484	1.8819	.0643	.1771	.2257	.2161	.7572	1.3207
	Y2015	.0092	.0094	.1446	.9785	.3314	-.0038	.1196	.1124	.6037	1.6566
	Y2016	.0161	.0110	.2111	1.4628	.1483	.0593	.1772	.1680	.6335	1.5785
	Stockholm	-.0205	.0244	-.3426	-.8370	.4056	.0005	-.1025	-.0961	.0787	12.7020
	Copenhagen	-.0273	.0265	-.3376	-1.0327	.3055	-.0098	-.1261	-.1186	.1234	8.1019
	Helsinki	-.0265	.0278	-.2663	-.9540	.3436	.0110	-.1166	-.1096	.1692	5.9100
	Oslo	-.0249	.0252	-.3410	-.9878	.3269	-.0264	-.1207	-.1134	.1106	9.0381

a. Dependent Variable: CAR

Appendix G. Multiple regression analysis, model 3 (without Staggered and Length)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
3	.358[a]	.1282	-.0279	.0305	1.9869

a. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Helsinki, Y2016, Copenhagen, Stockholm

b. Dependent Variable: CAR

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	.0091	12.0000	.0008	.8211	.628[b]
	Residual	.0622	67.0000	.0009		
	Total	.0713	79.0000			

a. Dependent Variable: CAR

b. Predictors: (Constant), Oslo, Size (log), Y2015, Y2012, Y2013, PEVC, Y2010, Y2011, Helsinki, Y2016, Copenhagen, Stockholm

Coefficients[a]

Model	B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
	Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	

3	(Constant)	.0729	.0514		1.4187	.1606					
	PEVC	.0006	.0074	.0101	.0827	.9344	-.0113	.0101	.0094	.8766	1.1408
	Size (log)	-.0120	.0078	-.2067	-1.5369	.1290	-.1599	-.1845	-.1753	.7191	1.3905
	Y2010	.0241	.0136	.2421	1.7663	.0819	.0914	.2109	.2015	.6928	1.4434
	Y2011	-.0006	.0181	-.0046	-.0349	.9722	.0289	-.0043	-.0040	.7415	1.3486
	Y2012	-.0125	.0236	-.0651	-.5270	.5999	-.1029	-.0642	-.0601	.8516	1.1742
	Y2013	.0348	.0178	.2542	1.9573	.0545	.1771	.2326	.2233	.7715	1.2962
	Y2015	.0094	.0093	.1478	1.0093	.3164	-.0038	.1224	.1151	.6064	1.6490
	Y2016	.0162	.0110	.2117	1.4774	.1443	.0593	.1776	.1685	.6336	1.5782
	Stockholm	-.0214	.0241	-.3576	-.8854	.3791	.0005	-.1075	-.1010	.0798	12.5369
	Copenhagen	-.0284	.0261	-.3506	-1.0884	.2803	-.0098	-.1318	-.1241	.1254	7.9772
	Helsinki	-.0270	.0276	-.2709	-.9781	.3316	.0110	-.1186	-.1116	.1696	5.8950
	Oslo	-.0256	.0249	-.3511	-1.0281	.3076	-.0264	-.1246	-.1173	.1116	8.9638

a. Dependent Variable: CAR

Appendix H. Univariate subsample tests

CAR – PEVC

Group Statistics

PEVC		N	Mean	Std. Deviation	Std. Error Mean
CAR	1.00	48	-.0075	.0322	.0046
	.00	32	-.0068	.0270	.0048

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CAR	Equal variances assumed	2.2607	.1367	-.0995	78.0000	.9210	-.0007	.0069	-.0144	.0130
	Equal variances not assumed			-.1030	73.8188	.9182	-.0007	.0067	-.0140	.0126

CAR – Lock-up Length

Group Statistics

Length >180d		N	Mean	Std. Deviation	Std. Error Mean
CAR	1.00	11	-.0066	.0352	.0106
	.00	69	-.0073	.0294	.0035

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CAR	Equal variances assumed	.5336	.4673	.0748	78.0000	.9405	.0007	.0098	-.0188	.0203
	Equal variances not assumed			.0656	12.3314	.9487	.0007	.0112	-.0236	.0250

CAR – Staggered

Group Statistics

Staggered		N	Mean	Std. Deviation	Std. Error Mean
CAR	1.00	51	-.0085	.0307	.0043
	,00	29	-.0051	.0292	.0054

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CAR	Equal variances assumed	.3264	.5694	-.4805	78.0000	.6322	-.0034	.0070	-.0174	.0106
	Equal variances not assumed			-.4875	60.8907	.6277	-.0034	.0069	-.0172	.0105