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The performance of Nordic private equity-backed IPOs

An empirical study on underpricing and aftermarket abnormal returns

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ABSTRACT

Using a sample of 267 Nordic IPOs, consisting of 62 private equity-backed issues and 205 non-sponsored issues between January 2001 and May 2017, we investigate the level of underpricing and aftermarket abnormal returns for all IPOs and the two subgroups. We test the level of underpricing by regression, on an equally-weighted and value-weighted basis, with five explanatory variables. We employ two abnormal return metrics, cumulative abnormal returns and buy-and-hold abnormal returns, over a 36-month event window to test the aftermarket performance. In addition, we test for differences between private equity-backed IPOs and non-sponsored IPOs. Our results indicate that the level of underpricing can be explained by the market capitalization of the IPO, and to some degree by the number of days between the announcement date and trading date, the percentage of shares kept by the pre-IPO owners and level of IPO market activity during the time of the IPO. We find that the entire sample, and non-sponsored issues as a subgroup, have statistically significant positive aftermarket cumulative and buy-and-hold abnormal returns on a value-weighted basis, but not on an equally-weighted basis for any group. Finally, we find no support for differences in underpricing or aftermarket abnormal return between private equity-backed issues and non-sponsored issues.

Keywords: Nordic private equity-backed IPOs, underpricing, long-run abnormal returns
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1. Introduction

1.1 Background

Private equity (PE) is an asset class that is generally defined as investing in non-public companies. The conventional investment strategy of PE firms is to use a high proportion of debt to reduce the initial equity share in the purchase of companies, which potentially leads to higher returns through leverage. This strategy has paved the way for the term leveraged buyout, which has become the defining operating procedure for PE firms. PE firms can either be generalists, meaning that they invest in all industries, or specialists who invest in a particular sector, e.g. Technology or Healthcare. Another way for PE firms to differentiate themselves is by focusing on specific geographical areas or by investing in different stages of a company's life cycle.

How PE firms increase the value of their investments is explained primarily by three alternatives. Valuations of the companies are often based on multiples of profit (e.g. EBITDA) as a metric, and by increasing the profit through higher sales or margins, PE firms can increase the equity value of the company. Positive changes in the multiple applied to the profit also increases the value of the company, ceteris paribus. Finally, free cash flow generation is the third way to increase value, as it can be used to deleverage the company or pay dividends to shareholders.

To maximize the value when assessing an investment opportunity, it is important that the PE firms reflect upon potential exit strategies. There are three exit strategies that are common in the PE industry:

1. The PE firm can sell its portfolio company to a non-sponsored (NS) backed firm, usually within the same industry as the portfolio company, which is referred to as a strategic or trade sale. Because of the potential synergies for the acquirer, it is common for them to pay a premium for the acquisition.
2. They can also sell the portfolio company to another PE firm, which is known as a secondary buyout. This is common when smaller PE firms sell to larger one, since the larger PE firms believe they can further develop the company through its next stages.
3. Lastly, the PE firm can exit their investment through an initial public offering (IPO). An IPO is often associated with high transaction costs, regulation, scrutiny and a lock-up period which prohibits the financial sponsor from exiting its position for a certain

amount of time. This exit strategy will be the focus of the paper as there is a multitude of available data and prior studies to compare with.

While there is widespread criticism of both IPOs in general and PE-backed ones, there is conclusive evidence that the former underperforms in the aftermarket, while the latter offerings seem to outperform both in the US and in Europe (Degeorge & Zeckhauser, 1993; Holthausen & Larcker, 1996; Cao & Lerner, 2009; Levis 2011). Similarly, Mogilevsky and Murgulov (2012) find that PE-backed IPOs experience lower levels of underpricing than NS-backed ones in the US. It is primarily by providing funding, improving the governance structure and increasing operating efficiency in which PE firms add value. By leveraging acquired knowledge from previous investments, the backers can provide strategic as well as operative guidance within their industries of expertise, and consequently outperform non-sponsored (NS) firms (Kaplan & Strömberg, 2009).

By studying previous literature on the topic of PE-backed IPOs, we note that US-focused studies outnumber their European counterparts, including the Nordic region. Therefore, the paper will focus on the Nordic markets and aims to measure the relative performance of PE-backed firms to NS-backed firms on the issuing day, and a three-year period following the IPO, to investigate whether PE-backed firms add value to public investors. With this in mind, the research question of the paper is: *How do Nordic IPOs perform and does the performance differ between the subgroups PE and NS?* The research question is of value since it provides further insight into the Nordic equity capital markets, the private equity industry, and the expectations of public investors on IPOs. Furthermore, we extend previously used conventional regression models on the level of underpricing in the Nordic region, by adding a variable that measures the days between the announcement date and trading date. As PE-backed IPOs have surged in the last few years, we also add a larger unstudied dataset, which could lead to new results as the phenomenon of PE-backed IPOs is relatively new in the Nordic markets. Secondly, our paper acts a point of reference for future studies to include new quantitative and qualitative elements, such as operating performance and relationships with underwriters and other stakeholders.

The methodology used in the paper can be divided into six steps:

1. We collected the data for all Nordic IPOs on the NASDAQ OMX Stockholm, Copenhagen and Helsinki (including First North markets), Nordic Growth Market and

Oslo Stock Exchange between January 2001 and May 2017. This was 267 IPOs, of which 62 were PE-backed.

2. We then classified each listing as either PE-backed or NS-backed.
3. We investigated the levels of underpricing and aftermarket abnormal returns using several different methods and metrics to strengthen the validity of our results and provide comparability with previous studies.
4. The cumulative abnormal returns (CARs) and buy-and-hold abnormal returns (BHARs) are calculated for a 36-month event window, following one month after the IPO to exclude the effect of underpricing on the aftermarket return.
5. We use the MSCI country indices (Sweden, Denmark, Finland and Norway) to calculate the abnormal returns, as our sample size restricts the usefulness of a self-constructed portfolio of matching firms.
6. We analyze and compare the results with prior studies and test for robustness and differences within the subgroups.

Our findings reveal that the IPOs in the sample, in total and by subgroup, are on average underpriced. Similarly, the results show that the market capitalization has a positive effect on the level of underpricing, and we find some support that the number of days between announcing and trading, the level of IPO market activity and retained ownership share by the pre-IPO owners also influence the level of underpricing. Regarding the effect of an active equity market on the level of underpricing, our findings show that firms are underpriced during high activity periods, but there is no support for underpricing levels different from zero during low periods. This lends some evidence to the hot issue market theory (Ibbotson and Jaffe, 1975; Ritter, 1984), in that firms are more likely to have higher levels of underpricing when the market is hot. Additionally, we find no support for a difference between PE-backed and NS-backed IPOs in terms of underpricing. Therefore, we find no support for the certification theory (Megginson & Weiss, 1991) or the market power theory (Chemmanur & Loutskina, 2006), as they would predict otherwise.

Furthermore, our results support that Nordic IPOs, and NS-backed IPOs, exhibit positive abnormal aftermarket returns on a value-weighted basis, but not that PE-backed IPOs differ from NS-backed IPOs in the aftermarket. Similarly, the findings do not support that the aftermarket returns differ from zero on an equally-weighted basis for any group or return metric. This contradicts the results of previous studies on PE-backed IPOs, and we present

some theories as to why and suggestions for future research (Degeorge & Zeckhauser, 1993; Holthausen & Larcker, 1996; Cao & Lerner, 2009; Levis 2011).

1.2 Delimitations

The paper will not investigate the sources of any relative out- or underperformance that is the result of PE-backing (e.g. if PE-backed firms have better or worse operating performance), but only if the existence of PE-backing leads to any difference. The literature explaining PE-backed firms' potential value creation is vast and the most prevalent explanations are (1) increased leverage, which creates a tax shield, (2) the debt reduces the agency cost of free cash flow by disciplining managers, (3) better corporate governance and efficient monitoring of managers and/or employees, and (4) improved incentive programs that are aligned with shareholder (sponsor) interests (Jensen, 1989a; Jensen, 1989b).

Additionally, only IPOs from the Nordic countries: Sweden, Finland, Norway and Denmark between the January 2001 and May 2017 are included in our sample. The underlying reason is testing whether results that have been found in US and wider European markets apply to our selected sample. We decided to use the selected time period to include a sizeable sample of PE-backed IPOs, and IPOs during both booms and busts.

An IPO is also only considered if it is the first time the company is listed, and if it is on one of the following Nordic exchanges: NASDAQ OMX Stockholm, Copenhagen and Helsinki (including First North markets), Nordic Growth Market or Oslo Stock Exchange. It must be an "original IPO", which means the firm has not been public before and did not move to the stock exchange from another exchange. The reasoning is that there is less information asymmetry if the company has previously been listed and both the offer price and share development should more accurately reflect intrinsic value as compared to a first-time listed company.

Furthermore, the paper will not study IPOs backed by venture capital funds (VC). VC firms differ in their strategy, holding period, expectations, size of ownership stakes and maturity of portfolio companies and we argue that they are not interchangeable terms and strictly different from one another (Kaplan & Strömberg, 2009).

1.3 Disposition

The remainder of the paper is organized by institutional background, empirical strategy, data, results and analysis, and conclusion.

Institutional background: This chapter will present the prior literature and theories on underpricing and long-run performance of IPOs in general, and PE-backed ones. Furthermore, we present some of our hypotheses in this section.

Data and empirical strategy: This chapter will describe the collection of data, the selected variables, the statistical tests and a brief overview of the IPO distribution. Furthermore, we present the methodology chosen for our study based on previous literature and data availability, as well as a critical reflection of potential biases and limitations in our study.

Results and analysis: This chapter presents the results from the collected data, the regression models, and the statistical tests used. We also analyze the results based on theories and previous research that have been presented in our study, and suggest further research for unanswered questions.

Conclusion: This chapter concludes the study by providing a summary, discussion and critical reflection of the results. Additionally, we present the stated null hypotheses and the support for rejecting them.

2. Institutional background

In this chapter, we first cover the general previous literature on IPOs in both the Nordic and foreign markets. Thereafter, we present the studies on PE-backed IPOs and theories that have been used to explain the results of those studies. We also present some of our hypotheses.

2.1 Previous literature

Studies on the subject of underpricing are in consensus that firms are initially underpriced at the time of the IPO, with Ritter (1984) finding an average underpricing level of 19% between the years 1960 and 1982. In addition to this, underpricing has been shown to exist on markets worldwide but the level of underpricing varies by country (Ritter, 1998). Loughran and Ritter (2004) also showed changing levels of underpricing throughout the years of 1980 and 2003. Recent studies by Jenkinson and Ljungqvist (2001), Schöber (2008), and Cao and Lerner (2009) had underpricing levels of 15-18%, 9.9% and 12.9%, respectively, indicating that underpricing levels are going down over time. The IPO market activity may also influence the levels of underpricing, as put forward by Ibbotson and Jaffe (1975) and Ritter (1984), in their hot issue market theory, which states that firms which become public during periods of high IPO activity will have higher levels of underpricing.

Literature on IPO aftermarket performance is abundantly focused on the US market, and there seems to be consensus that going public has a negative effect on firm performance. Ritter (1991) found that IPO firms showed a 29% abnormal underperformance, with an industry and size-adjusted benchmark, and Loughran and Ritter (1995) found an underperformance of 30%. Studies on European markets have a similar attitude toward IPOs, in that they tend to underperform in terms of share price development or operating performance. Firms that were listed underperformed relative to market indices in four studies for different European markets (Levis, 1993; Espenlaub et al., 2000; Schuster, 2003; Goergen et al., 2007).

Expectedly, the performance of IPOs in the Nordic markets is of interest to the paper. In 2003, Schuster found that 72% of Swedish IPOs underperformed the market after three years, and the average return was -12.7% over three years, while Loughran et al. (1994) found that Swedish IPOs outperformed the benchmark by 1.2%, between 1980 and 1990. Furthermore, Keloharju (1993) and Jenkinson and Ljungqvist (2001) found that IPOs underperformed on the Finnish market. The results are highly sensitive to delimitations and the form of comparative benchmark used however, as argued by Espenlaub et al. (2000). Although there is an established pattern of IPO underperformance internationally, most studies do not differentiate between the backers of the IPO, which will be further elaborated below. Finally, our conservative null hypothesis states that:

H_1: Nordic IPOs do not exhibit abnormal aftermarket returns.

2.1.1 The performance of PE-backed IPOs

The effect that sponsor-backing has on IPOs has been investigated to a large degree in the financial literature, and the main studies have been made on the US market and are usually focused on VC-backed companies.

There are different theories as to the role a sponsor plays in the backing of an IPO. For example, Barry et al. (1990) argue that PE funds reduce ex ante uncertainty by acting as a filter through screening and monitoring firms. They may see hundreds of different opportunities per year and end up with one purchase, effectively screening the companies of highest quality as compared to NS-backed firms. Additionally, sponsors have access to large networks, can monitor the board of directors and take an active role in the governance of the company. Levis (2011) argues that financial sponsors could create value by installing better management teams in sponsor-backed companies as compared to NS-backed companies.

PE firms are also usually subject to a lock-up period following an IPO, restricting them from completely exiting their position for a limited time (usually a six to twelve-month period), hence guaranteeing continued monitoring after listing their portfolio company. This assures potential investors that the owners are not looking to offload a bad company, as there is a stricter requirement for transparency for a public company. Levis (2011) notes that financial sponsors often retain a large ownership share after listing their portfolio company, either as an active strategy or through the aforementioned lock-up clauses. As such, one could expect the sponsors to monitor the company better than the public market. However, research has shown that the share price tends to fall between two to three percent when the lock-up period ends, due to the high inflow of shares (Brav & Gompers, 2003). This is the "market overhang" effect, which exerts downward pressure on the share price as the market realizes that the PE firm is highly probable to exit their position, which would flood the market with shares and lead to an oversupply.

The certification role that financial sponsors play is studied by Megginson and Weiss (1991), which states that they repeatedly introduce companies to the public market and the offer price should be based on all inside information, therefore accurately reflecting the intrinsic value of the company and reducing any underpricing. A PE firm would therefore effectively have certified the firm and the price for the investors' sake already. The certification theory has been tested by other researchers with mixed results however, both across different time periods, markets and sponsor types (Francis & Hasan, 2001, and Lee & Wahal, 2004 in the United States; Schertler, 2002 and Franzke, 2004, in France and Germany; da Silva Rosa et al. 2003 in Australia; Levis, 2011 and Coakley et al. 2009 in the United Kingdom; Ferretti & Meles, 2011 in Italy).

The analysis of underpricing and the cost of going public is commonplace in both research and the debate of sponsors' roles in IPOs. It has been argued that it may be an inappropriate variable for assessing the effect that sponsor-backing has on IPOs, as the market price can deviate from the intrinsic value (Chemmanur & Loutskina, 2006). The certification hypothesis is rejected in favor of the market power theory, which states that sponsors with long term relationships with key actors in the IPO market (sell-side analysts, underwriters, institutional investors) can positively affect the participation in the IPOs of their own portfolio companies, and therefore drive up prices by increasing demand. This was tested by Chemmanur and Loutskina (2006) through measuring the fair value of each floatation in their sample, and they assessed that sponsor-backed IPOs were (more) overvalued than NS-backed IPOs, both in

regards to the offer price and first day closing price. This effect dissipated over time however, as prices more accurately reflected intrinsic values. Furthermore, Levis (2011) and Mogilevsky and Murgulov (2012) found that PE-backed IPOs experience lower levels of underpricing than NS-backed ones. Subsequently, we state the conservative null hypotheses below:

H_2: Nordic IPOs do not exhibit any underpricing.

H_3: Nordic PE-backed IPOs do not differ from NS-backed IPOs in terms of underpricing.

Degeorge and Zeckhauser (1993), and Holthausen and Larcker (1996) found no evidence of market underperformance for PE-backed IPOs, with the abnormal returns being positive but statistically insignificant. Cao and Lerner (2009) found that PE-backed IPOs outperformed NS-backed IPOs between 1980 and 2002, for various benchmarks. Levis (2011) found that PE-backed IPOs outperformed NS-backed IPOs in the UK between 1992 and 2005, while showing statistically significant positive abnormal returns compared to index benchmarks. Bergström et al. (2006) also found that European PE-backed IPOs outperformed non-backed IPOs in the long term, as did van Frederikslust and van der Geest (2001) for a sample of firms in the Netherlands.

Although there is no conclusive evidence of the direction that PE-backing has on long-term performance, it seems to indicate that the market is not able to incorporate fully the expectations of relative performance that PE-backing will have in the first-day closing price, and it is therefore of interest to study the aftermarket performance. We state the conservative null hypothesis based on the subgroups below:

H_4: Nordic PE-backed IPOs do not differ from NS-backed IPOs in terms of abnormal aftermarket returns.

We decided to use an event window of three years, similarly to other studies conducted on long-run IPO performance (Ritter, 1991; Loughran et al., 1994; Loughran & Ritter, 1995; Brav & Gompers, 1997). As there is no generally accepted practice of measuring long-run returns, we decided to use a variety of different methods to certify that our results are both comparable and accurate (Schöber, 2008).

3. Empirical strategy

In this section, we first present our empirical strategy on underpricing based on the previous literature in the prior section, and explain our choice of variables for the regressions and test statistics. Secondly, we present the empirical strategy on long-run abnormal performance of

the Nordic IPOs, in regards to our chosen abnormal return metrics and weighing method, as well as the test statistics used and potential biases.

3.1 Underpricing

3.1.1 Regression variables

Underpricing is calculated in a standardized way, which is shown below:

$$r_i = \frac{P_{i,t}^C - P_{i,t}^O}{P_{i,t}^O}$$

where r_i is the first-day return of the firm *i*, and $P_{i,t}^O$ is the offering price of firm *i* on the day *t* and $P_{i,t}^C$is the closing price on day *t*.

The level of underpricing is equally-weighted and value-weighted for all IPOs and the respective subgroups, PE and NS. The market capitalization has been converted into Euros for both the underpricing and long-run sample, as to have a common currency. Furthermore, the market capitalization has been GDP-deflated, with a base year of 2010, with the level of GDP-deflation depending on the country where the firm is listed in.

$$r_i^w = \sum_{i=1}^{N} w_i * r_i \begin{cases} w_i = \frac{1}{N} \text{ (equally weighted)} \\ w_i = \frac{Mcap_i}{\sum_i^N Mcap_i} \text{ (value weighted)} \end{cases}$$

where r_i^w is the weighted level of underpricing for *N* IPOs, w_i is the weight of the firm *i*, N is the sample size and $Mcap_i$ is the GDP-deflated market capitalization in Euros.

In addition to this, we have chosen five independent variables in regressing the level of underpricing, of which two are dummy variables. These are the GDP-deflated market capitalization, in Euros, of the firm at the time of the IPO, the percentage of ownership by the pre-IPO owners after listing, the days between announcing the IPO and the trading date, the owners of the firm pre-IPO (dummy variable for PE) and the level of IPO market activity (dummy variable) at the time of the IPO. The variables are further defined below.

$$UP_i = \beta_0 + \beta_1(LN\_MCAP_i) + \beta_2(RETAINED_i) + \beta_3(DAYS\_BEFORE\_TRADING_i) + \beta_4(PE\_BACKED_i) + \beta_5(IPO\_ACTIVITY_i) + \varepsilon_i$$

We also present another approach to the regression due to the existence of several outliers in our underpricing sample. The underpricing variable is winsorized (replacing values in the 1st and 99th percentile) and the regression is altered as such:

$$UP\_WIN_i = \beta_0 + \beta_1(LN\_MCAP_i) + \beta_2(RETAINED_i) + \beta_3(DAYS\_BEFORE\_TRADING_i) + \beta_4(PE\_BACKED_i) + \beta_5(IPO\_ACTIVITY_i) + \varepsilon_i$$

For both methods, we have regressed the equally-weighted underpricing and value-weighted underpricing portfolios.

The size of the firm – "LN_MCAP"

Beatty and Ritter (1986) argue that the greater the "ex ante" uncertainty is about the value of the company, the greater the expected underpricing is. Thus, the less information asymmetry there is, the lower the underpricing will be. Smaller firms are usually less diversified and should therefore carry more risk, as well as having less public information available for thorough analysis. They should therefore be underpriced at higher levels than larger firms. To control for this, we have included the natural logarithm of the GDP-deflated market capitalization in Euros at the time of the IPO. The natural logarithm is used as there are large absolute differences within the sample, with some extreme values, and using the logarithm reduces the influence of the extreme observations.

H_5: The market capitalization at the time of the IPO does not influence the level of underpricing.

1 – (the deal value divided by market capitalization) – "Retained"

This variable measures the percentage of shares held by the pre-IPO owners after listing. We expect there to be a positive relationship between the level of ownership and underpricing, as the previous shareholders stand to lose less from underpricing (as only the offered shares are being sold at a discount). A seller should therefore attempt to maximize their return by reducing the level of underpricing as their retained ownership stake is lower (Habib & Ljungqvist, 2001).

H_6: The level of retained ownership share by the pre-IPO owners after listing has a negative effect on the level of underpricing.

The number of days between announcing and trading – "DAYS_BEFORE_TRADING"

The variable is the number of days between the announcement date of the IPO and the actual trading date. We expect there to be a negative correlation as there should be less information asymmetry and more time for thorough analysis as the days increase between announcement and trading. We did not find any studies that looked at this variable on the Nordic IPO market

and believe that it can have a significant explanatory value. Thus, we state a conservative null hypothesis:

H_7: The number of days between the announcement date and trading date has no effect on the level of underpricing.

Pre-IPO owners of the firm (PE vs NS) – "PE_BACKING"

The dummy variable is included to account for differences in underpricing between the subgroups. We hypothesize, as stated in the institutional background, that PE-backed IPO firms will experience less underpricing compared to NS IPO firms due to better financial expertise, the prevalence of better companies that have been certified and better relationships with underwriters.

Level of IPO activity in the Nordic market (high vs medium/low) – "IPO_Activity"

This dummy variable is divided into two groups: high and medium/low, both of which are measures of the level of IPO activity in the Nordic market. It explains whether a specific year is a "high" or "medium/low" IPO year, by taking on a value of one if the number of IPOs for the year is above the 75th percentile for our sample. Consequently, it takes on a value of zero if the number is below the 75th percentile (classified as low if below the 25th and medium if between the two). We expect a positive relationship between the variable and the level of underpricing, as we believe firms are more likely to accept the increased cost of going public when many other firms are doing so as well. Furthermore, we believe the standard for being able to IPO a firm is lower during boom periods, which should lead to more uncertainty and information asymmetry. This is also in accordance with the hot issue market theory, as put forward by Ibbotson and Jaffe (1975) and Ritter (1984). Thus, we state a conservative null hypothesis below:

H_8: The level of IPO activity has no correlation with the level of underpricing.

3.1.2 Test statistics

We employ several different tests to statistically verify the results, and our hypotheses. The regression variables are tested in the main models as we establish coefficients, p-values and the statistical significance of each variable. Six different linear ordinary least squares regressions are used where all explanatory variables are included. Each regression has a unique dependent variable, as we have two dependent variables, both of which are equally-weighted and value-weighted. We also present the raw underpricing and adjusted underpricing.

Furthermore, we use two-sided Student's t-tests to test for differences in the average underpricing between the two subgroups, PE-backed and NS-backed IPOs, on an equally-weighted and value-weighted basis.

3.2 Long-run performance

In our study, we seek to present comparable and accurate results of the long-term performance of Nordic PE-backed IPOs between January 2001 and May 2017. We therefore decided to use a plethora of common methodologies rather than one specific way of measuring the long-term performance, as no methodology has yet been deemed a winner. Below, we have presented the common methodologies and the merit of each.

Generally, there are two approaches to analyzing the long-run price performance of a stock. There is the cumulative abnormal return (CAR) method as well as the buy-and-hold abnormal return (BHAR) method. These can be further examined from either an event-time or calendar-time perspective.

In our study, we look at the share price performance of the firms for a three-year (36 months) horizon. However, we wish to exclude the effect of underpricing from the long-run performance of the company, and have therefore decided to exclude the first month after listing. Subsequently, we measure the performance from the last trading day in the month following the IPO to the last trading day 36 months later.

3.3 Benchmark

A firm's return cannot in isolation tell much of the underlying performance, but must be measured relatively to either the market or peers. Consequently, using an appropriate benchmark is of utmost importance in measuring the long-run abnormal return. There are two types of conventional benchmarks used in previous research: equity indices and matching firms or portfolios of matching firms (Schöber, 2008).

The sample firms in our study are benchmarked against MSCI Sweden (MXSE), MSCI Denmark (MXDK), MSCI Finland (MXFI) and MSCI Norway (MXNO). A Swedish firm is matched against MSCI Sweden and so on. These were chosen as they include approximately 85% of the equity universe or free float-adjusted market capitalization in each respective country. Due to our sample size, we have decided against a benchmark based on matching firms as a reasonable matching procedure based on market capitalization, book-to-market ratio, beta and industry would be severely limited in sample size and data availability

for both the matching portfolio and our IPO samples (Ritter, 1991; Loughran & Ritter, 1995; Gompers & Lerner, 2003).

3.4 Time regime approach

The choice of time regime can be divided into the event time or calendar time approach (Schöber, 2008). Both methods have different merits and are discussed below.

Using an event-time approach, an event window is defined for each observation and the returns are calculated with respect to the chosen start date. Hence, each observation occurring within our selected time period (January 2001 to May 2017) and during the full event window of 36 months is included. Each IPO is considered and weighted in separation and the calendar dates become irrelevant. Thus, each firm is measured against the relative benchmark corresponding to the respective event window. It has been the most commonly used method in prior literature.

Some authors argue that the calendar time approach is superior for the measurement of long-run returns (Fama, 1998; Mitchell & Stafford, 2000; Schultz, 2003; Gompers & Lerner, 2003). It is suggested that the event time approach does not fully correct for cross-sectional correlations, which would exist if IPOs cluster around certain dates. It is further theorized that IPOs tend to cluster in times of high markets leading to overlapping returns. Therefore, an event-time approach would overstate the statistical significance of the returns. Schultz (2003) also stated that event-time analyses could indicate significant IPO underperformance, despite of situations where the expected abnormal return is zero.

In summary, the event time approach allows a comparison across different IPO dates, while the calendar time approach can be used to detect variation in abnormal returns across years (Bergström et al., 2006). In our paper, we have decided to only use the event time approach, as this is the most common method used in prior literature and our restricted sample size for PE-backed IPOs limits the usefulness of the calendar-time approach. We do not get a rolling portfolio for the entire time period with PE-backed IPOs, as there are gaps of at least 36 months between them for some years.

3.5 Abnormal return

Barber and Lyon (1997) note that there are two methods of calculating abnormal returns: the cumulative abnormal return (CAR) and buy-and-hold abnormal return (BHAR). The authors favor the latter approach on conceptual grounds, as it better captures investor experience. Although the topic has been debated among researchers, there is as of yet no universally

preferred method (Schöber, 2008). BHARs are generally more skewed due to the possibility of extreme results through compounding (Kothari & Warner, 1997) and the distributional property of CARs is better understood, which enables more reliable statistical tests for abnormality (Schöber, 2008). It is even stated that the choice of metric can influence the power of statistical tests as well as the extent of abnormal performance, which could lead to differing conclusions (Brav et al., 2000). Most studies utilize one of the methods or both, which we have chosen to do as well for comparability and completeness (Bergström et al., 2006)

The returns following an IPO and the respective benchmark is calculated through monthly total returns. A total return index better represents an investor's experience when buying a stock, as compared to stock prices, which is why we have chosen to use it to calculate the monthly returns. A firm that is delisted during an event window has a shorter time horizon, which we account for by including the corresponding abnormal return on the last monthly observation prior to the delisting (Ritter, 1991; Brav & Gompers, 1997). The calculations are performed as follows:

$$R_{i,t} = \frac{TR_{i,t} - TR_{i,t-1}}{TR_{i,t-1}}$$

$$R^{B}_{i,t} = \frac{TR^{B}_{i,t} - TR^{B}_{i,t-1}}{TR^{B}_{i,t-1}}$$

where $R_{i,t}$ is the return of the firm *i* in the event month *t*, $TR_{i,t}$ is the total return index of firm *i* in the event month *t*, $R^{B}_{i,t}$ is the return of the benchmark *B* for the firm *i* in the event month *t* and $TR^{B}_{i,t}$ is the total return index of the index *B* for the firm *i*, in the event month *t*.

3.5.1 Abnormal return metrics

For the CAR method, returns are calculated for each observation in their respective event time months. The returns are then subtracted by the corresponding monthly return of a benchmark to arrive at an abnormal return. These are then summed for each firm across the entire event window, as to have a cumulative abnormal return.

$$CAR_{i,T} = \left[\sum_{t=1}^{T} AR_t \; where \; AR_t = \sum_{n=1}^{N} w_{i,t}(R_{i,t} - R^{B}_{i,t})\right] \begin{cases} w_{i,t} = \frac{1}{N_t} \text{ (equally weighted)} \\ w_{i,t} = \frac{Mcap_{i,t}}{\sum_{t=1}^{T}\sum_{i}^{N} Mcap_{i,t}} \text{ (value weighted)} \end{cases}$$

Where $CAR_{i,T}$ is the cumulative abnormal return for the firm *i* over the event time *T*, N_t is the group's sample size in the event month *t*, $w_{i,t}$ is the weight of firm *i* in the event month *t*,

$Mcap_{i,t}$ is the time-varying GDP-deflated market capitalization in Euros of firm *i* in the event month *t*.

The BHAR method compounds the monthly return of each firm in our chosen time period and subtracts the compounded return of a benchmark across the same time period.

$$BHAR_{i,T} = \sum_{i}^{N} w_{i,t} \left[\prod_{t=1}^{T} (1 + R_{i,t}) - \prod_{t=1}^{T} (1 + R_{i,t}^{B}) \right] \begin{cases} w_{i,t} = \frac{1}{N_t} \text{ (equally weighted)} \\ w_{i,t} = \frac{Mcap_{i,t}}{\sum_{t=1}^{T} \sum_{i}^{N} Mcap_{i,t}} \text{ (value weighted)} \end{cases}$$

Where $BHAR_{i,T}$ is the buy-and-hold abnormal return for the firm *i* over the event time period *T*, N is the sample size in the event month *t*, and $Mcap_{i,t}$ is the time-varying GDP-deflated market capitalization in Euros of firm *i*.

3.5.2 Abnormal return test statistics

To test whether the aftermarket performance of the Nordic IPOs is significantly different from zero, we can employ parametric or non-parametric tests. One alternative is the Student's t-test, which we used in the case of underpricing. It requires that the returns follow a normal distribution. In Appendix 2, we plotted the abnormal returns for our different metrics, and concluded that the returns are skewed. Additionally, our return metrics accumulate or compound the abnormal returns over a 36-month period, which has the potential for cross-sectional dependence between the sample. Researchers have also presented arguments that the Student's t-test statistic is unrealistic in the assumptions regarding normally distributed IPOs, and that conventional standardized tests are not fit to handle positive cross-sectional dependence (Cowan & Sergeant, 2001). We therefore decided not to use t-tests for the abnormal returns, and instead deemed the Wilcoxon signed-rank test, which is non-parametric, a better alternative. Barber and Lyon (1997) emphasize that it is superior in the presence of extreme outliers, which further supports our choice as compounding returns tend to be biased upwards, and Appendix 2 reveals the presence of outliers. It tests the null hypothesis that the median abnormal return is equal to zero for all Nordic IPOs and subgroups.

In addition to this, we will test if there is any difference in the median abnormal returns between PE-backed and NS-backed IPOs. With a similar line of reasoning as above, we use the Mann-Whitney U-test, a non-parametric test to compare the medians between the subgroups.

3.6 Potential biases

Survivorship bias

We include all IPOs that were listed between January 2001 and May 2017, and any delisted firm is handled appropriately to account for the removal from the stock exchange as described previously. In addition to this, the CARs and BHARs leading up to the event will include any negative or positive return because of the delisting, and therefore be fully accounted for in our dataset. Furthermore, the long time period used includes a variety of different firms in different market conditions, including the aftermath of the dot-com bubble and the 2007-2008 financial crisis, which should therefore limit any potential bias which is unaccounted for.

Benchmarking bias

We acknowledge that there may be a bias in the calculation of CARs and BHARs by using equity indices, as it may not be the most appropriate benchmark for the IPOs at hand. However, broad equity indices have been used in prior studies and therefore provide comparable results and our dataset is too limited to include any portfolio benchmark based on size and risk.

Omitted Variables Bias

When a regression model incorrectly excludes one or more important causal factors, it could lead to an omitted variables bias, as the model compensates for the missing factors by over- or underestimating the effect of the missing factors. We use regressions in attempting to explain the levels of underpricing. We have attempted to mitigate this bias by including variables based on acknowledged previous empirical studies, as well as including additional explanatory variables that we believe hold some value. By doing this, we have attempted to account for all explanatory variables that were emphasized in the literature and that were available for our dataset.

Skewness bias

Barber and Lyon (1997) argue that the chosen abnormal return metrics display positive skew over long time periods, which therefore affects the returns and statistical tests. We have accounted for this by using non-parametric tests which are better suited to handle extreme outliers, and have therefore avoided the issue of assuming the returns to be normally distributed.

4. Data

In this chapter, we present how we collected the data. As there is no general accepted practice of identifying samples for an IPO study, or classifying the sponsors as PE firms or any other type of risk-capital provider, we also explain the methods used for identifying the PE-backed IPOs.

4.1 Selecting the firms

Before collecting the data set, we reviewed the literature and deemed a three-year horizon to be reflective of the long-run performance of a stock. This requires a significant sample as PE-backed IPOs are relatively scarce and we therefore included all IPOs between January 2001 and May 2017. Additionally, as we focus on the underpricing and long-run performance of PE-backed IPOs, we researched the existing classification methodologies. There are some challenges involved in classifying the backers of an IPO due to both a lack of information but also differences in investment timing strategies (Schöber, 2008). A common method is to use IPO prospectuses, financial databases, financial newspapers and trade publications to classify the backers (Muscarella & Vetsuypens, 1989; Gertner & Kaplan, 1996; Cao & Lerner, 2009). We obtained classifications of whether an IPO was PE-backed or not in our initial dataset from a Bloomberg Terminal (Bloomberg), which the Swedish House of Finance provided access to. Furthermore, we used the sponsors' classifications of themselves as PE firms. If these two were in disagreement, we looked at financial newspapers and the traits of the pre-IPO owners, and classified them by ourselves.

We obtained the initial list of IPOs within our selected time horizon and chosen stock exchanges from Bloomberg, and cross-checked the data with the Nordic Stock Exchanges websites and Thomson Reuters Financial Datastream (Datastream). This resulted in an initial sample of 311 IPOs, of which 64 were PE-backed.

4.2 Underpricing data

The level of underpricing is measured by two components: the offering price and the first day closing price. The offering prices were collected from Bloomberg, IPO prospectuses, press releases, the Swedish Tax Agency and regulatory filings. In the case of first day closing prices, we used both a Bloomberg and Datastream, and utilized the unadjusted closing price on the date of the IPO.

To regress the level of underpricing, we have chosen to use five independent variables, of which two are control variables. All variables were collected via Bloomberg or

Datastream. We adjusted the sample for missing data and the final underpricing sample is 267 firms, of which 62 are PE-backed.

Table 1
IPO volume distribution by year

The table displays the volume distribution of PE and NS IPOs on the Nordic Stock Exchanges between January 2001 and May 2017. It is the frequency of IPOs by year, country and subgroup (PE and NS). The data was collected from a Bloomberg Terminal and Thomson Reuters Financial Datastream, with supplemental data from other sources.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Sweden	**4**	**3**	**0**	**2**	**4**	**8**	**7**	**2**	**1**	**2**	**5**	**1**	**2**	**9**	**31**	**56**	**22**	**159**
PE	0	3	0	0	0	3	1	0	0	1	1	0	0	5	14	11	5	44
NS	4	0	0	2	4	5	6	2	1	1	4	1	2	4	17	45	17	115
Denmark	**1**	**0**	**0**	**0**	**1**	**2**	**1**	**1**	**0**	**3**	**1**	**0**	**0**	**1**	**2**	**3**	**0**	**16**
PE	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	3
NS	1	0	0	0	1	2	1	1	0	2	1	0	0	0	2	2	0	13
Norway	**1**	**2**	**1**	**3**	**5**	**7**	**6**	**1**	**1**	**3**	**2**	**2**	**6**	**9**	**8**	**2**	**2**	**61**
PE	0	0	0	0	1	1	0	0	0	0	0	0	0	3	2	1	0	8
NS	1	2	1	3	4	6	6	1	1	3	2	2	6	6	6	1	2	53
Finland	**0**	**1**	**0**	**0**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**5**	**10**	**7**	**2**	**31**
PE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	7
NS	0	1	0	0	2	1	1	0	0	0	0	1	1	5	4	6	2	24
Total	**6**	**6**	**1**	**5**	**12**	**18**	**15**	**4**	**2**	**8**	**8**	**4**	**9**	**24**	**51**	**68**	**26**	**267**
PE	0	3	0	0	1	4	1	0	0	2	1	0	0	9	22	14	5	62
NS	6	3	1	5	11	14	14	4	2	6	7	4	9	15	29	54	21	205

As seen in Table 1, the number of IPOs has increased since financial crisis in 2007-2008 and it is currently at high levels, both for PE- and NS-backed IPOs. The occurrence of PE-backed IPOs prior to 2014 was lacking in comparison to NS-backed IPOs and it is evident that there has been a surge in the last few years.

4.3 Long-run data

The long-run sample is based on the same initial list as the underpricing sample. However, as the event window is set to 36 months after the first month of IPO, we decided to exclude all firms that were listed after March 2014. We collected share and index total returns from Bloomberg and removed the firms which had missing data. The adjusted long-run sample is 104 firms, of which 17 are PE-backed.

5. Results and analysis

In this section of the thesis, we present the results from the various studies that have been conducted. We start by presenting the underpricing results, and then the long-run performance. For each of the sub-sections, we analyze and summarize our main findings.

5.1 Underpricing results

Table 2
Underpricing descriptive statistics

The table reports descriptive statistics for the underpricing by subgroup. Panel A reports the data based on the sample's unadjusted underpricing, which is further divided into raw, equally-weighted and value-weighted underpricing. The value weights are based on the GDP-deflated market capitalization of each firm in Euros at the day of the IPO, by group. Panel B reports the data based on the sample's winsorized underpricing, with the weights being calculated in the same way. The significance levels refer to two-sided t-tests of whether the returns are statistically different from zero.

Panel A: Underpricing

Descriptive	Raw underpricing			EW underpricing			VW underpricing		
statistics	PE	NS	Total	PE	NS	Total	PE	NS	Total
Maximum	47.5%	147.3%	147.3%	0.8%	0.7%	0.6%	3.2%	1.9%	1.4%
Minimum	-33.3%	-84.4%	-84.4%	-0.5%	-0.4%	-0.3%	-0.3%	-0.6%	-0.4%
Median	4.8%	1.0%	2.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Mean	6.5%***	4.0%**	4.6%***	0.1%***	0.0%**	0.0%***	0.2%***	0.0%**	0.0%***
Standard deviation	0.128	0.245	0.223	0.002	0.001	0.001	0.005	0.002	0.001
Sum (for EW & VW)				6.5%	4.0%	4.6%	10.6%	6.3%	7.5%

Panel B: Adjusted underpricing

Descriptive	Raw underpricing (win)			EW underpricing (win)			VW underpricing (win)		
statistics	PE	NS	Total	PE	NS	Total	PE	NS	Total
Maximum	47.5%	109.6%	109.6%	0.8%	0.5%	0.4%	3.2%	1.9%	1.4%
Minimum	-33.3%	-49.4%	-49.4%	-0.5%	-0.2%	-0.2%	-0.3%	-0.3%	-0.2%
Median	4.8%	1.0%	2.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Mean	6.5%***	4.1%***	4.7%***	0.1%***	0.0%***	0.0%***	0.2%***	0.0%**	0.0%***
Standard deviation	0.128	0.224	0.206	0.002	0.001	0.001	0.005	0.002	0.001
Sum (for EW & VW)				6.5%	4.1%	4.7%	10.6%	6.6%	7.6%

*** p<0.01, ** p<0.05, * p<0.1

As seen in Table 2, the sample shows a higher average unadjusted and winsorized underpricing for PE-backed IPOs on an equally-weighted and value-weighted basis as compared to NS-backed IPOs. All groups have positive underpricing levels that are statistically significant from zero. We expected PE-backed IPOs to have lower levels of underpricing because of better financial expertise, operating performance and relationships with the underwriters, but the descriptive results indicate that it is the opposite case. The results are therefore contradicting the certification theory (Megginson & Weiss, 1991) and market power theory (Chemmanur & Loutskina, 2006), but as previously stated these already had mixed results. Whether this difference is statistically significant will be tested below.

The level of underpricing is quite low compared to early studies on underpricing. It is 4.6% for the equally-weighted total group, 6.5% for the PE-backed IPOs, and 4.0% for NS-backed IPOs. This compares to Jenkinson and Ljungqvist (2001) who found average underpricing levels of 15-18%. However, recent studies such as Schöber (2008) and Cao and Lerner (2009) presented higher average equal-weighted underpricing levels of 9.9% and 12.9%, respectively, which would imply that the markets have developed over time. It could

mean that the information asymmetry is lower today than it was in the early 2000s as equity capital markets have become more sophisticated, or that the Nordic countries have stricter regulation and governance that leads to lower information asymmetry. Another hypothesis is that the necessity of underpricing IPOs to draw investors is lower in the Nordic region, which would imply that investors believe the firms to be less uncertain, or that the underwriters are less incentivized to underprice IPOs. This would be a point of reference for future studies on underpricing in the Nordic markets.

Table 3
IPO sample distribution and IPO activity

The table displays the IPO sample distribution in percentage. It is grouped by the subgroups PE and NS as well the Nordic IPO activity at the time of each respective IPO. The sample covers 267 firms, of which 62 are PE-backed, between January 2001 and May 2017. IPO activity is deemed high if the number of IPOs for a year is above the 75th percentile of our sample, and classified as medium/low if it is between the 75th and 25th or below the 25th percentile, respectively. The average level of underpricing is presented on an equally-weighted and value-weighted basis, which is grouped by the subgroups PE and NS as well as the IPO activity as well. The total and subgroup level underpricing are also equally-weighted and value-weighted, based on type pre-IPO owners (PE or NS) and IPO market activity. Panel A shows the unadjusted underpricing returns while Panel B shows the winsorized underpricing returns. The significance levels refer to two-sided t-tests of whether the returns are statistically different from zero.

Panel A: Underpricing

IPO	IPO sample distribution (%)			Avg. EW underpricing			Avg. VW underpricing		
Activity	PE	NS	Total	PE	NS	Total	PE	NS	Total
High	87%	65%	70%	6.7%***	5.8%**	6.0%***	9.0%***	11.3%**	10.4%***
Medium/low	13%	35%	30%	5.3%	0.9%	1.3%	16.6%	2.3%	4.0%
Total/Avg.	**100%**	**100%**	**100%**	**6.5%*** **	**4.0%** **	**4.6%*** **	**10.6%*** **	**6.3%** **	**7.5%*** **

Panel B: Adjusted underpricing

IPO	IPO sample distribution (%)			Avg. EW underpricing (win)			Avg. VW underpricing (win)		
Activity	PE	NS	Total	PE	NS	Total	PE	NS	Total
High	87%	65%	70%	6.7%***	5.5%**	5.8%***	9.0%***	11.3%**	10.4%***
Medium/low	13%	35%	30%	5.3%	1.6%	2.0%	16.6%	2.7%	4.4%*
Total/Avg.	**100%**	**100%**	**100%**	**6.5%*** **	**4.1%*** **	**4.7%*** **	**10.6%*** **	**6.6%** **	**7.6%*** **

*** p<0.01, ** p<0.05, * p<0.1

As shown in Table 3, the PE-backed IPOs occur more often during a high IPO activity period as compared to NS-backed IPOs. Schöber (2008) found the same results in the US while Bergström et al. (2006) found the opposite result for France and UK. The level of equally-weighted underpricing is also higher during a high period for both groups, as compared to the medium/low period, but the results are less drastic for PE-backed IPOs. However, the results switch for PE-backed IPOs on a value-weighted basis while they stay consistent for the larger sample of NS-backed IPOs and the total group. Both differences for PE-backed IPOs may be due to the small sample size in the medium/low activity period.

It is interesting to note that there is no support for the level of underpricing being statistically different from zero during times of medium to low IPO activity, except the winsorized underpricing for the total value-weighted group at a 10% significance level. It seems that firms are less likely to be underpriced during periods of low IPO activity, as opposed to periods of high IPO activity where all groups have positive underpricing levels that are statistically significant at 5% and 1% significance levels. This implies that there could be a timing element to IPOs, which would mean that firms that list during low activity periods are different in terms of operating performance, size or other factors, as compared to firms during high activity periods. As PE-backed IPOs occur more often in high activity periods in our sample, it could also mean that they are particularly prone to target their IPOs in "hot" periods. This was studied by Michala (2016) on the US market where he did not find any such differences, and it could be applied on the Nordic market as well to see if the results hold. Our results however lend some credibility to the hot issue market theory by Ibbotson and Jaffe (1975), and Ritter (1984), in that firms are more likely to be underpriced during periods of high IPO activity.

Table 4
OLS regression - Explanatory factors of underpricing

The table reports the output from regressions on raw, equally-weighted and value-weighted underpricing on five explanatory variables. Each type of weighting is run on unadjusted underpricing and winsorized (adjusted) underpricing, where we have winsorized the 1st and 99th percentile of the sample. LN_MCAP is the natural logarithm of the GDP-deflated market capitalization in Euros on the day of the IPO. DAYS_BEFORE_TRADING is the amount of days between the announcement date and trading date of the IPO. RETAINED is 1 – (the deal value of the IPO divided by the total market capitalization on the day of the IPO), which is the retained share by the pre-IPO owners. PE_BACKED is a dummy variable which takes on the value of one if the IPO is backed by a private equity firm, and zero otherwise (i.e. backed by a non-sponsor). IPO_ACTIVITY is also a dummy variable that takes on the value of one if the frequency of IPOs during the observation's year is above the 75th percentile for our sample, and zero otherwise.

VARIABLES	(1) Raw Underpricing	(2) Raw Adj. Underpricing	(3) EW Underpricing	(4) EW Adj. Underpricing	(5) VW Underpricing	(6) VW Adj. Underpricing
LN_MCAP	0.0206***	0.0218***	0.0001***	0.0001***	0.0003***	0.0003***
	(0.0072)	(0.0069)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
DAYS_BEFORE_TRADING	-0.0008***	-0.0007***	-0.0000***	-0.0000***	0.0000	0.0000
	(0.0003)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
RETAINED	0.0670	0.0648	0.0003	0.0002	0.0004*	0.0004*
	(0.0547)	(0.0529)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
PE_BACKED	-0.0224	-0.0204	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0245)	(0.0234)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
IPO_ACTIVITY	0.0605**	0.0525*	0.0002**	0.0002*	0.0003	0.0002
	(0.0299)	(0.0269)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Constant	-0.0949**	-0.0981**	-0.0004**	-0.0004**	-0.0016**	-0.0016**
	(0.0414)	(0.0401)	(0.0002)	(0.0002)	(0.0006)	(0.0006)
Observations	267	267	267	267	267	267
R-squared	0.0780	0.0785	0.0780	0.0785	0.1679	0.1762

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of our main regressions are presented in Table 4 above. It has been divided into six regressions, where we run the raw, equally-weighted and value-weighted unadjusted and winsorised underpricing.[1] The raw/equally-weighted regressions have relatively low explanatory power of 7.80% and 7.85% R^2 while the value-weighted has 16.79% and 17.62% R^2, for the conventional and adjusted underpricing, respectively.

The LN_MCAP variable is significant at a 1% level with a positive coefficient for all regressions, which shows that a larger IPO, on average, will experience higher levels of underpricing than smaller firms. We expect there to be more public information available and higher interest for larger firms, as they are more ubiquitous in everyday life and usually have more stakeholders, which should result in increased analyst, institutional and media coverage.

[1] Raw and equally-weighted regressions show the same results; both are included to allow a comparison between the size of the coefficients with the value-weighted regression.

This should in turn allow larger firms to price their IPOs closer to their true value as there is less asymmetric information and arguably risk as well. With this reasoning, the results are counter-intuitive and contradicts previous research which argues that smaller firms are more speculative than larger ones (Beatty & Ritter, 1986).

The DAYS_BEFORE_TRADING has a negative coefficient and is significant at a 1% level for the equally-weighted regressions, while it has no significance for the value-weighted regressions. We believe it to be intuitive for the variable to have a negative relationship with underpricing, as there should be less information asymmetry when the market knows well in advance that the firm will IPO and it could allow the underwriters greater flexibility in spurring interest among investors and deciding on a fair price. It may also be a sign of confidence by the underwriters and issuing firm, as they would not announce it early if they did not think that it would gain the attention of investors and the media. However, this does not hold for the value-weighted regression and should therefore be interpreted with care.

The variable RETAINED, which measures the level of retained ownership by the pre-IPO owners, has a positive coefficient at a 10% significance level for the value-weighted regression, but is insignificant for the equally-weighted regression. Previous literature argues that a lower ownership share retained by the pre-IPO owners should reduce the level of underpricing, as their wealth loss is greater ceteris paribus (Habib & Ljungqvist, 2001). Another way of thinking is by considering that more shares are being offered if they retain a lower ownership share, and thus they lose more if they sell the shares at a discount (offering price) as compared to the first-day closing price. Our results for the value-weighted regressions are in-line with this, as a higher ownership stake retained leads to higher underpricing (or lower ownership stake leads to lower underpricing). It is however only for the value-weighted regression that this holds true.

The dummy variable PE_BACKED has negative coefficient for all regressions, but is insignificant. We argued that a PE-owners should have more financial expertise, better relationships with underwriters and more experience with the IPO process, which should therefore lead to lower levels of underpricing. The coefficients are in-line with our reasoning and the evidence put forward by Levis (2011) and Mogilevsky and Murgulov (2012), in that PE-backed IPOs experience lower levels of underpricing compared to NS-backed ones. However, our results are not statistically significant and will be tested for robustness below.

The dummy variable IPO_ACTIVITY has a positive coefficient for all regressions, that is significant at a 5% and 10% level for the unadjusted and adjusted equally-weighted regressions, respectively. This appeared in Table 3 where it was clearly indicated that IPOs had a higher level of underpricing during periods of high IPO activity in the Nordic market. We expected that firms were more likely to accept the increased cost of going public when other firms were doing so as well, and that the quality of the listed companies would be lower, which could be tested in future studies by observing the operational performance in different periods of IPO market activity. Our results are in-line with Ibbotson and Jaffe (1975) and Ritter (1984), in that firms that list during periods of high IPO activity are underpriced at higher levels. This was not statistically significant for the value-weighted regressions however.

Appendix 1 illustrates how the underpricing differs between the subgroups PE and NS, and we include t-tests to check for robustness in our results. On average, PE-backed IPOs have higher levels of unadjusted and adjusted underpricing, both weighted equally and by value. This runs against our hypothesis but is not statistically significant at any conventional level. It contradicts the results of Levis (2011) and Mogilevesky and Murgolov (2012), but it lends some support to disproving the certification and market power theory for the Nordic IPO market, as they would predict a difference in the level of underpricing. However, one would need to include other explanatory variables to be certain (e.g. reputation of the PE firms, relationship with underwriters and operating performance). Future research on these qualitative and quantitative elements could therefore provide answers as to any potential difference between the subgroups, and why the theories do not hold for the Nordic market.

In summary, the market capitalization at the time of the IPO is a statistically significant explanatory variable for the level of underpricing, while the days between announcing and trading, the IPO market activity and level of retained ownership by the pre-IPO owners after listing also likely have some explanatory power. However, we find no evidence that PE-backed IPOs differ from NS-backed IPOs at the time of the IPO in terms of underpricing.

5.2 Long-run IPO performance

Table 5
Descriptive statistics of event-time CARs and BHARs

The table reports the long-run performance from the sample of 104 IPOs, of which 17 were PE-backed, between January 2001 and March 2014. The event time is 36 months, with a start date one month after the IPO to exclude any potential underpricing effect. The IPOs were listed on the Nordic stock exchanges: NASDAQ OMX Stockholm, Copenhagen and Helsinki (including First North markets), Nordic Growth Market or Oslo Stock Exchange. For each IPO, cumulative abnormal returns (CARs) are calculated by summing monthly returns during the event window. Similarly, buy-and-hold abnormal returns (BHARs) are calculated by compounding monthly returns. Each IPO is matched against the respective country's index: MSCI Sweden, MSCI Denmark, MSCI Finland and MSCI Norway, to arrive at an abnormal return metric. Panel A shows cumulative abnormal returns and Panel B shows buy-and-hold abnormal returns. The significance levels refer to two-sided Wilcoxon signed-rank tests of whether the median values are different from zero.

Panel A: CARs

Descriptive	EW Cumulative abnormal returns			VW Cumulative abnormal returns		
statistics	PE	NS	Total	PE	NS	Total
Maximum	57.6%	206.8%	206.8%	10.5%	11.5%	10.0%
Minimum	-148.7%	-210.5%	-210.5%	-3.5%	-0.9%	-0.8%
Median	13.3%	15.7%	15.7%	0.4%	0.0%***	0.0%***
Mean	-10.3%	4.3%	1.9%	0.9%	0.5%	0.4%
Standard deviation	0.549	0.896	0.849	0.038	0.017	0.014
Observations	17	87	104	17	87	104
Sum (VW)				15.7%	45.4%	40.8%
P-value (two-tailed)	0.49	0.40	0.54	0.62	0.00	0.00

Panel B: BHARs

Descriptive	EW Buy-and-hold abnormal returns			VW Buy-and-hold abnormal returns		
statistics	PE	NS	Total	PE	NS	Total
Maximum	42.5%	293.4%	293.4%	10.4%	11.7%	10.2%
Minimum	-82.7%	-93.9%	-93.9%	-3.6%	-0.9%	-0.8%
Median	-7.4%	-5.2%	-6.3%	0.3%	0.0%***	0.0%***
Mean	-16.4%	1.8%	-1.2%	0.9%	0.5%	0.4%
Standard deviation	0.383	0.763	0.716	0.037	0.018	0.014
Observations	17	87	104	17	87	104
Sum (VW)				14.9%	45.5%	40.9%
P-value (two-tailed)	0.11	0.32	0.13	0.69	0.00	0.00

*** p<0.01, ** p<0.05, * p<0.1

Table 5 reports the CARs and BHARs for all groups in our sample of IPOs. As can be seen in Table 5, Panel A and Figure 1, the average value-weighted CARs for the total sample and NS-backed IPOs are very high at a 1% significance level, at 40.8% and 45.4%, for the entire samples respectively, while not significant and vastly lower at 15.7% for the PE-backed IPOs. Due to these differences, we can establish that the largest NS-backed firms contribute the most towards the positive results, while the largest PE-backed IPOs perform worse as they have a lower average return. Some companies had abnormally high market capitalizations, and it is possible that they have a very large impact on the results, even though such IPOs are uncommon. As an example, Statoil had a GDP-deflated market capitalization of 24.4 billion Euros in the first event month, which is a 28% weight for the entire sample.

On an equally-weighted basis, the returns are rather low and not statistically different from zero at any conventional level. As can be seen in Figure 1, the returns are mostly negative until after event month 25. For PE-backed equally-weighted IPOs, the returns are almost negative for the entire event window, and the average return is -10.3%. It appears that PE-backed IPOs are performing worse than NS-backed IPOs, but the observations are not statistically significant. We believe that a potential difference in IPO timing could explain why our sample shows lower, although not significant, returns for PE-backed IPOs, which will be further discussed below.

In Panel B and Figure 2, the value-weighted BHARs for the entire total group and entire NS-backed IPOs are also high, 40.9% and 45.5% respectively, at a 1% significance level. Correspondingly to the CAR method, the return for all PE-backed IPOs is lower at 14.9% and not significant. On an equally-weighted basis, the average returns are negative both for the total sample and PE-backed IPOs at -1.2% and -16.4%, while slightly positive at 1.8% for NS-backed IPOs. The results are only statistically different from zero at an 11% and 13% significance level for the PE-backed IPOs and total sample, respectively. The median return is negative for all groups. Only the value-weighted BHARs for the NS and total IPO samples are positive for the entire event window, while it dips below or stays negative for all other samples, as is evident in Figure 2.

Our results differ from previous studies from the US (e.g. Ritter, 1991; Cao & Lerner, 2009) and UK (Levis, 2011), where IPOs showed significant negative abnormal returns. Similarly, they also differ from Keloharju (1993) and Jenkinson and Ljungqvist (2001), who found evidence of underperformance on the Finnish market, as well as Schuster (2003) who had comparable results for the Swedish market. However, there is a pattern of negative returns for most of the event window, which is seen graphically in Figure 1 and 2, and the average equally-weighted BHAR for the total group is negative, but not statistically different from zero.

Figure 1
Equally-weighted and value-weighted cumulative abnormal returns

Equally-weighted and value-weighted cumulative abnormal returns are plotted for the first 36 months, following one month after the IPO to exclude the effect of underpricing. Month 0 is therefore one month after the IPO. The graph shows the results for the total group, as well as the subgroups PE and NS. The benchmark indices are MSCI Sweden, Denmark, Finland and Norway, which are matched by the IPO's stock exchange.

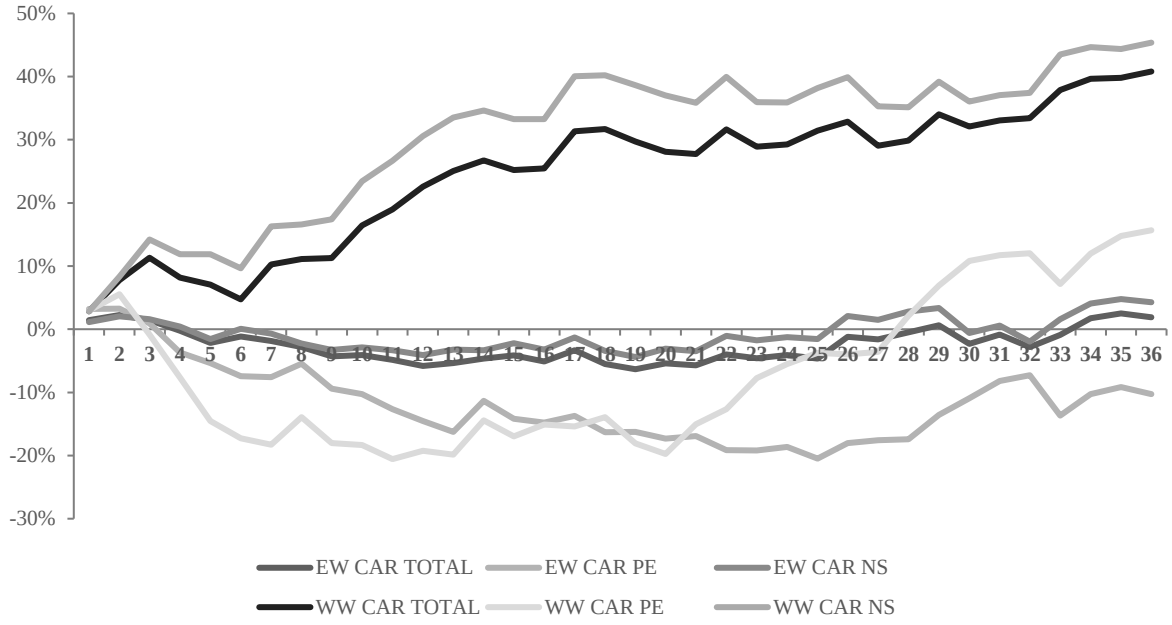
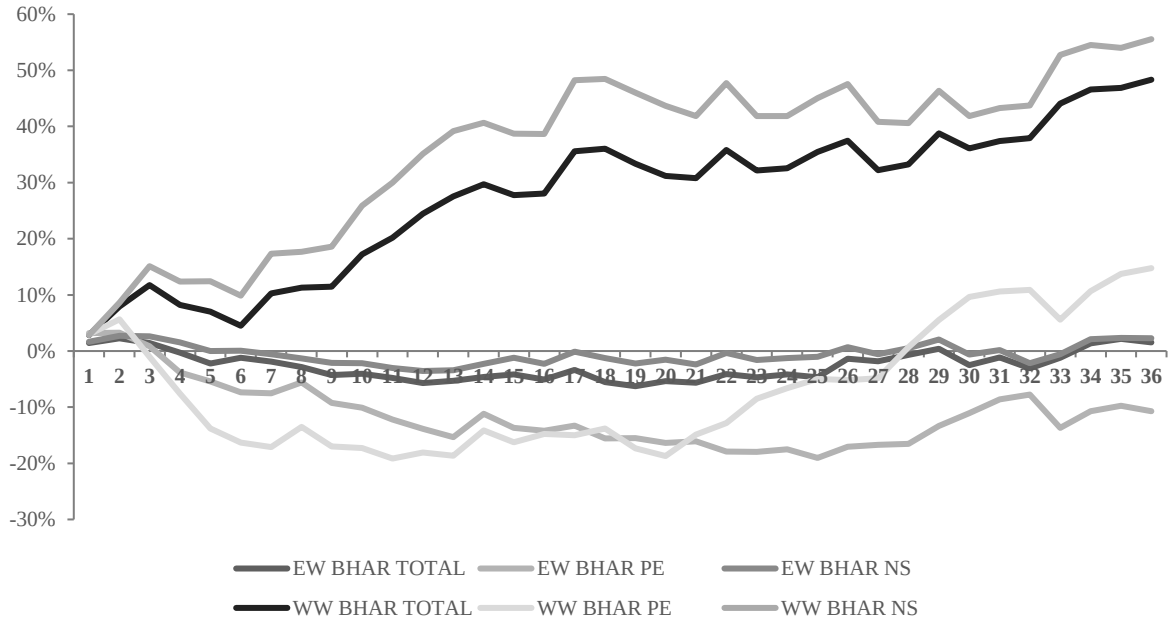


Figure 2
Equally-weighted and value-weighted buy-and-hold abnormal returns

Equally-weighted and value-weighted buy-and-hold abnormal returns are plotted for the first 36 months, following one month after the IPO to exclude the effect of underpricing. Month 0 is therefore one month after the IPO. The graph shows the results for the total group, as well as the subgroups PE and NS. Note that the graph will differ slightly from Table 5, Panel B, as the returns here are compounded monthly as the sum of each subgroup's weighted returns, instead of summing the total event time buy-and-hold abnormal returns of each subgroup, where each firm has been weighed and compounded individually.



It is possible that our choice of using MSCI country indices as a benchmark resulted in the prevalence of positive abnormal returns, as Brav and Gompers (1997) argued that a size and book-to-market benchmark diminishes abnormal returns. Similarly, Espenlaub et al. (2000) argued that the results are highly sensitive to delimitations and the form of comparative benchmark used. However, as stated before, we deemed our sample too small to effectively match each IPO with a corresponding firm. Similarly, our samples do not produce more extreme results by using BHAR over CAR, as BHARs tend to be biased upwards, which was evident in other studies (Barber & Lyon, 1996, 1997; Schöber, 2008).

In addition to this, our NS-backed IPOs show higher returns, on average, than the PE-backed IPOs, whereas van Frederikslust and van der Geest (2001), Bergström et al. (2006), and Levis (2011), found the opposite in the Netherlands, wider Europe and UK market respectively. Other researchers have put forward theories as to why PE-backed IPOs should outperform NS-backed IPOs. Bergström et al. (2006) argue that PE-backed IPOs could have better aftermarket performance as the PE firms themselves are less likely to take a low-quality firm public, due to other exit routes with less publicity and reporting requirements. Additionally, the PE firms usually retain a large ownership position post-IPO (Bergström et al., 2006), and they are therefore more likely to take the companies with good operating performance public to maximize their return. NS-backed firms may go public due to other reasons and it is therefore not as certain that they will outperform (Ritter & Welch, 2002). It would therefore be of value for future studies to compare the operating performance of PE-backed IPOs with NS-backed IPOs for our sample, as it is possible that the PE-backed ones are not of higher quality as put forward by Bergström et al. (2006), which would explain the results.

Although the results above show a difference in the median between the subgroups, we wish to test whether there is any statistically significant difference between PE-backed IPOs and NS-backed IPOs, for all abnormal return metrics and weighing methods, which is done below.

Table 6
Mann-Whitney U-test of difference between PE-backed and NS-backed IPOs

The table reports Mann-Whitney U-test results by comparing the 36-month median CAR and BHAR between PE-backed IPOs and NS-backed IPOs. The two abnormal return metrics are weighted both equally and by value. Mean rank is shown with the expected rank in brackets. The significance levels in the far-right column refer to two-sided Mann-Whitney U-tests of whether the median returns of the two subgroups are equal for each abnormal metric and weighing method.

	Number of observations	Mean rank	z-statistic	P(| Z | > | z |)
Equally-weighted CAR				
NS	87	4673 [4568]		
PE	17	787 [893]		
Total	**104**	**5460 [5460]**	**0.93**	**0.35**
Equally-weighted BHAR				
NS	87	4631 [4568]		
PE	17	829 [893]		
Total	**104**	**5460 [5460]**	**0.56**	**0.58**
Value-weighted CAR				
NS	87	4617 [4568]		
PE	17	843 [893]		
Total	**104**	**5460 [5460]**	**0.44**	**0.66**
Value-weighted CAR				
NS	87	4623 [4568]		
PE	17	837 [893]		
Total	**104**	**5460 [5460]**	**0.49**	**0.63**

As can be seen in Table 6, none of the Mann-Whitney U-tests yield any statistically significant difference between PE-backed IPOs and NS-backed IPOs for any of the abnormal return metrics or weighing method. Consequently, we find no support that PE-backed IPOs differ in their aftermarket performance from NS-backed IPOs in our sample. This differs from the results of van Frederikslust and van der Geest (2001), Bergström et al. (2006), Cao and Lerner (2009), and Levis (2011). In Table 1, we see that most of the recent PE-backed IPOs have occurred since 2014. This could be a factor explaining the difference in the results compared to prior studies, as private equity is a relatively new phenomenon in the Nordic region and the more recent PE-backed IPOs could potentially differ from the early- to mid-2000s. Similarly, the IPO volume distribution for the PE-backed IPOs cluster around 2002, 2006 and 2014 for the long-run sample. As the 2002 and 2006 sample is relatively close to dot-com bubble and financial crisis of 2007-2008, respectively, it is reasonable to believe that the distribution of performance may differ for the PE-backed sample as compared to the NS-backed sample, which is more evenly distributed across the years.

It could also be a difference in timing, as we saw in Table 3 that PE-backed IPOs had a higher proportion of their listings during times of high IPO activity than NS-backed IPOs.

Firms that become public during these periods are more uncertain and therefore more underpriced, in accordance to the hot issue market theory, and it could also have some explanatory value for the long-run performance. This suggests that a similar study should be done in the next few years, as the aftermarket performance of the IPOs after 2014 can be measured for at least 36 months and can therefore be included. Additionally, future studies can include the effect of the IPO market activity on the aftermarket returns between the subgroups PE-backed and NS-backed.

In summary, our findings show positive abnormal returns on a value-weighted basis for the entire sample and NS-backed IPOs at a 1% significance level. We find no support for abnormal returns that are statistically different from zero on an equally-weighted basis for any of the groups, and no difference in the median abnormal return between PE-backed and NS-backed IPOs for any of the return metrics and weighing methods.

7. Conclusion

Using a sample of 267 IPOs, of which 62 are PE-backed and 205 are NS-backed, from January 2001 to May 2017, this paper investigates the underpricing and aftermarket abnormal performance of IPOs on the Nordic market. The motivation has been to analyze and compare the financial performance of PE-backed IPOs to NS-backed IPOs. The research question is divided into two: *How do Nordic IPOs perform and does the performance differ between the subgroups PE and NS?* This has been answered by eight hypotheses, each of which is tested by an appropriate statistical test. A summary of the results from the paper is presented below in Table 7.

Table 7
Our hypotheses for the paper

The table below presents the null hypotheses stated in the paper, the appropriate tests used and whether the null hypotheses could be rejected or not.

Null hypotheses	**Statistical test**	**Rejected**
Underpricing		
H_2: Nordic IPOs do not exhibit any underpricing.	Two-sided t-test	Yes
H_5: The market capitalization at the time of the IPO does not influence the level of underpricing.	Two-sided t-test	Yes
H_7: The number of days between the announcement date and trading date has no effect on the level of underpricing.	Two-sided t-test	Yes[1]
H_8: The level of IPO activity has no correlation with the level of underpricing.	Two-sided t-test	Yes[1]
H_6: The level of retained ownership share by the pre-IPO owners after listing has a negative effect on the level of underpricing.	Two-sided t-test	Yes[2]
H_3: Nordic PE-backed IPOs do not differ from NS-backed IPOs in terms of underpricing.	Two-sided t-test	No
Long-run performance		
H_1: Nordic IPOs do not exhibit abnormal aftermarket returns.	Wilcoxon signed-rank test	Yes[2]
H_4: Nordic PE-backed IPOs do not differ from NS-backed IPOs in terms of abnormal aftermarket returns.	Mann-Whitney U-test	No

1) equally-weighted 2) value-weighted

Our results support that IPOs are underpriced as a group, and by subgroup, but only in periods of high IPO activity. Similarly, in our regressions, we find a statistically significant positive correlation between the market capitalization at the time of the IPO, and the level of underpricing. Our findings also support that the days between the announcement date and trading date has a negative impact on the level of underpricing while the level of IPO market activity has a positive impact, both on an equally-weighted basis. The retained ownership of the pre-IPO owner only has a positive correlation with underpricing for the value-weighted regression, at a 10% significance level. The prevalence of a PE or NS-backer has no

explanatory power, and there is no statistically significant difference in the level of underpricing between the two groups.

For the aftermarket abnormal returns, we conclude that the value-weighted CARs and BHARs are positive at a 1% significance level for the total group and NS-backed IPOs, but we find no support for abnormal returns for PE-backed IPOs. The equally-weighted return metrics show no results that are statistically different from zero for any of the groups. Additionally, we find no difference in the median CAR and BHAR between PE-backed IPOs and NS-backed IPOs, and can therefore not determine whether there is any performance difference between the groups.

Topics for future studies are given through the paper, and we have found unanswered questions to some interesting results. Points of references include the difference in underpricing in the Nordic markets compared to the wider European market and the effect of relationships with underwriters, operating performance and reputation of the PE firms on the level of underpricing. Additionally, the difference in operating performance between PE-backed and NS-backed firms after listing and the effect that timing the listings with the IPO market activity has on the aftermarket performance would be of interest to provide more robustness as to why PE-backed firms do not outperform NS-backed firms, which previous studies and theories imply that they should do.

In our analysis, we have only focused on returns through the event-time approach and with broad equity indices, as our sample was too limited for a calendar-time and matching portfolio approach. Additionally, we have used non-parametric tests to determine the statistical significance for the aftermarket returns. This ultimately limits the results in terms of comparability with other studies which have used the calendar-time approach, matching portfolios, or standardized tests.

Similarly, we do not investigate the operating performance of the IPO firms or any difference in timing between the subgroups. Therefore, it remains to be seen if the subgroups differ in any other way, as we find no such support at this moment in terms of underpricing or aftermarket abnormal return.

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9. Appendices

Appendix 1
T-tests for underpricing by subgroup and weighting

The tables below illustrate t-statistics and p-values for the difference in means between the subgroups (PE-backed and NS-backed IPOs). The sample covers 267 firms, of which 62 are PE-backed, between January 2001 and May 2017. The adjusted underpricing in Panel B and D refers to winsorized underpricing returns for the 1st and 99th percentile. Panel A and B show the underpricing, equally-weighted by subgroup, while Panel C and D show the underpricing, value-weighted by subgroup.

Panel A: EW Underpricing

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
NS	205	0.0404	0.0171	0.2447	0.0067	0.0741
PE	62	0.0650	0.0162	0.1277	0.0326	0.0974
Total	267	0.0461	0.0137	0.2231	0.0193	0.0730
Diff		-0.0246	0.0324		-0.0883	0.0391

Diff = mean(NS) - mean(PE) t = -0.7596

H_o: diff = 0 degrees of freedom = 265

H_a: diff < 0 H_a: diff != 0 H_a: diff > 0

Pr(T<t) = 0.2241 Pr(|T|<|t|) = 0.4481 Pr(T>t) = 0.7759

Panel B: EW Adj. Underpricing

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
NS	205	0.0412	0.0157	0.2243	0.0103	0.0720
PE	62	0.0650	0.0162	0.1277	0.0326	0.0974
Total	267	0.0467	0.0126	0.2060	0.0219	0.0715
Diff		-0.0239	0.0299		-0.0827	0.0350

Diff = mean(NS) - mean(PE) t = -0.7987

H_o: diff = 0 degrees of freedom = 265

H_a: diff < 0 H_a: diff != 0 H_a: diff > 0

Pr(T<t) = 0.2126 Pr(|T|<|t|) = 0.4252 Pr(T>t) = 0.7874

Panel C: VW Underpricing

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
NS	205	0.0002	0.0001	0.0013	0.0000	0.0004
PE	62	0.0005	0.0002	0.0013	0.0001	0.0008
Total	267	0.0003	0.0001	0.0013	0.0001	0.0004
Diff		-0.0002	0.0002		-0.0006	0.0002

Diff = mean(NS) - mean(PE) t = -1.1678

H_o: diff = 0 degrees of freedom = 265

H_a: diff < 0 H_a: diff != 0 H_a: diff > 0

Pr(T<t) = 0.122 Pr(|T|<|t|) = 0.2439 Pr(T>t) = 0.878

Panel D: VW Adj. Underpricing

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
NS	205	0.0002	0.0001	0.0013	0.0001	0.0004
PE	62	0.0005	0.0002	0.0013	0.0001	0.0008
Total	267	0.0003	0.0001	0.0013	0.0001	0.0004
Diff		-0.0002	0.0002		-0.0006	0.0002

Diff = mean(NS) - mean(PE) t = -1.1403

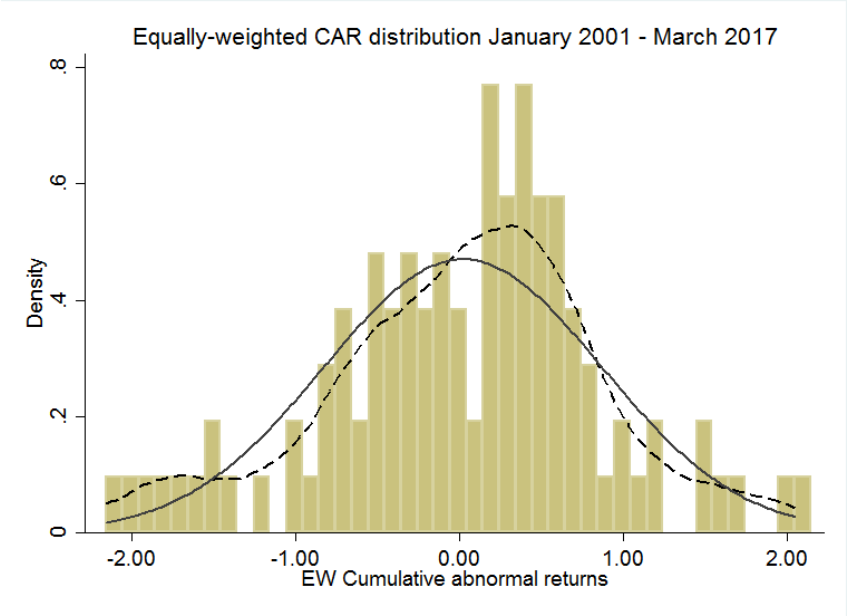
H_o: diff = 0 degrees of freedom = 265

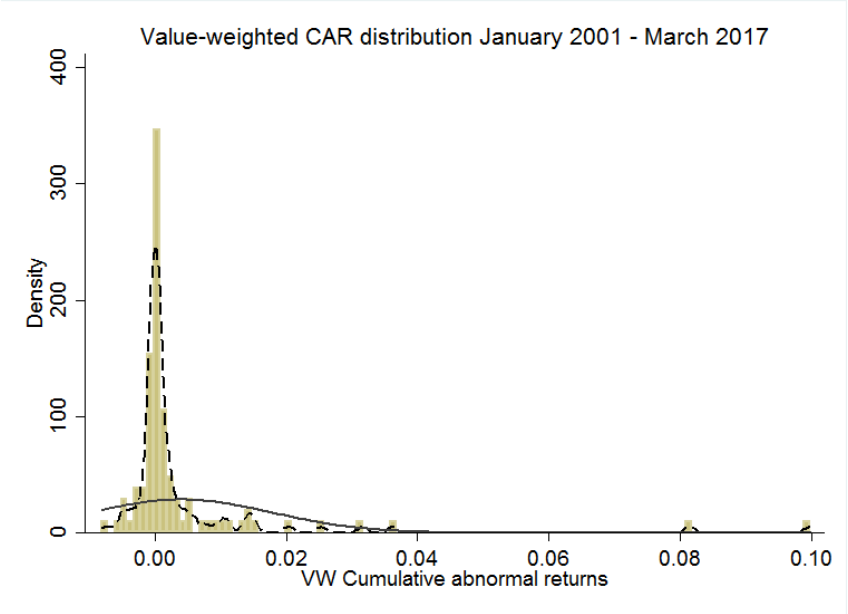
H_a: diff < 0 H_a: diff != 0 H_a: diff > 0

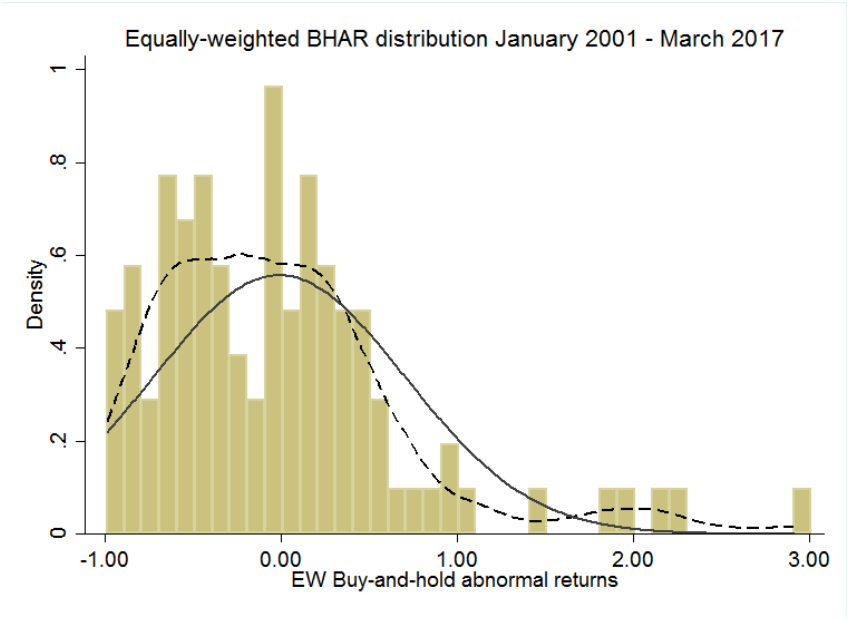
Pr(T<t) = 0.1276 Pr(|T|<|t|) = 0.2552 Pr(T>t) = 0.8724

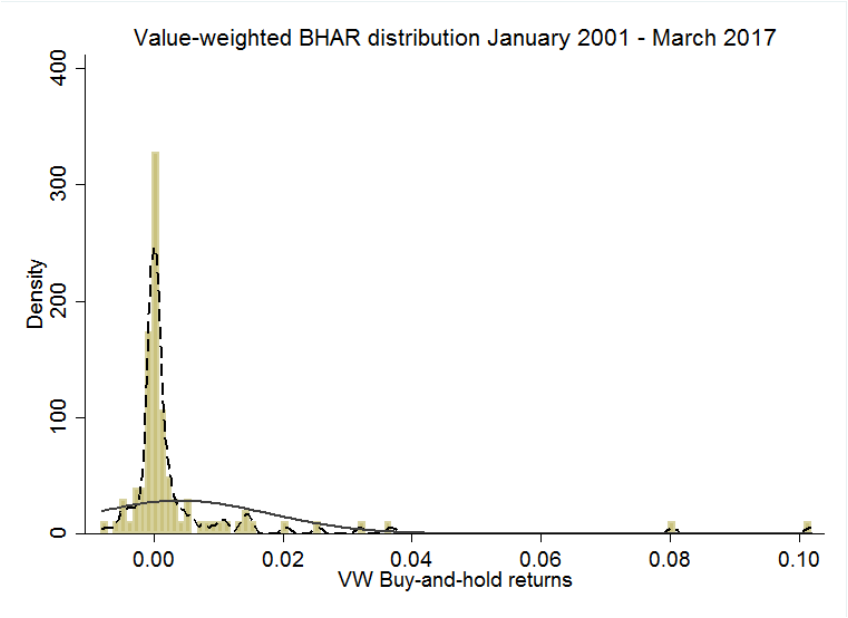
Appendix 2
Histogram for the aftermarket abnormal return metrics

Distribution of CARs and BHARs for the 36-month event window following one month after an IPO. The sample consists of 104 IPOs between January 2001 and March 2017. The bars show the histogram of CAR and BHAR distribution and the solid lines show the fitted normal distribution whereas the dashed lines show the kernel distribution plot.






Equally-weighted BHAR distribution January 2001 - March 2017
Density
0
.2
.4
.6
.8
1
-1.00
0.00
1.00
2.00
3.00
EW Buy-and-hold abnormal returns


Value-weighted BHAR distribution January 2001 - March 2017
Density
0
100
200
300
400
0.00
0.02
0.04
0.06
0.08
0.10
VW Buy-and-hold returns