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Master Thesis

Thesis Master of Science

Initial Public Offerings: A Study of the Nordic Market

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Abstract:

We present a quantitative study within the field of corporate finance to investigate underpricing on initial public offerings within the Nordic financial markets. Our design allows us to study how the technology sector differs compared to other sectors with new and unique data. Moreover, is the technology industry subject to higher degrees of uncertainty compared to other sectors? Is there a reason for large valuation differences? We find that IPO underpricing is present in the 455 IPOs from 2010-2018. Further, we find that in general, initial returns of technology firms differentiate from the market average. We conclude that firm size can explain some of the variation in underpricing, and that this also holds for technology firms.

Acknowledgement

We would like to thank our supervisor, Associate Professor Siv Staubo at Handelshøyskolen BI Oslo, for guidance and relevant input for our thesis.

Oslo, June 2019

Lars K. Nyland and Odd Kåre E. Mistereggen

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1. Introduction and motivation

When choosing a topic for our thesis, we quickly ended up with initial public offerings (IPO). Throughout our master's degree we have had several fascinating finance courses, and especially applied valuation where we were formally introduced to IPOs and the underpricing phenomenon. Our motivation for this subject arised due to our common interest in corporate finance, and since both authors have a macroeconomic background, we wanted to explore a broader picture than what has been covered in current literature. In addition, as Norway's Oslo Børs is more of a natural resources exchange than our neighbours in the Nordic, we wanted to look closer at the Nordic IPO market. In addition, technology firms are in a greater extent present at other Nordic exchanges rather than Oslo Børs. Further, our motivation for digging deeper into the technology sector comes from what we have heard about the internet bubble of the 90s and then specifically related to the vast number of IPOs that unfolded around that time. Moreover, we are convinced that this is an exciting industry for the future, and the major upheavals that have taken place in recent years make this sector particularly interesting.

Technology firms and IPOs have been a hot topic for several years because of the underpricing shown in several empirical studies. In chapter 2, we will present a literature review on this topic. Especially during the dotcom bubble of the 1990s, the interest in IPOs skyrocketed with average first day returns on 73% (Ljungqvist & Wilhelm, 2003). Therefore, we want to see if technology companies today are still «leaving money on the table». The number of IPOs have increased in recent years due to rally in stock markets and low interest rate environment (among other reasons). Further, as prior research on IPO underpricing is mainly focusing on confirming the underpricing and providing theoretical explanations, we find it fascinating to investigate whether the technology-sector is significantly more underpriced compared to other sectors. Is the technology industry subject to higher degrees of uncertainty compared to other sectors? Is there a reason for large valuation differences? Being able to answer these questions are fundamental to conclude that tech companies are more underpriced than others.

This study looks into the Nordic IPO market, i.e. IPOs done in Norway, Sweden, Denmark and Finland (excluding Iceland). We want to compare how the pricing of technology companies varies from other sectors. As technology companies often have high projected revenue growth, but lack the financial and operating history, pricing of these companies is difficult. In particular, we will test whether there are significant differences in the Nordic IPO market on pricing of technology companies versus other sectors. I.e. What are the causes of IPO underpricing in the technology sector, and why is this sector different than the others? Especially, what are the fundamental reasons for these differences? We present the following four hypotheses to address these issues:

1. *Nordic IPOs between 2010-2018 have been fair priced*
2. *No significant difference between the level of underpricing between tech IPOs and non-tech IPOs.*
3. *Technology sector underpricing variance is equal to all other sectors variances.*
4. *No significant difference between the level of underpricing between young and old companies.*

In our thesis, we will focus on the first-day performance of IPOs. Another interesting field is the long-term performance of IPOs, but this will not be discussed in this thesis. Consequently, we will not go very deep into the process of the IPO itself as we want to keep the main focus on the underpricing phenomena, and it will only be explained short.

Our thesis investigates a well-studied-subject, however with new and unique data. Previous studies typically investigate one country (e.g. Sweden), whereas we include countries such as Sweden, Norway, Denmark and Finland. One of the primary benefits is that we are able to expand the demographic, which in turn could be of great interest for international agents in the financial markets. The Nordic region as a whole, despite their demographic differences, are often clustered together and compared to Europe, Asia, U.S., and emerging markets. Being able to study the market as a whole, is a unique part of our study, which, by the best of our knowledge, is not done previously. For this reason, we are able to investigate a well-known subject in a much more generalizable setting, which is essential for research.

We believe our study will have great implications for practitioners. Agents working in the financial industry can use this knowledge and insight to reduce underpricing and help firms that are going public with leaving less money on the table in the future. There are many costs associated with the process of going public and the issuing firm should therefore want to minimize it. A way of doing this is to be more selective about which underwriter they choose and to what extent these underwriters are able to minimize the underpricing, even under difficult conditions, such as the public offering of technology firms.

We have set the time frame to cover IPOs done on the Nordic exchanges from 2010 – 2018. When choosing the timeframe, the trade-off is between the relevance of the sample size and its size. According to the central limit theorem (CLT), as the sample size gets larger, the distribution of means calculated from repeated sampling will advance towards normality. This will hold true regardless of whether the population is normal or skewed, provided a large enough sample size. Our sample contains over 450 IPOs and should therefore be sufficiently large for the CLT to hold. As we added smaller markets like spotlight in order to increase our sample size and also to catch more of the smaller firms, we wanted a rather neat timeframe to have as up to date results as possible. Several studies on IPO underpricing have chosen to exclude the smaller markets due to lower liquidity, smaller IPO size and less regulated. As our thesis will investigate underpricing with focus on typical growth companies as in the technology sector, we have included these IPOs, but we have excluded the OTC markets from our sample. One problem with lower liquidity on the smaller exchanges is that they will cause larger bid-ask spreads that could cause problems when calculating returns. Nevertheless, we find it beneficial to include this in our final sample as we seek to find broad generalizable evidence.

2. Literature review

In this chapter, we will first present what an IPO is. Then we will go on to describe the Nordic IPO market and the process of going public. After this, we present the underpricing phenomenon and discuss the literature on this topic. Finally, we will present a comprehensive overview of other studies done on IPOs.

2.1 Initial Public Offering

The process of selling stock to the public for the first time is called an initial public offering (IPO). This process makes a privately held company into a public company. There are usually two types of stock offerings in an IPO: A primary offering where new shares are issued and sold in the market to raise additional cash, or a secondary offering where some existing shareholders will sell some of the shares they hold. Anyway, the IPO will change the ownership structure of the firm, as the previous shareholders are either diluted by the effect of additional shares in the firm or because they have sold existing shares.

So why do firms decide to go public? Ritter and Welch (2002) asked this question and the answer was mainly for two reasons. First, to raise capital and secondly to create a public market for the shares. Access to capital markets is often essential for firms in a growth phase. Other benefits of being publicly traded is that it can more easily attract new investor that can contribute with funding if needed. Being traded on a public market place also gives the company's shareholders a possibility to easily exit the investment. The process of selling shares in a company that is privately held can often be complicated because of the lack of liquidity. Being publicly traded addresses these issues. It also allows insiders to cash out as both individual investor and VC/PE funds can facilitate an exit through the IPO. Other advantages of being public is that shares can be used in M&A deals, reward and incentivize key people by giving them shares and share options. By asking CFOs, Brau and Fawcett (2006) found that creating public shares for use in future acquisitions as the most important reason for going public. In a survey with a scale from 1-5, 59% of the CFOs gave this a 4 or 5, indicating strong support. Establishing a market price or value of the firm was the only other motivation given support from more than half of the population (51%).

Going public is a time-consuming and expensive process with transparency and disclosure requirements and pressure to deliver both in the short and long-term (Berk & DeMarzo, 2016). Transparency could be seen both as a positive and a negative thing. For investors, this will often be more positive as being public will create active monitoring on management by both analysts and investors. Companies that are heavily invested in R&D would probably not want to share as much information as they have to when public, as the requirements for financial reporting and publishing is strict.

Ritter (1987) states that firms going public has both direct and indirect costs. The direct costs are fees to investment banks and the indirect costs of underpricing. Ritter finds that small, more speculative firms tend to raise small amounts of money using best efforts offers, and larger and more established firms ted to raise larger amounts of money using firm commitment. The average transaction costs for firm commitment is 21.22% and 31.87% for best efforts (Ritter, 1987, p. 280). Another finding by Ritter was that the direct costs of going public is comparable between best effort and firm commitment, the indirect costs (underpricing) was greater for best efforts. So overall, the costs of going public was higher for best effort offers.

2.1.1 IPOs in the Nordics

When a company choose to go public in the Nordic region, their shares are listed on one of the exchanges. In Norway there is both Oslo Stock Exchange and Oslo Axess. Listing on Oslo Stock Exchange represents a full listing that follow all the requirements set up by EU, while Oslo Axess gives companies access to a regulated marketplace with less requirements. For larger companies with a proven track record, Oslo Stock Exchange is the obvious choice. Oslo Axess helps companies with less than three years of history to access capital (Oslo Børs). The same characteristics also applies for the other Nordic countries. Large companies would want to list on the main exchange, while often growth companies with less history would want to list on the less demanding exchanges. In our sample, we have used the following exchanges from Sweden: Stockholm Stock Exchange (Stockholm), First North Stockholm (FN Stockholm), Spotlight and Nordic Growth Market (Nordic GM). From Finland we have included Helsinki Stock Exchange (Helsinki) and First North Finland (FN Finland) and from Denmark we have used Copenhagen Stock Exchange (Copenhagen) and FN Denmark. The distribution of listings on the different exchanges can be seen in figure 1.

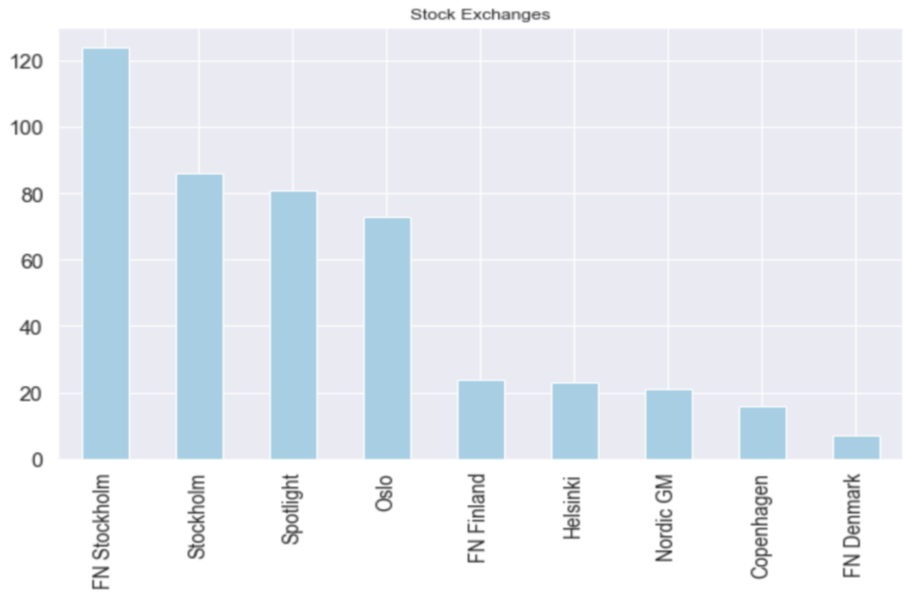

Figure 1 - Distribution of listings on the different exchanges in our sample. Here, Oslo Børs and Oslo Axess in under "Oslo".

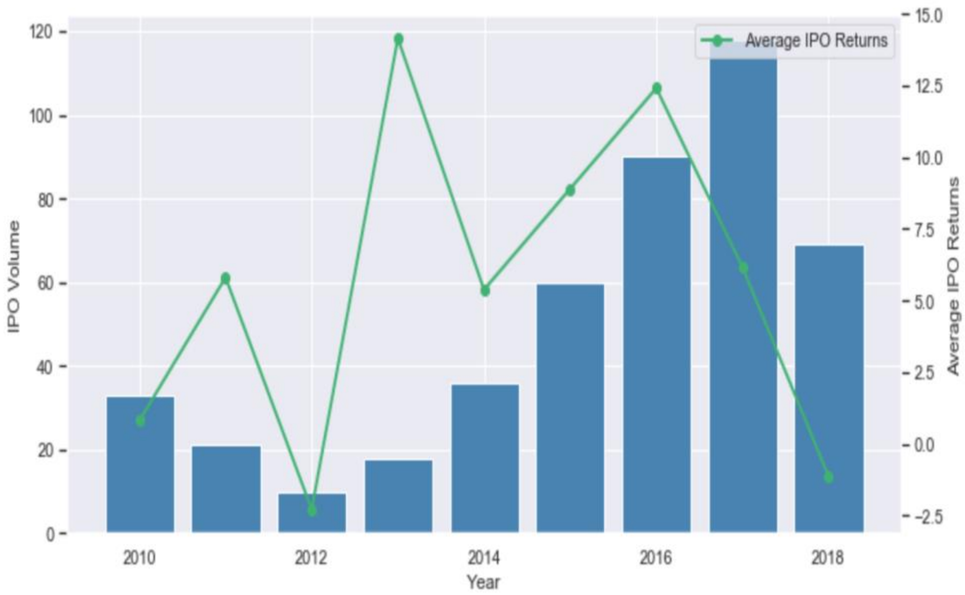

Figure 2 - Number of offerings and average first-day returns on Nordic IPOs, 2010-2018.

2.1.2 The process of going public

When a firm decides to go public, they will work with an underwriter, i.e. an investment bank that will manage the offering and organize the whole process. The firm and the underwriter must together decide what kind of offering they want, and at which market they would want to be listed on. This could be either primary or secondary offerings. The most common are primary offerings where new shares are sold to raise new capital. In the Nordic countries, the companies can usually choose between the main market which are aimed towards more mature companies. For companies wanting to list on the Oslo Stock Exchange for example, the admission rules are that a company has at least three years of financial history and a market capitalization of 300M NOK or higher. Smaller markets like Oslo Axess or Spotlight in Sweden has a less detailed requirements for listing. Table 13 in appendix A displays the listing requirements for IPOs on the Nordic markets we have included in our data sample. The main exchanges and the First North market in Denmark, Finland and Sweden are incorporated under Nasdaq and therefore have the same listing requirements.

The underwriter will then choose between three forms of deals; best efforts, firm commitment and auction IPOs. Best-efforts are when the underwriter does not guarantee that the stock will be sold but tries to sell the stock for the best price and if they are not capable of selling all stocks, the deal will be withdrawn. In a firm commitment IPO, the underwriter guarantees that the stock will sell at the offer price. If the underwriter is not able to clear their books, the underwriter has to bear all the risk. The auction IPO alternative has been used to some extent but is not as widely spread as the first two options.

The next step in the process of going public is the prospectus. This will give investors all insight into background, business strategy, financials, management, risks and comments on valuation of the company. The prospectus is required to be released before an IPO and gives investors a possibility to get more and detailed information on the company.
Then the underwriter will try to gather the market demand for the offering. This is often done by going on a "road show" where underwriters and managers travel to meet investors and promote the IPO. Investors will then give the underwriters non-binding bids and give the underwriters a sense of investors valuation. This is called "book-building". This process is the most common used in the Nordics.

The final step before the company goes public is the allocation of shares. When the offer price is set, investors will subscribe. If the investors want more shares than what the company offers, the IPO is oversubscribed. In an oversubscribed IPO, most of the shares will be allocated to institutional investors or the investors that has been bidding the highest price.

When all the prior steps are done, the company is ready to be listed on the listing date. This is the first day the company will be publicly traded. From this point on, the market will control the price. It's normal for the underwriter to be involved in price stabilization if the share price goes below the offer price. Investors who did not receive their desired number of shares, can now buy these. If the closing price on the first day of trading exceeds the offer price, we say the IPO was underpriced. If the IPO was underpriced, the company has left money on the table, because the market had a higher willingness to pay and could have raised even more money. We will now present the underpricing phenomena in a more detailed way and also present four theories on underpricing.

2.2 Underpricing of initial public offerings

Ljungqvist (2007) defines underpricing as the percentage difference between the price at which IPO shares were sold to investors (the offer price) and the price at which the shares subsequently trade in the market (p. 381). As we will go into in the next section, the most used valuation method is a mix of the Discounted-cash-flow method and multiples. This is then supplemented by the recent history of comparable IPO to get to the final valuation. Typically, the underwriters will set a price so that the return on first-day of trading is positive. The following figure illustrates the average first-day return in a number of European countries and the U.S. between 1980 and 2018. The average return varies from 3.3% in Russia to 50.8% in Greece. Norway, Denmark, Finland and Sweden have respectively average returns of 6.8%, 7.4%, 14.2% and 25.9%.

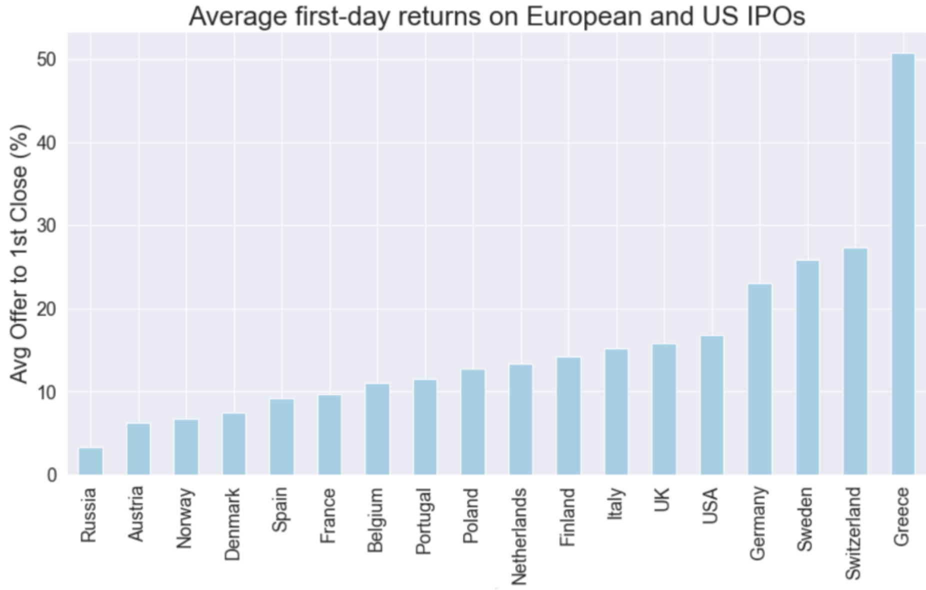

Figure 3 - Average first-day returns on a selected number of countries in the time period between 1980-2018. Source: Ritter (2018).

History from the U.S. stock market has showed that from 1960 - 2015, the average return on first-day of trading was 17% (Berk and DeMarzo, 2016). In addition, our sample from 2010 - 2018 on the Nordic IPO market, shows on average a positive initial return on first-day of trading of 6.32%.

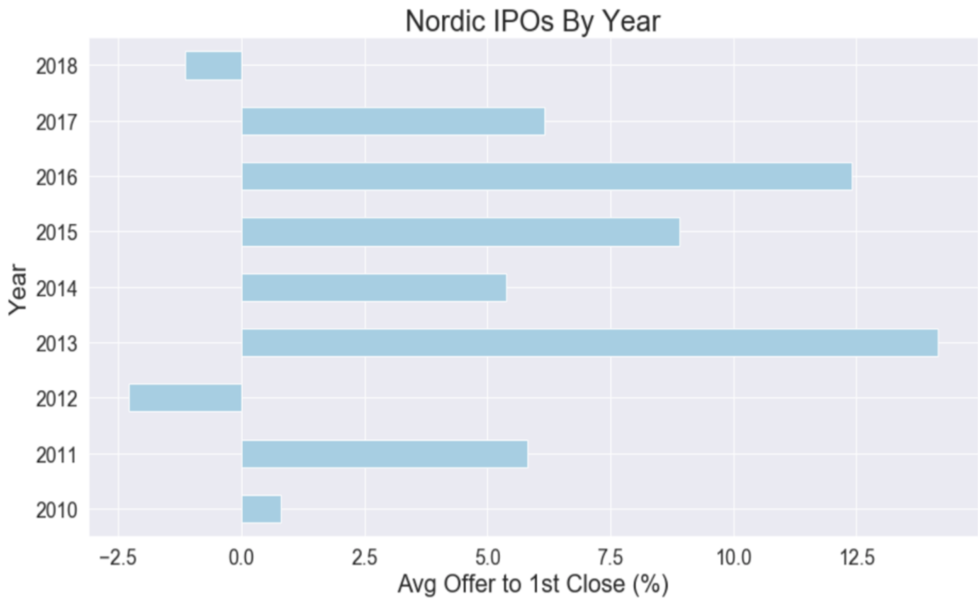

Figure 4 - Average offer to 1st close in percent from 2010 - 2018 in the Nordic market.

So, on average, firms leave money at the table. How come is not straightforward, but we will present some relevant explaining theories in the coming section. The most common used alternative in an IPO is the First Commitment IPO, meaning that the investment bank will have to bear the risk if they are not able to sell all the shares they have bought for the IPO. For this reason, the underwriter has the incentive to price the IPO as low as possible to reduce their exposure. On the other hand, their fees are on average 4-7% of the gross proceeds. Loughran and Ritter states that if the underwriter receive compensation from both the issuer (the gross spread) and investors, they have an incentive to recommend a lower offer price than if the compensation was merely the gross spread (2004, p.8). We will use Ljungqvist framework from 2007 to group underpricing into the following four categories: asymmetric information, institutional explanations, ownership and control, and behavioural explanations.

2.2.1 Asymmetric information

In an IPO transaction, the three major parties are the firm issuing the stock, the underwriters, and investors. Asymmetric information models that tries to explain underpricing assumes that one of these parties knows more than others. One of the most known of these models are winner's curse (Rock, 1986). This model builds on Akerlof's (1970) model about the lemon market. Winner's curse occurs when investors that have incomplete information tend to overpay. For the uninformed investor in unattractive offerings they get all the shares they demand, as opposed to attractive offerings, one must also consider the informed investors which will now receive a fraction of the shares. The implication this have on return for the uninformed investors is that they will get less shares in underpriced (attractive) IPOs and full number of shares in the unattractive IPOs. From this, the uninformed investors are not willing to buy, unless the conditional expected returns are non-negative so that the uninformed investors at least break even. Hence, Rock suggests that underwriters are underpricing IPOs to ensure that the uninformed investors participate in the IPO.

Schwert et. al. (2010) found that when the fraction of difficult-to-value companies goes public (young, small and technology firms), the degree of underpricing is higher. This is in line with the reasoning that firms that have high information asymmetry should also have higher volatility of initial returns (p. 427).

Another asymmetric information model is the signalling theory, the main idea behind this theory is that issuing firms will use underpricing as a way to signal the firms "true" high value. This is a costly way of doing it, because the successful firm can return to the market later to sell more equity at more favourable terms than previously. Ibbotson (1975) states that firms use this strategy to "leave a good taste in investors mouths". And when the firm chooses to raise equity next time, those investors would be more willing to repeat it, as they had a great return last time.

2.2.2 Institutional explanations

In literature, there are three institutional explanations for underpricing of IPOs. The first one is the lawsuit avoidance hypothesis, where the basic idea from Logue (1973) and Ibbotson (1975), argues that companies going public want to sell their shares at a discount to ensure that their investors are satisfied with their return from the IPO and reduce the likelihood of future lawsuits from disappointed investors.

The second theory from the institutional point of view relates to price support. One of the tasks for the underwriter is to help stabilize the share price after the offering so that in don't experience large drops. They do this by overselling the IPO up to 15%. This means the underwriter has a 15% short position. If the stock price falls below the offering price, the underwriter will cover the short by buying the stock at offer price and in this way reduce further decline. If the market price exceeds above the offer price, the over-allotment option will come into play. This gives the underwriter the right to buy shares at strike (offer price). The profit for the underwriter will then be the market price less strike price times the shares. This mechanism of price stabilization helps increase the initial return of the IPO as underwriters keeps the share price at or above the offering price. Such interventions would tend to eliminate the left tail of the distribution of initial returns (Ljungqvist, 2007). As the underwriter receives fees based on the offering price, they have the incentive to put this as high as possible and because of the "greenshoe option", they have limited their downside.

The third theory of IPO underpricing from an institutional standpoint is that it has a tax effect. Depending on the tax situation for the specific company, there could be tax advantages for the firm, leading managers to prefer underpricing to some extent. For example, if a country has a much higher tax level for employment income than capital gains, a company have an incentive to pay employees an asset that will appreciate down the road, such as shares in the firm before an IPO. The average underpricing in Sweden fell from 41% in 1980-1989 to 8% in 1990-1994 after the Swedish tax authorities made the gains from underpricing subject to income tax. This clearly removed an incentive for the firms to have larger underpricing (Ljungqvist, p. 408, 2007).

2.2.3 Ownership and control

Brennan and Franks (1997) states that underpricing can be used by managers of the firm to protect their private interest by allocating shares strategically when they decide to go public. They argue that underpricing is used to get the IPO oversubscribed so that managers are allowed to distribute shares only to the investors they want holding shares. Another finding in the paper is that the rationing that occurs in an oversubscribed IPO discriminates applicants that want a large block of shares. By having smaller investors, the managers can keep greater control of the now public firm.

To reduce agency costs, Stoughton and Zechner (1998) argued that by allocating shares to large outside investors who is able monitor management, this could be seen as value creation for the other shareholders. They argue that monitoring is a public good that all shareholders benefit from, whether or not they contribute. As the incentive to monitor increases with their stake in the company, and it will therefore be optimal to obtain large shareholders, and thereby establish an incentive to engage in monitoring activities.

2.2.4 Behavioural explanations

Behavioural theories for IPO underpricing assume the presence of irrational investors. These investors either bids to high so that the price of IPO shares exceeds their true value, or they are subject to cognitive biases leading to an extensive underpricing from the underwriter as the investors fail to put enough pressure on them.

Informational cascades are introduced in Welch (1992) and exist when investors make their investment decisions sequentially. Initial sales work as a signal and successful initial sale creates a snowball effect leading to extensive demand. On the other hand, disappointing initial sale will keep the demand low over time. This existence of cascades gives the investor who invest early in the offering process market power. The early investors can in this way claim a lower underpricing from the start to commit to the IPO in the first place.

Ljungqvist et al. (2006) presented a theory they called investor sentiment. According to this theory, investors are buying or selling assets depending on the investor sentiment rather than the fundamental value. They assume some sentiment investors hold optimistic beliefs about the future of the company going public. In their view, it is the issuer’s objective to capture all “surplus” under the sentiment investors demand curve, meaning to maximize the excess valuation above the fundamental value of the stock. In order to do this, they would need to hold some shares back to prevent a surplus in the market. Firms will try to use institutional investors as a middleman and holding on to the stock while gradually sell off. This creates a risk exposure for investors holding the stock and they would need to get compensated for it. This is done by buying shares at above fundamental value but is expected to gain from this by selling them on to retail investors at an even higher price. As companies going public is characterized as young and difficult to value, over time, the IPO stock price will have a mean-reverting process to its fundamental value. This is in line with the evidence of Ritter (1991) that the long-term performance of IPOs is negative. A problem with this theory is that it assumes constraints on short sales. If these constraints are not present, as in the actual market, arbitrage is possible. In a market where short-selling is allowed, investors will short the stock back to its fundamental value and exposing the institutional investors to the risk.

Loughran and Ritter (2002) argued that issuers don’t “get upset” of leaving money “on the table” because they will tend to sum the wealth loss due to underpricing with the larger wealth gain on retained shares as prices jump in the after-market. They use the prospect theory introduced by Kahneman and Tversky (1979) and states that by integrating the bad news (leave money on the table) and the good news (a high increase of net worth), the stockholders will great with their net gain.

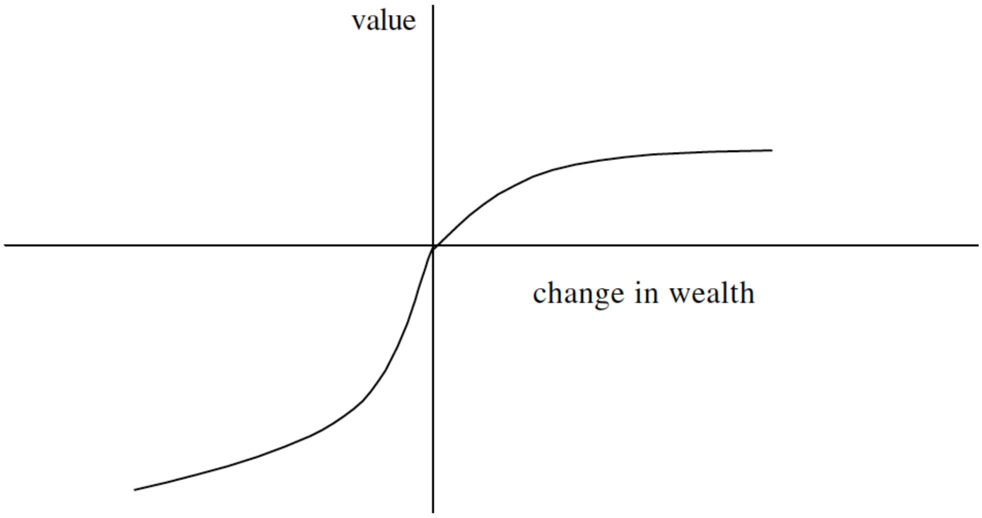

Figure 5 - Prospect theory's value function based on Kahneman and Tversky (1979). Source: Loughran and Ritter (2002).

Prospect theory assumes that gains and losses are valued differently. Each individual has a value function in terms of gains and losses. The function is concave in gains and convex in losses, as presented in figure 4. In the context of going public, the reference points become the offer price and not the historical cost price. When individuals face to outcomes, prospect theory argues that can either treat them independently or together. Whether individuals treat them together or not, depends on the amount of value. An individual would rather take two gains separately than one gain of twice the size. This is because the because the value function of a positive value gain is concave. And as the value function for losses is convex an individual would rather take the losses together. When a firm leaves money on the table, the shareholders can therefore treat the bad news (leaving money on the table) together with the good news (large increase in net wealth) and still feel good about it, because the gain from going public is markedly higher. This also highlights how important the framing is. If the firm that is going public could set distinguish between the cost of underpricing and the net gain of going public, instead of as a package, most firms would be much more resistant to the cost of underpricing. But because this comes as a package, the good news outweighs the bad news and there is much less opposition.

To summarize, IPOs are underpriced in almost all countries and we also know that the number of firms going public and the extent of underpricing of these companies varies over time. We have presented some of the theories trying to explain underpricing and the empirical evidence supports in first-hand the view of that information frictions (including agency conflicts) has the most effect on underpricing (Ljungqvist, 2007). Theory of asymmetric information between stakeholders participating in the IPO, such as Rock's winner curse theory is also a widely accepted model. Often will the theories on underpricing only explain some parts of the picture and in order to understand the whole picture, we would need to use them together.

2.3 Other studies on IPOs

From 2010 to 2018, the number of firms going public has varied greatly. From 2010 to the bottom year of 2012, the trend was negative. From 2012 to 2017 it was a steady increase to about 120 firms going public. 2018 was step back to around 65 with negative initial return. The average first day return on the IPOs in our sample is equal to 6.32%. However, if we look into sector specific first day returns, we find that the technology sector has 10.14% average first day returns, followed by the industrial sector with 9.64%. This difference in first day returns opens up for investigation related to underpricing within sectors and shows us that these IPO phenomena are not restricted to Silicon-valley companies but perhaps a much broader financial market. In fact, studies on different international markets have documented substantial abnormal returns related to IPOs, see for instance Ritter (2018) or Younesi, Ardekani & Hashemijoo (2012). This contradicts Eugene Fama's Nobel-prize winning theory, the efficient-markets hypothesis, hence imposing a challenge for financial research.

The literature on IPO underpricing is extensive, however the literature still leaves with open ended questions which are considered a scope for further research. Usually, the literature is categorized in research topics such as the timing and the reason of going public, the initial underpricing of IPO stocks, aftermarket activities, and the long-run performance of IPOs. Further, the literature is dominated by empirical studies, whereas the number of theoretical studies is relatively modest. However, the goal of this paper is not to provide a new innovative theoretical framework, but rather investigate whether the technology-sector is significantly more underpriced compared to other sectors in the Nordic market. Nevertheless, the initial underpricing of IPOs appears to be substantial across several international markets. For instance, Welch & Ritter (2002) and Loughran & Ritter (2004), provides evidence from the periods 1980s, 1990-1994, 1995-1998 and the internet bubble years 1999-2000, and the years thereafter. For the US, average first day returns were 7.4% for 1980-1989, 11.2% for 1990-1994, 18.1% for 1995-1998, 65% for 1999-2000, and 14% for 2001. Loughran & Ritter (2004) feature this time-variation to the characteristics of the companies going public. Further, Ljungqvist & Wilhelm (2003) found similar effects, particularly for many high-tech firms going public on Nasdaq, which gave reason for the tremendous increase in the number of IPOs during the late 1990s (Welch & Ritter, 2002, p. 9).

Studies related to aftermarket activities provides evidence that there is a difference between aftermarket and expected return behaviour for IPOs in later periods. Potential explanations are market maker activities and the time up to the lockup period. For underwriter activities such as price support, see Bradley et al. (2001) and Aggarwal (2000). On the other hand, Wagner (2004) provides another explanation for abnormal aftermarket performance related to risk considerations. The literature on long-run performance of IPOs suggests that the performance is rather weak when compared to a relevant market index. Ritter (1991) interpreted this long-run underperformance as an indication of cyclic over-optimism with respect to the earnings potential of young growth companies. In contrast, Brav et al. (2000) found that this poor long-run performance was not unique to issued companies. In addition, Eckbo & Norli (2004) suggests that long-run underperformance of the Nasdaq IPOs could be explained with a risk factor model.

The above-mentioned empirical features are often used to derive theoretical predictive models. For instance, Ljungqvist et al. (2003) developed a model based on sentiment investment behaviour and short-sale constraints which offers testable implications with respect to underpricing and long-run performance, among other reasons. Benninga et al. (2005) endogenize the IPO timing decision in their model and predicted, among other issues, IPO clustering and long-run performance.

3. Methodology

We will in this chapter present a framework for valuing companies. Then we will go into how you can value an IPO and present the theory on this topic. Finally, we state our hypothesis.

3.1 Valuation Framework

When valuing firms, there are three main ways of doing it. These are the Dividend-Discount-Model (DDM), Discounted-Free-Cash-Flow (DCF) model and valuation based on comparable companies. The Dividend-Discount-Model says that today's stock price should equal all future dividend payments, discounted back to their present value. This method is not preferable when valuing high-growth companies like technology firms often are, as these companies would want to use all their cash to finance increased growth, not distribute it to its shareholders.

In the DCF method we will estimate the firm's enterprise value by finding the market value of equity, adding cash and subtracting debt. Here the market value of equity is given by forecasting free cash flow and then discount this by the weighted average cost of capital (WACC). To estimate value per share, we divide equity value by the number of shares. Some of the advantages of the DCF-method is that it offers the closest estimate of a stock's intrinsic value and that it also isn't significantly influenced by the short-term market conditions. The DCF-method is highly sensitive to the assumptions used, for instance, the growth rate for forecasting. On the other hand, a strength is the ability to adjust for each specific firm.

The last method for valuation is using comparable firms. In this method, rather than value the firm's cash flows directly, we will estimate the value of the firm based on the value of other, typically already trading public companies. One way to do this is by applying multiples, which is a ratio of the value to some measure of the firm's scale. The most used valuation multiple is the price-earnings (P/E) ratio. This is calculated by dividing the stock price to earnings per share. Other multiples using share price are for instance, the price-sales (P/S) or price-book (P/B). Besides these, common practice is to use multiples that are based on the firm's enterprise value.

This could be enterprise value divided by earnings before interest and taxes (EV/EBIT) or enterprise value divided by earnings before interest, taxes, depreciation, and amortization (EV/EBITDA). If one company would have been perfectly equal to another, multiples would match precisely, but in the real world, no firms are identical. Therefore, only using multiples is not considered as an adequate way in valuing a firm. A mix between the DCF-method and multiples if you have comparable companies are most likely the most effective way of valuing a stock before an IPO (Deloof, et al, 2009). However, finding comparable firms is challenging, especially within the technology sector were firms often have unique firm specific characteristics.

Koller et al. (2015) provides a framework for valuing high-tech companies. They argue that instead of starting by analysing past performance, you should rather start by identifying the long-term development of the company, and then move backwards. These companies typically lack data as they often are young and, hence focusing on the potential size of the market is important. In addition, one should also focus on potential market shares, and what level of return of capital the company is able to generate.

3.1.1 Valuing IPOs

As mentioned earlier, firms that go public are typical young companies without a long financial history. This makes it difficult to apply the normal DCF-approach when valuing a company as this requires multiple years of financial history. Academics has therefore suggested to use multiples like price-to-earnings, price-to-sales, enterprise value-to-sales and enterprise value-to operating cash flow ratios. However, Kim and Ritter (1999) found that this is of limited use if they use historical numbers rather than forecasted ones. They argue that within an industry, these ratios vary so greatly that they have limited predictive value. Therefore, they are suggesting that practitioners should use forecasts as this will improve the valuation accuracy substantially. They also come to the conclusion that the valuation methods predict better when valuing old firms than young firms as we would expect. Another interesting point that Kim and Ritter presents is the role of the investment bank when valuing IPOs. Stating that using the midpoint of the offer range results in smaller prediction error than using comparable firms, investment bankers are more accurate when valuing IPOs. As they also are able to map the market demand through contact with market participants, investment bankers have an additional value according to the study.

Roosenboom (2007) performed a study on 228 IPOs on Euronext Paris between 1990-99 to find out how underwriters selected methods to value IPOs. His findings were that underwriters usually used multiples, DDM, and the DCF-method to value IPO firm's equity. He also found that underwriters preferred to use multiples when valuing technology firms and fast-growing firms and/or profitable firms. As we would expect, he found that the DDM is more popular on mature firms paying out dividends. The DCF-method was preferred when the aggregate returns of the stock market were high and a possible explanation Roosenboom has for this is that during high returns, investors are more eager to buy stocks and therefore also more willing to believe the underlying assumptions of the DCF-method.

Another study done in the field of how underwriting investment banks value IPOs is Deloof, et al. (2009). They look at 49 IPOs on Euronext Brussels from 1993-2001 and finds that the lead underwriter almost always uses several valuation techniques, of where the DCF is the most common method. This is in contrast to the findings of Kim and Ritter (1999), Roosenboom (2007) and several other academic papers suggesting that the most used valuation technique is multiples of comparable firms. They present evidence suggesting that the DDM tends to underestimate value, while the DCF produces the most accurate result. On the other hand, the results they present suggest that DDM, DCF and commonly used multiples have roughly the same accuracy. As Ritter and Kim (1999) proposed, investment banks are relying on forecasted earnings and cash flow which yields more precise valuation than using pre-IPO data. Another interesting discovery from the study revealed that investment bankers often underestimate the IPO intentionally, by applying a discount to value estimates in DCF-method. Loughran and Ritter (2004) states that if the underwriter receive compensation from both the issuer and the investor, they have incentives to propose a lower offer price than if the compensation was merely the gross spread - which is in line with what Deloof, et al. (2009) found.

3.2 Hypotheses

In order to formally test some of the previous findings on the Nordic market, we will form four hypotheses. The first hypothesis is a test to check for general underpricing in our dataset.

Hypotheses:

1. *Nordic IPOs between 2010 - 2018 have been fair priced.*

Where we define a fair priced IPO as having zero underpricing, meaning that the underwriter's valuation is the same as the market valuation after the 1st day of trading. In a market without friction where the efficient market hypothesis holds, this hypothesis will also hold. Our null hypothesis is that there is no significant underpricing in this time period. The alternative hypothesis is that we can observe significant underpricing in the time period. If we get a p value smaller than or equal to 0.05, we will reject the null hypothesis that Nordic IPOs has been fair priced and support the alternative hypothesis that there is significant underpricing.

2. *Technology sector underpricing variance is equal to all other sectors variances.*

If hypothesis 2 is rejected, we would expect that the variance of underpricing of technology IPOs is statistically significant from non-tech IPOs. As technology firms often has the characteristics of firms that are difficult to value, such as low earnings, young and focused on future growth rather than profitability today. A larger variance of underpricing will then work as a proxy for the differences in value perception between the investment banks and the market.

3. *No significant difference between the level of underpricing between tech IPOs and non-tech IPOs.*

If hypothesis 3 is rejected, we would expect that there is more underpricing of tech IPOs than it is by non-tech IPOs. Technology firms are typically younger firms when they go public and are much harder to value. This increases the level of asymmetric information. Hence technology firms are often more risky than non-tech firms. Consequently, investors require higher returns for higher risk, therefore increasing the level of underpricing. This would be in line with Beatty and Ritter (1986) findings that there is a positive relationship between the ex-ante uncertainty about the IPO value and it's expected underpricing.

4. *No significant difference between the level of underpricing between young and old companies.*

If hypothesis 4 is rejected, we would expect that there is more underpricing of young companies than old companies. According to Ljungqvist and Wilhelm (2003), the age of a company can be used as a proxy for valuation uncertainty. As young firms lack historical financial data, we would according to theory expect young firms to be more underpriced than older firms. Loughran and Ritter (2004) classified young firms as 7 years or younger and older firms as older than 7 years. We will follow their suggestion and it also fits well with our data, where the median age of a company in our dataset is 7 years.

4. Data and preliminary analysis

4.1 Data description

Our data is gathered from Bloomberg, Bloomberg Finance L.P. We have extracted IPOs performed in the period 2010-2018 on all major exchanges in Norway, Sweden, Denmark and Finland. We excluded Island from our sample, because there were not any technology IPOs during the sample period, hence the population is clearly not representative for our research. In addition, the OTC exchanges such as Norway OTC and Dansk OTC were excluded mainly because of their size and impact (e.g. liquidity), but also because of data quality. We believe in the reasoning of the Director of Research at Google, Peter Norvig - «good data beats more data...». Further, we have only included IPOs were there have been shares issued in relation to the listing. Implicitly this means we have excluded listings, list changes, separate listings as well as offerings of preferential shares, which implies we are only studying initial public offerings of common shares.

To avoid missing transactions, we have used the websites of Nordnet Bank, Oslo Børs, nyemissioner and Nasdaq to control for potentially missing IPOs and quality checks related to listing dates, shares offered, etc. From our initial sample from Bloomberg, firms that have been delisted or gone default was missing. We have therefore added back these companies in order to avoid survivorship bias. Survivorship bias is the tendency for failed companies to be excluded from performance studies because they no longer exist. It often causes the results of studies to skew higher because only companies which were successful enough to survive until the end of the period are included.

4.1.1 Source & Definitions

The dependent variable we will use is first-day returns. This is simply the return during the first-day of trading, which is the is the percentage difference between the closing price first day of trading and the offer price:

$$R_i = \frac{P_{t+1,i} - P_{t,i}}{P_{t,i}} \tag{4.1}$$

Where R_i is the first-day return of IPO firm i, $P_{t+1,i}$is the first day closing pricing of IPO firm i, and $P_{t,i}$ is the offer price of IPO firm i at the time of the offering. A positive first-day return means that the market price is higher than the offer price and is therefore underpriced. This implies that the valuation of the IPO has been lower than the market valuation. We can define

$$If\ R_i < 0: The\ IPO\ is\ overpriced$$

$$If\ R_i = 0: The\ IPO\ is\ fair\ priced$$

$$If\ R_i > 0: The\ IPO\ is\ underpriced$$

Some prior research uses market-adjusted return instead of the simple first-day return, but Beatty and Ritter (1986) argues that adjustments for market movements in the first-day return calculation would only result in minor changes. Therefore, we will throughout our thesis use simple first-day return, not adjusted for market movements.

We have defined firm age as the difference between the IPO year and the founding year. Founding year has been manually gathered from different sources for each company's home country. Norwegian company data is gathered from Brønnøysundregisteret, Swedish data is gathered from proff.se which uses Creditsafe as source, Danish data is gathered from CVR and Finnish data from virre prh. All of these are government official business registration centres except from the Swedish. Loughran and Ritter (2007) suggested that firm age affected the outcome of IPOs. They found that younger firms (0-7 years) on average yielded a higher initial return. We have therefore added a dummy variable in our regression model for young and old companies, were we have set young companies to 0-6 years and old companies to be 7 years or older. The median company age in our dataset is 7 years old. The Age variable shows patterns of being log-normally distributed and we have therefore created a variable called *log age* that we use in our regression model. Typically, firms will seek to go public early on rather than late, so it has the characteristics of a log-normal distribution.

Other firm specific variables we have added in our dataset is revenue, earnings before interest and taxes (EBIT) and offer size. This has been gathered through data from Bloomberg and we have manually added data from prospectus and annual reports where there was missing data. These numbers have been picked from the year before the IPO took place, i.e. ex ante financial measurements. The one-time expenses from the IPO will often reduce the EBIT for the year before IPO, but we still mean EBIT is a suitable measure. Offer size is calculated by multiplying the offer price with the number of shares offered in the IPO. We will then see if these three variables have already been taken into account in the offer price or if they can explain to some degree the underpricing. For financial institutions, we have used operating result instead of EBIT. This is because for a financial institution, interest income and interest expenses are a part of their core operations and will therefore be a better measure than EBIT. Revenues offer size and EBIT collected from Bloomberg was in local currency, so we have adjusted all sizes to Norwegian Kroner (NOK), using the exchange rates from 9. April 2019.

4.1.2 Industry classifications

For industry classification, we have used the Bloomberg standard, however, with some moderations. For instance, we have merged industries were there were few observations into something more appropriate. In addition, we have merged the non-cyclical consumer with cyclical-consumer sectors as we find these to be rather similar. With more observations within each sector, we are able to take advantage of the law of large numbers and our data will be more robust from an econometric point of view. Table 1 displays industry observations before adjustments.

Industry	Observations
Consumer, Non-cyclical	139
Technology	70
Industrial	70
Financial	58
Consumer, Cyclical	45
Communications	33
Energy	27
Basic Materials	7
Utilities	4
Diversified	2

Table 1 - Industry sectors before adjustments.

As you can see from the table 1, we have sectors with very few observations. Hence, from diversified we moved Volatil AB to financials and Aurora LPG Holding to industrial. From utilities we have moved Viafin Service to the Industrial sector, and Fjordkraft, Orsted and Climeon to the energy sector. From Basic Materials we have moved all 7 companies to the industrial sector. Then we are left with 6 industry classifications: energy, consumer, industrial, financial, technology and communications. Even though there exist more industries than this, we argue that broader sector classifications are beneficial because we are able to obtain more generalized results. However, this comes at the cost of accuracy for sectors such as consumer because this is our most generalized sector classification. For instance, we could have included health Sector as a classification, which has similar characteristics as the technology sector as this often includes young growth companies etc. On the other hand, we are convinced that using an already established classification system is the best in order to avoid biases and arbitrary assumptions. After these adjustments, the final industry classifications and their observations are summarized in table 2.

Industry	Observations	Initial Return
Consumer	184	6.12%
Industrial	79	9.64%
Technology	70	10.14%
Financial	59	-0.06%
Communications	33	1.44%
Energy	30	7.73%

Table 2 - Industry sectors after adjustments.

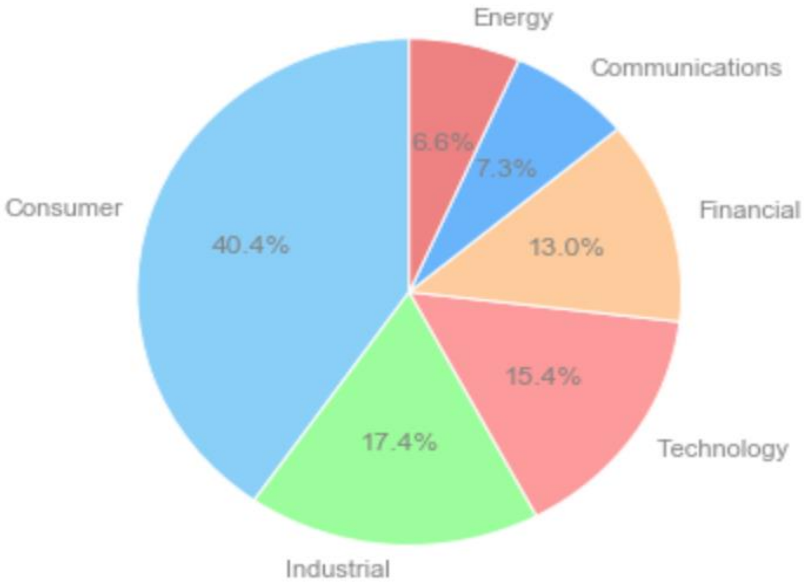

Figure 6 - Pie chart of the sectors and their percentage of the total sample. I.e. Consumer sector represent 40.4% of the sample.

4.1.3 Exchange

Firms going public operate in different industries, but they are also listed on different exchanges. As the exchanges in the Nordic countries have a different set of rules and requirements for listing, we would expect to see some differences between the companies listed on the other exchanges. That being so, we see that the companies listed on the main exchanges have substantially larger revenues and EBIT than the companies listed on the secondary exchanges. Firms listing on the main exchange are also on average older than the firms listing on the smaller exchanges. It is worth mentioning that the four exchanges located in Sweden accounts for 69% of the listings. A brief summary of listing requirements for the exchanges in our sample is provided in the appendix.

Exchange	Observations	EBIT	Revenues	Age	Initial Return
Oslo	73	504.89	3,652.26	18	2.71%
Stockholm	86	190.33	2,397.59	15	10.41%
Copenhagen	16	460.47	15,021.90	16	8.94%
Helsinki	23	409.44	2,787.90	13	5.33%
FN Stockholm	124	0.35	83.41	9	8.29%
FN Denmark	7	-4.36	5.98	10	9.66%

FN Finland	24	16.06	273.40	16	0.54%
Spotlight	81	-1.55	10.04	8	9.27%
Nordic GM	21	-4.01	22.17	14	-16.42%

Table 3 - Average of firm-specific variables by exchange. Revenues and EBIT are in million NOK.

By looking at initial returns, Stockholm has the highest of 10.41% and Nordic GM has the lowest with -16.42%. Large deviation from zero would imply that the market has a different perception than the underwriters on the value of the firm going public. According to theory on asymmetric information, one would expect that IPOs done on the smaller exchanges with less demanding regulations would lead to a higher degree of underpricing, but just looking at the mean of the initial return, this doesn't seem to be the case. It is worth noting that by splitting the data this way, we create smaller sample sizes and we should therefore be careful about making any statements and it serves more as a way to get an overall look at the data.

4.1.4 Extreme values & Distribution

4.1.4.1 Dependent variable

Outliers often represents a fundamental challenge in empirical financial research. Our study is no exception, and as we are conducting OLS regression we have to make sure we are not subject to outlier biases. There is no clear consensus on how to deal with extreme values, however, there are plenty of methods. In order to correctly test for spurious outliers and their influence we conducted two visualization techniques. In order to not violate the normality assumption when conducting OLS regression, we can visualize our sample by a simple density histogram. In figure 7 you can see our raw data sample. As you can see, we have several extreme values and the sample is slightly skewed to the right. In addition, we conducted a Shapiro normality test, which confirmed our suspicion of non-normal distribution. Note that when working with real numbers in studies, having normal distributions are more the exception than the rule.

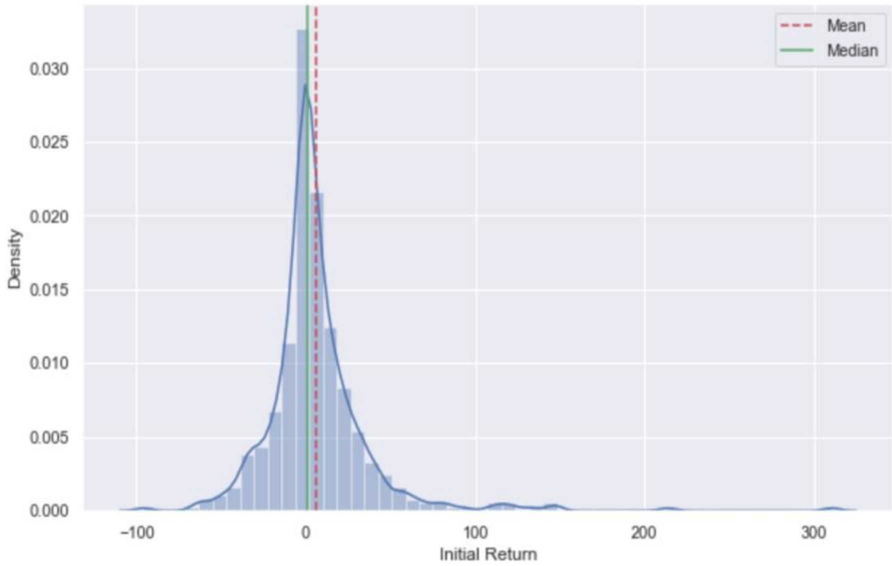

Figure 7 - Histogram showing initial return and density in our sample.

Further, we run an outlier test called Cook's Distance of our regression model A. This test plots the influence of outliers in a regression and shows us studentized residuals versus leverage. As we can see from figure 8, we have several values that may distort the accuracy of our regression. With these two findings we argue that making small adjustments to ensure the robustness of our models is highly important.

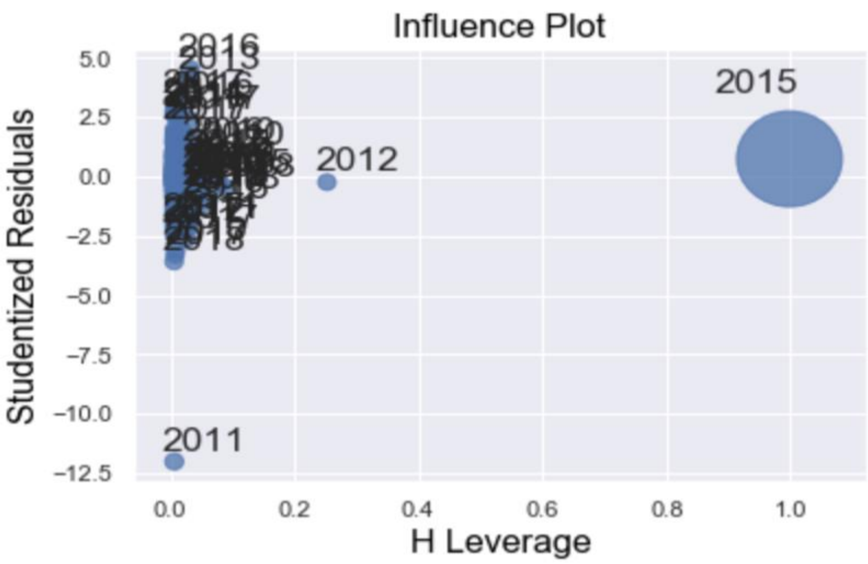

Figure 8 - Cook's Distance test, outlier influence plot

We believe that instead of removing observations, which will lead to a highly biased sample, it is better to use the winsorizing method. In fact, according to a study by Adams, Hayunga, Mansi, Reeb & Verardi (2019), for the 3.572 studies published in the top 4 financial journals during 2008 to 2017, only 28% actually mentions outliers. In addition, the 717 studies that uses OLS regression and mention outliers, the large majority (52%) uses winsorizing. However, one major concern with winsorizing is that extreme values are affecting our sample, and one could argue that manipulating raw data is dangerous. On the other hand, if the impact of outliers is strong enough it is utmost important to ensure robustness of the statistical models.

For us to be able to study a generalizable effect of underpricing under these circumstances, our empirical results cannot be driven by a small fraction of our sample. On the other hand, the level of winsorizing can be arbitrary, and hence we have to evaluate different levels to find the most appropriate for our data. We believe our sample and distribution is best with 1% as we are able to compromise outlier effects without causing too much inference. In figure 9, you can see our winsorized distribution, it is still skewed to the right, however we are able to replace the 1% extreme values with the highest value in the 99th percentile and reduce the impact of outliers. From Figure 10 on Cook's Distance, you can see a remarkable difference in outliers influence compared to the raw data sample. In appendix C, you will find normal probability plots of both data sets. Note that we once again conducted a Shapiro normality test which still confirmed the non-normality of the distribution. However, our sample size should be sufficiently large enough for CLT to hold and hence our distribution should approximately converge towards normality.

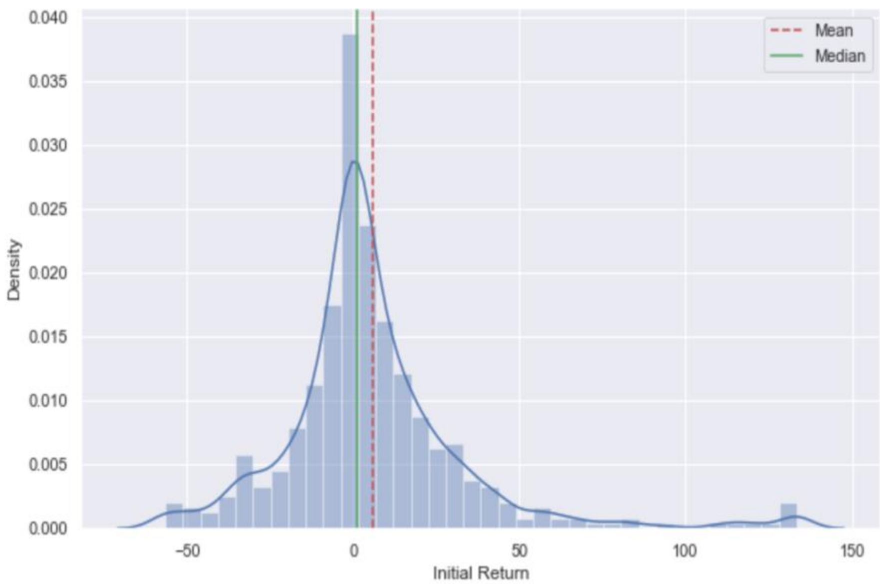

Figure 9 - Histogram showing winsorized initial returns and density.

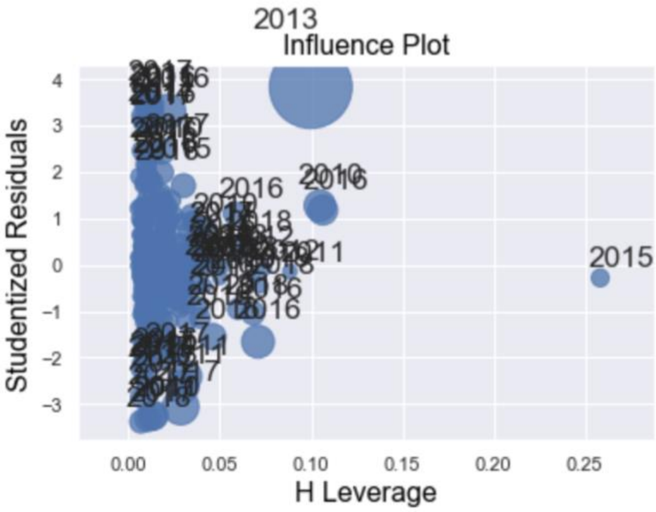

Figure 10 - Cook's distance, influence plot after 1% winsorizing of initial return.

4.1.4.2 Independent variables

The importance of normality is just as valid for our independent variables as for our dependent. Since we are working with accounting figures such as revenues and earnings before interest and taxes, we encountered extreme values and non-symmetrical distributions for these numbers as well. For instance, due to the nature of revenues only being positive, the distribution is clearly right-skewed (See Figure 13 in appendix B). In order to deal with this, we took the natural logarithm and obtained a much better distribution in addition to being adjusted for extreme values.

Further, our data for EBIT varies and is subject to extreme values in both negative and positive numbers. Hence, we found it most appropriate to winsorize as we did with initial return in the previous section. In order to avoid arbitrary biases, we set the level at 1% again for consistency and generalizability. This gave us a much more symmetrical distribution and we were able to adjust the extreme values (See Figure 14 in appendix B).

4.2 Statistical methods

As we are investigating IPO underpricing between industries in the Nordics, summary statistics can provide substantial insight. However, this alone is not sufficient to answer our hypothesis as well as fundamental questions, and therefore we will utilize more powerful statistical tools. Moreover, if the technology industry is subject to higher degrees of uncertainty compared to other sectors, we need to look at average effects to confirm the uncertainty.

In our attempt to find a reason for large valuation differences between sectors we need to look at what can actually explain the variation of returns. We will therefore investigate if the technology sector is subject to greater valuation variances by comparing the variance of initial returns against other industries. If we find a significant difference, this would not explicitly imply that tech is subject to higher degrees of uncertainty, as variance only measures deviations from the mean. Instead it will show us variation in terms of investment banks valuation against the market perception of valuation, which can be interpreted as an indicator for valuations difficulties and uncertainty.

4.2.1 T-test

We will use a two-sided t-test to examine whether the underpricing phenomenon is present. The null-hypothesis is that the expected value (mean) of our sample is equal to the population mean (zero). If the p-value is lower than our chosen alpha, we will reject the null-hypothesis that the mean is statistically significantly different from zero, which will prove that underpricing exists.

4.2.2 Levene's test of variances

To check for homogeneity of variances we will conduct Levene's test of homogeneity of variances. The null-hypothesis is that all input samples are from populations with equal variances, which in our case can be translated into; technology sector underpricing variance is equal to all the other sectors variances. Hence, we will categorize the groups as technology firms against the rest of the sample. The test statistic, W, is defined as

$$W = \frac{(N-k)}{(k-1)} \times \frac{\sum_{i=1}^{k} N_i (Z_{i} - Z_{..})^2}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} (Z_{ij} - Z_{i.})^2} \tag{4.2}$$

Where N is the total number of observations, $N_i$is observations in group i, $k$is number of groups, $Z_{ij} = \left| Y_{ij} - \underline{Y_i} \right|$where $Y_{ij}$is the value of observation $j$from group i, $Z_i$is the mean of $Z_{ij}$for group i and $Z_{..}$is the average for all Z_{ij}. Further, the test statistic, W, will be compared to the critical value, which is taken from an F-distribution with k-1 and N-k degrees of freedom. Levene's approach is powerful and robust to non-normality, it will accept slight deviations from normality and hence it is a good fit for our data (Gastwirth, Gel & Miao, 2009).

If the p-value is lower than our chosen significance level, we can reject the null-hypothesis, which proves that the underpricing variance in the technology sector is statistically significantly different from the other industries. If we cannot reject the null-hypothesis, we will not be able to say that technology underpricing variance is different than the other sectors. Thus, we will be able to find indications for whether difficulties in valuations of technology firms compared to other sectors is present or not.

4.2.3 Kruskal Wallis H-test

Due to patterns of skewness in our sample, we will conduct a Kruskal Wallis in order to ensure the validity of our results. It is a nonparametric version of the ANOVA test, thus more reliable when facing non-normality in the comparison of two groups. The Kruskal Wallis tests the null-hypothesis that the population median of all the groups are equal. Hence, we can use it to test for medians between industries and firm age. Note that rejecting the null does not indicate which of the industries that differs. The test-statistic H is calculated by:

$$H = (N-1)\frac{\sum_{i=1}^{k} n_i(\underline{r_i}-\underline{r})^2}{\sum_{i=1}^{k}\sum_{j=1}^{n_i}(r_{ij}-\underline{r})^2} \tag{4.3}$$

Where N is the total number of observations, n_i is the number of observations in group i, $r_{ij}$is the rank of observation j from group i, $\underline{r_i}$ is the average rank of all observations in group i and $\underline{r}$ is the average of all the r_{ij}.

By investigating not only the mean, but also the median can give us insightful information when it comes to the variation of underpricing. If the observed p-value is lower than the chosen significant level and we reject the null-hypothesis, this would imply that the underpricing medians are differently distributed among industries. Although we will not be able to conclude which industries, it is important for us to seek answers related to average effects. These answers are important in order to draw robust and powerful conclusions later.

Further, we will also conduct this test for our hypothesis 4. If the observed p-value here is lower than the chosen significant level and we reject the null hypothesis, this would imply that the underpricing medians are differently distributed among young and old firms. If we find a significant effect, it can indicate that firm age has an impact on the degree of underpricing. By conducting this test, it allows us to check whether potential industry underpricing is not only explainable by age, but also other factors. For instance, if we cannot reject the null hypothesis, we will not be able to say that company age has a significant impact on the average underpricing - which opens up for other factors to explain it.

4.2.4 Regression OLS

We will apply OLS regression to investigate whether the degree of underpricing can be explained by several factors. The goal is not to explain all factors, as this would require an extremely comprehensive model. However, we aim to examine some of the factors which are found in other empirical studies and see how well these can explain elements in the Nordic IPO market. In order to properly create robust OLS regressions we will have several models. However, our main regression is defined as:

$$ln(1 + Initial\ return_i) = \beta_o + \beta_1 ln(1 + age_i) + \beta_2 ln(1 + Revenue_{i-1}) + \beta_3(1 + EBIT_{i-1}) + \beta_4 \ln(1 + Offer\ Size_i) + D_j Tech + D_k Age_k + D_g Delisted_g + \varepsilon_i \quad (4.4)$$

Where we have adjusted for firm size by dividing Initial return, Revenue, and EBIT by Offer Size. In addition, we took the natural logarithm of Revenues and Age while winsorizing EBIT at 1%. These operations were made to appropriately adjust for extreme outliers and make the variables more symmetrical as we are working with extremely skewed data. For us being able to detect general effects, it is utmost important to look at the broad picture and not overestimate few extreme observations as these occur very rarely.

As most valuation methods take into account common accounting measurements like revenue and operating profits, we argue it is interesting to see whether these measurements can explain some of the variation in underpricing. We expect that the IPO underwriter and market participants use such tools in their valuation models, thus, we expect that Revenue and EBIT should be in-significant as this information already has been incorporated in the stock price. Further, as theories suggests we have used company age as a proxy for risk to see whether age itself can explain some of the variation in initial returns. In addition, firm size is expected to have a big impact on the degree of underpricing. For instance, small firms have a potentially larger upside compared to already big and established companies even though their economies of scale. When it comes to the size of the firm and the IPO, there are many factors to take into account, however, as we are investigating the degree of underpricing, we believe including this variable in the regression can provide us with some useful insight.

We have also added three sets of dummy variables to adjust for age, industry and risk. In other words, we have made a dummy variable for the technology industry to see whether just being a firm in the technology sector can explain some of the underpricing. Further, we have created one dummy to adjust for young firms which are defined as firms younger than 7 years. We have also included a delisted dummy, to see whether firms who have either gone bankrupt or just been delisted can have an effect on the underpricing. For instance, one can imagine that firms who have been delisted perhaps where taking more risk which then could have an effect on the level of underpricing and/or valuation in relation to the IPO.

Our relatively large sample size gives us the opportunity to take advantage of the central limit theorem. In addition, when transforming data, we are able to make our predicted residuals much more symmetrical as we can observe from figure 11.

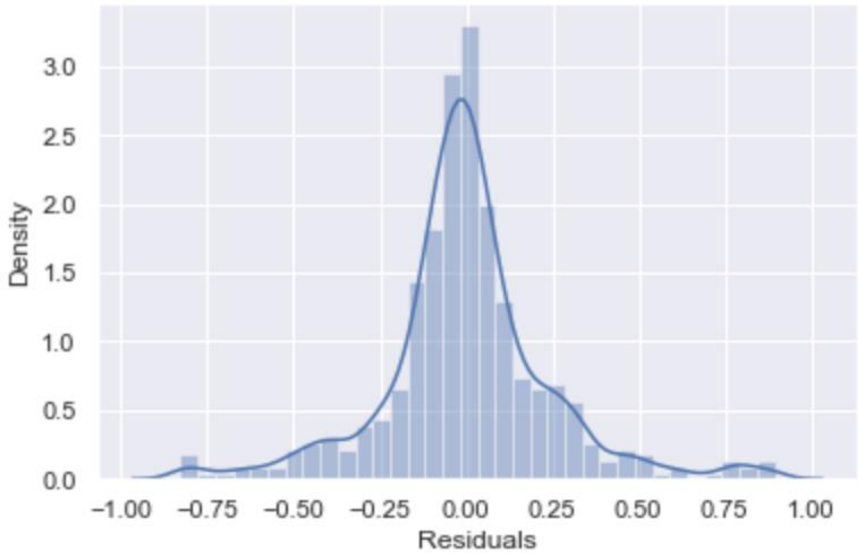

Figure 11 - Distribution density of predicted residuals.

Gujarati (2015) states that when working with cross-sectional data one can often encounter heteroscedasticity. This does not alter the unbiasedness and consistency properties of the OLS estimators; however, they are no longer best linear unbiased estimate, but simply linear unbiased estimate. Thus, we will check for heteroscedasticity in the regression above. The first step is to look at the squared residuals against fitted values.

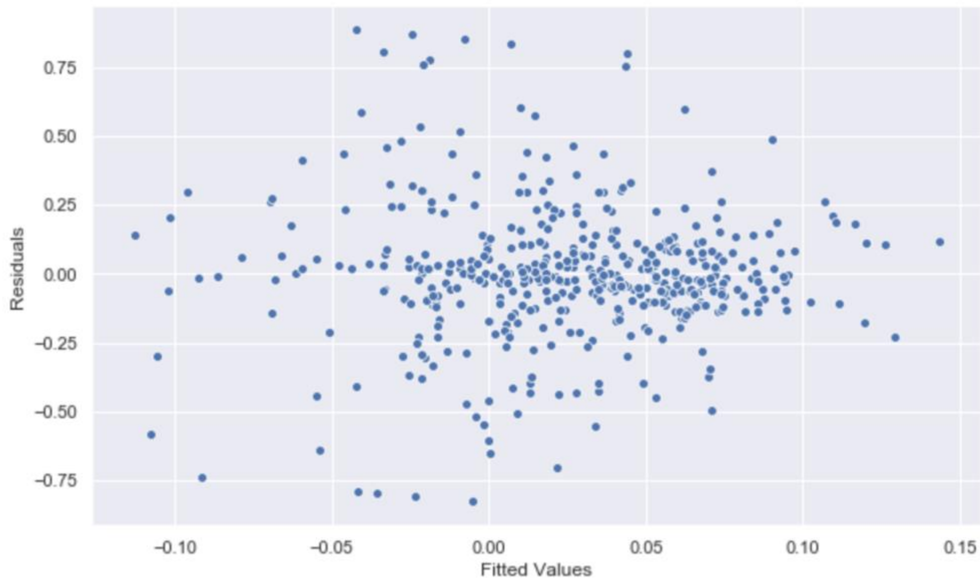

Figure 12 - Scatterplot regression residuals versus fitted values.

By the graph it can seem to be some systematic relationship between the squared residuals and the estimated values for the underpricing. Therefore, we ran a formal test for heteroscedasticity called Breusch-Pagan. The F-statistic was highly significant which means that we reject the null hypothesis about homoscedasticity. Accordingly, we will run our subsequent regressions with robust standard errors in order to obtain heteroskedasticity-corrected standard errors.

4.3 Descriptive statistics

Variable	Mean	Median	Std	Min	25% p	75% p	Max
Initial return	5.81%	1.50%	27.97%	-56.57%	-6.00%	14.71%	133.33%

Table 4 - Statistics for winsorized initial return.

The table above presents 1% winsorized initial return from our sample. The mean return of 5.81% is well below previous studies and especially findings from American markets. For instance, Ritter (2018) finds an average first day returns for US IPOs between 2001 and 2018 of 14.9%. Further, the median is closer to zero compared to the mean which may indicate that large values moves the mean upwards. In fact, the max value is much larger than the minimum value which provides additional evidence for this. However, the mean return indicates that the underpricing phenomenon still exists and illustrates the difference between the valuation of the IPO and the markets perception of its fair value.

In large samples one can argue that t-tests are valid and hence applicable in cases when working with non-normal data even when our data seem to be affected by some skewness. Our test-results shows us that our mean is statistically significant different from zero, and hence we have confirmed the underpricing phenomenon.

As we are focusing on the technology sector, it is interesting to look at differences between sectors. Table 5 presents the 1% winsorized data grouped by sectors in the entire sample period.

Sector	Observations	Mean	Std	Median	Min	Max
Communications	33	1.71%	30.99%	1.43%	-56.57%	114.66%
Consumer	184	6.10%	28.61%	2.90%	-56.57%	133.33%

Energy	30	5.04%	44.41%	-0.78%	-50.00%	133.33%
Financial	59	0.60%	18.73%	2.14%	-56.57%	53.33%
Industrial	79	7.40%	43.37%	0.27%	-50.00%	133.33%
Technology	70	9.94%	30.61%	5.18%	-34.78%	133.33%

Table 5 - Initial returns for different sectors.

As we can observe from the table, technology sector has the highest mean with 9.94%, followed by industrial at 7.40%. However, the technology sector has only the 4th largest std, which may indicate that the technology sector has less large negative underpricing than the other sectors. In fact, if we look at the minimum, we can confirm that this is the case. As the lowest variation in returns for technology is -34.78%, it seems that the mean is highly driven by positive large underpricing. The lowest variation in initial returns can be observed in the financial industry with a mean of 0.60%. In addition, it also has the lowest std with only 18.73% which is far below all other sectors. Moreover, we have found some indication that the technology sector is actually more underpriced than the others. This opens up for further investigation, which we will conduct in the empirical section in chapter 5.

5. Results and analysis

5.1 Hypothesis 1 - Fair priced IPOs

To formally test whether IPOs between 2010 and 2018 in our sample have been fair priced, we have used a two-sided t-test. The purpose of this test was to check if underpricing actually exists in the Nordic markets. Our null-hypothesis states that IPOs in the Nordic between 2010-2018 have been fair priced. i.e. the mean underpricing is zero and the markets are efficient. The results can be seen in table 6.

Variable	Observations	Mean	Std
$Initial\ Return_W$	455	5.81%	27.97%
T-stat = 4.4353 p-value = 0.0000			

Table 6 - Two-sided t-test for the mean of one group of scores.

We observe that the mean underpricing is calculated to be 5.81% and the std is 27.97% as shown in table 6. However, this could potentially be just by chance, and hence we have conducted a test to validate that the mean is different from zero. The test gives a significant p-value; hence we can reject H0 that the IPOs have been fair priced. Our results prove that initial returns from Nordic IPOs between 2010-2018 are statistically significantly different from zero. Consequently, we have confirmed that IPO underpricing exists in our sample and we will investigate potential reasons for this further.

5.2 Hypothesis 2 - Industry Variance

As we are interested in whether the technology sector is subject to more uncertainty and underpricing compared to other industries, we believe it is important to look at industry specific variance. We have split our data into two groups, where one group only contains technology firms and the other group contains the rest of the sample. In table 7, we have displayed the statistics.

Variables	Observations	Mean	Median	Std
Technology	70	9.94%	5.18%	29.74%
Rest of the sample	385	5.07%	1.04%	27.61%
W-stat = 3.2682 p-value = 0.0713				

Table 7 - Levene's test for equal variances.

From the descriptive statistics we can see that the technology sector has a higher mean compared to the rest of the sample. In addition, the technology industry is also subject to a higher standard deviation. Consequently, one can interpret this as that technology industry is subject to greater variations in terms of initial returns first day of trading compared to the rest. This could exhibit industry differences in standard deviations which can be an indication of difficulties with valuation. For this reason, we formally tested whether technology variance is statistically different from the rest with Levene's test of variances. Our null-hypothesis states that there is no difference between technology initial return variance compared to the rest of the sample. The test results provide a significant p-value on the 10% level; hence we can reject the null and there is evidence of a significant difference in terms of initial return variance between tech and non-tech IPOs. This indicates that, in general, initial returns of technology firms differs from the market average.

5.3 Hypothesis 3 - Technology underpricing

As we have found evidence of industry variance differences, it is moreover interesting to see whether the initial returns itself are different as well. Since our data is clearly non-normal and rather skewed, we will conduct a Kruskal Wallis H-test which is robust towards this. The Kruskal Wallis tests the null-hypothesis that the population median of all the groups are equal. We used the same two groups as in 5.2, which you can observe from the observations in table 8.

Variables	Observations	Normal
Technology	70	No
Rest of the sample	385	
H-stat = 0.8879 p-value = 0.3460		

Table 8 - Kruskal Wallis H-test.

Our null-hypothesis states that there are equal distributions across industries. From the results, we can observe a p-value of 0.3460 which is clearly not significant. Hence, we cannot reject the null and say that there is a significant difference between technology returns and rest of the sample. This result sort of contradicts our previous findings in section 5.2. Hence, we cannot conclude that the distribution of underpricing is significantly different among industries using this nonparametric test. Consequently, these discoveries are not in line with Beatty and Ritter (1986) findings - that there is a positive relationship between the ex-ante uncertainty about the IPO value and it's expected underpricing.

5.4 Hypothesis 4 - Young and Old companies

We were not able to reject hypothesis 3, however, theories suggest that there is more underpricing of young companies than old companies. So, in order to see if this phenomenon is present in our sample, we split our data into two groups; young and old. Interestingly, the sample is fairly evenly spread when it comes to age with respectively 204 and 251 observations for young and old companies.

Variable	Observations	Mean	Std	Normal
Young	204	4.52%	29.45%	No
Old	251	6.87%	26.72%	
H-stat = 1.3700 P-value = 0.2420				

Table 9 - Two-sided t-test for the means of two independent samples of scores.

We can observe that the mean is also fairly close to each other, which may indicate that underpricing on young and old companies does not differ that much. However, the standard deviation shows us otherwise with a larger difference (29.45% for young vs 26.72% for old). The reason for this may be that younger companies varies more than older companies, however, in both ends of the scale. That can be interpreted as that the initial returns varies more for younger firms, but that variation can be a result of both underpricing and overpricing. So, we conducted a Kruskal Wallis H-test where our null hypothesis states that there is no difference in initial return between young and old companies. The test provides a non-significant p-value; hence we cannot say there is a significant difference between young and old companies in terms of median initial return. According to Ljungqvist and Wilhelm (2003), the age of a company can be used as a proxy for valuation uncertainty, but our findings contradicts this. From our findings, we are not able to conclude that the underpricing distributions are different across age. This means that for our sample, there is no statistically difference in underpricing for young companies (0-6 years) and old companies (7 years and older). Hence, we are not able to conclude that younger companies are more underpriced than older ones.

5.5 Regression analysis

As we have found significant variation in industry variance, we have found differences in Revenue, EBIT, firm age and offer size, and consequently we will investigate these variables further in a regression to see whether this can explain some of the variation in initial returns. We ran the regression presented in section 4.2.4 and our results are presented in table 10. To adequately ensure robustness of our regressions we have included several models. The only significant coefficient is offer size, which is significant on the 5% level in all the models.

Table 10 - Regression results.

*Table 10 reports the results from four different regression models with the natural logarithm of 1 + initial return as the dependent variable. Model A includes four independent variables. Model B, C, and D adds dummy variables for tech, young, and delisted companies. * represents significant at the 10% level, ** represents significant at the 5% level and *** represents significant at the 1% level.*

	Model A ln(1+ IR)	Model B ln(1+IR)	Model C ln(1+IR)	Model D ln(1+IR)
Constant	-0.0500	-0.0658	-0.0107	-0.0004
	(0.0044)	(0.029)	(0.055)	(0.057)
Ln (1+Age)	0.0086	0.0087	-0.0090	-0.0104
	(0.010)	(0.010)	(0.016)	(0.016)
Ln (1+Revenue)	-0.0075	-0.0082	-0.0075	-0.0066
	(0.012)	(0.012)	(0.012)	(0.012)
$Ebit_W$	0.0070	0.0065	0.0068	0.0064
	(0.014)	(0.014)	(0.014)	(0.015)
Ln (1+Offer Size)	0.0130**	0.0146**	0.0150**	0.0148**
	(0.006)	(0.006)	(0.006)	(0.006)
Tech Dummy		0.0569	0.0550	0.0527
		(0.034)	(0.034)	(0.034)
Young Dummy			-0.0445	-0.0454
			(0.037)	(0.037)
Delisted Dummy				-0.0646
				(0.042)
Observations	455	455	455	455
R-squared	0.014	0.021	0.024	0.030
Adjusted R-squared	0.006	0.010	0.011	0.015

The best model is Model D, which has the best R-squared as well as adjusted R-squared. In addition, it also had the best AIC and BIC value. Our variables can explain 3% of the variation in initial IPO returns. At first glance, this may seem like a small number compared to other studies. However, one must keep in mind that we have a fairly large sample and are looking for generalizable results, thus, explaining 3% of the variation in returns for all Nordic IPOs between 2010-2018 should be sufficient to draw conclusions. This is as it should be. If the R-squared was high, it would imply that the initial return on an offering is predictable (Beatty & Ritter, 1986). In addition, we have deemed the goodness of fit of less importance and consider the theoretical relevance of the variables more important as we are not building a predictive model. For further regression diagnostics such as partial regression plots and CCPR - see appendix D.

As expected, revenues and EBIT are not significant - which provides evidence for that underwriters as well as market participants already have incorporated these measurements in their valuations. As a result of this, different opinions about revenues and operating profits does not have a significant impact on the variation in returns. The revenue coefficient is negative, which indicates that the more underpricing the lower the revenue which may reflect variations in revenue estimates. On the other hand, the results are not significant and hence we must be careful to not overestimate our findings. We can also see that age is not significant, which also indicates that company age is already incorporated in agents' expectations. However, what is interesting is that the coefficients Age and Young dummy has a negative relationship with the degree of underpricing. This may indicate that the higher the degree of underpricing is, the younger the company is - which is in line with findings from Schwert et. al. (2010), that younger firms may have larger upside potential. According to the asymmetric information theory, age is used as a proxy for uncertainty, hence younger firms should have higher degree of underpricing than older firms. Consequently, we have found similar evidence as Ljungqvist and Wilhelm (2003) and indications that in fact age can be used as a proxy for uncertainty - although not significant.

Further, the variable Offer Size is clearly significant on all models at the 5%-level. This finding suggests that the size of the IPO has a big influence on the variation in returns. However, the coefficient is positive, which is not in line with our expectations from the asymmetric theory - since one would expect higher degrees of underpricing with smaller firms i.e. a negative coefficient. On the other hand, the coefficient value is low and close to zero as well as being on logarithmic form - which makes interpretation difficult. One more interesting remark is that variation in returns of companies that have been delisted is not significant. As one can imagine that most delisted companies are risk takers, intuitively it is more difficult to value these firms. However, our regression results show us that this is not the case and one cannot use the IPO initial return variation as a proxy for whether or not a company will be delisted in the future.

5.6 Technology regression

We found that technology industry variance is significantly different from the rest of the sample and has the highest initial return. Hence, we investigate this further by running a technology specific regression to see whether we can explain some of the difference in initial returns first day of trading. A negative factor in this model is the number of observations compared to the previous regression presented in section 5.5. With only 70 observations, it will be difficult to draw generalizable conclusions about the technology sector as a whole, while at the same time the market in the Nordics is what it is, and it can at least give us some indication of the Nordic technology sector. We get fairly similar results as in the previous regression, where only the variable Offer Size is significant - now at 10% instead of 5%. From the model comparisons table 11, we can observe big variation in adjusted R-squared. Consequently, Model A appears to be the best fit for our data and is considered to be the best model.

Table 11 - Technology Regression.

Table 11 reports the results from four different regression models done on companies classified within the technology sector with the natural logarithm of 1 + initial return as the dependent variable. Model A includes four independent variables. Model B also includes 1 + the natural logarithm of the age of the company. Model C and D adds dummy variables for young and delisted companies. * represents significant at the 10% level, ** represents significant at the 5% level and *** represents significant at the 1% level.

	Model A ln(1+ IR)	Model B ln(1+IR)	Model C ln(1+IR)	Model D ln(1+IR)
Constant	-0.0184 (0.083)	-0.0349 (0.104)	-0.0015 (0.086)	-0.0004 (0.057)
Ln (1+Revenue)	-0.0417 (0.033)	-0.0438 (0.035)	-0.0439 (0.033)	-0.0104 (0.016)
$Ebit_W$	0.0360 (0.023)	0.0349 (0.025)	0.0332 (0.025)	-0.0066 (0.012)
Ln (1+Offer Size)	0.0275* (0.015)	0.0261* (0.016)	0.0273* (0.015)	0.0064 (0.0 15)
Ln (1+Age)		0.0115 (0.040)		
Young Dummy			-0.0455 (0.037)	-0.0454 (0.037)
Delisted Dummy				-0.0646 (0.042)
Observations	70	70	70	70
R-squared	0.055	0.056	0.059	0.072
Adjusted R-squared	0.012	-0.002	0.001	-0.000

Model A can explain 5.5% of the variation in returns for the technology sector in the Nordic market. Hence, there is definitely factors our model does not capture, however, it is an interesting finding when our model only includes 3 firm specific variables. The coefficient for Revenue is still negative - which indicates that there is a negative relationship between Revenue and initial return for technology firms. On the other hand, EBIT has a positive relationship with initial returns for model A-C, and changes to negative in model D. As the coefficient changes when variables are included or excluded, one must be careful to draw conclusions due to the sensitivity. Further, offer size is significant and positive. This is additional evidence for what we discovered in the previous regression - that IPO initial returns increases with offer size. Since this also holds true for technology companies, it is reason to believe that the high variation in first day of trading returns is moderately influenced by the size of the IPO and the amount of capital raised.

5.7 Alternative explanations

In this section, we will present some alternative explanations to underpricing that we have not focused on in our thesis. Ibbotson and Jaffe (1975) presented a theory they called "Hot Issue" markets. They defined these markets as periods in which the average first monthly performance of new issues is abnormally high. They find evidence that suggests first month residuals don't follow a random walk and that investors can concentrating on buying when the expected new issue returns are high. More companies will go public in bull markets than bear markets and during these bull markets it tends to be more underpricing of IPOs. After "hot issue" markets were first documented by Ibbotson and Jaffe (1975), several other papers have also come to the same conclusion. See for example Ritter (1984) and Ibbotson, Sindelar and Ritter (1988).

Other variables we also not have looked at is the number of shares offered, VC-backed or PE dummy or offer type. We decided to use offer size as a proxy for size. This could have been done in several different ways. Some have chosen to use market capitalization which is probably the most accurate alternative. We found it difficult as this would have required to not only have the number of shares offered, but also find the total amount of outstanding shares for every firm. One way to solve this problem could have been to use market capitalization of public outstanding shares, but this would only have been a shortcut and not fully reflected the actual market capitalization of the company. Something we could have done, was to include the shares offered in the transaction as an additional variable. For example, you could expect companies issuing more shares to the public is either more or less underpriced.

Multiples is another variable we chosen not to put too much emphasis on. Two common multiples used to in research to investigate underpricing is price-to-earnings or price-book. According to our section 3.1.1 on valuing IPOs, most underwriters use this method in valuation and we therefore expected that this variable would not yield any statistically significant results. This has also been the case for other studies that has included multiples. Kim and Ritter (1999) argue that the price-to-earnings (P/E), market-to-book, and price-to-sales multiples of comparable firms have only modest predictive ability without further adjustments.

Another factor we could have looked at is whether the firm was backed by venture capitalists (VC) or owned by a private equity (PE) fund. Statistics provided by Ritter (2017) from 1980 - 2015 found that IPOs that was VC-backed had an average initial return of 26.9% versus non VC-backed IPOs of 12.6%. For companies backed by PE-fund, the average initial return was 8.9% versus non PE-fund of 13.7% (Ritter, 2017).

Finally, offer type is a factor that previously have explanatory power on the underpricing phenomenon. Ritter (1987) found that on average the amount of underpricing is greater with best effort than firm commitment. Usually, smaller firms will choose best effort over firm commitment and some of the differences will be wiped away when he holds size constant and adjust for economies of scale. Firms picking firm commitment raised on average four times more capital than firms picking best effort. 72% of the firms raising less than $2 million choose best effort. Average initial underpricing is 14.8% for first commitment and 47.78% for best efforts. This is in line with what we have indicating throughout this study and also in line with our findings. Larger, more mature companies have on average less underpricing than smaller, younger companies.

6. Conclusion

In this thesis, we have found that in our sample of 455 IPOs done in Norway, Denmark, Sweden and Finland between 2010 - 2018 the average underpricing is 6.32%. This is in line with what previous research has found on the Nordic market. From hypothesis 1, we were able to conclude that the IPOs in our sample were significantly underpriced. We From the descriptive statistics we find the technology sector to be the most underpriced with a mean of 10.14%. Previous studies done on both the U.S. market and markets in the Nordic countries have often found this to be substantially higher, but these studies often include the time period around 2000 where technology IPOs was significantly underpriced. A lower underpricing today than in previous studies is in line with what we should expect as the sector now is more mature. For investors, this study also confirms that investing in IPOs has on average yielded a positive return.

The technology sector has the highest underpricing of all sectors with a mean of 10.14%. Despite this, we are not able to find significant differences in the distribution of underpricing between industries. However, we find a statistically significant difference in technology industry variance compared to the market average. We have therefore found indications that it is challenging for investment banks to value technology IPOs. We discussed common valuation techniques used by underwriters in section 3.1 and we saw that underwriters use multiples techniques when valuing IPOs, but still has problems with meeting the valuation in the market. This is especially clear for the technology sector where we found a higher variance. As technology firms often has high growth opportunities, most valuation techniques are sensitive to future forecasts and assumptions, leading to difficulties in consensus valuations.

Further, we are not able to conclude that younger companies on average experience more underpricing than older companies. In our sample, older firms have a higher underpricing by looking at the mean than younger firms which contradicts theory, but the findings are not significant. We find that the standard deviation of younger firms is higher than older firms, indicating that younger firms varies more in both ends of the scale.

From our first regression model, the only variable that is statistically significant is offer size. The positive coefficient contradicts the predictions from asymmetric information theory - as from there we would expect companies going public with a smaller offer size to be more underpriced i.e. a negative coefficient. We also find that the young dummy has a negative relationship which may indicate younger firms tend to be more underpriced, but the effect is not significant. None of our firm specific variables such as age, revenues or EBIT was effective indicators of underpricing. Age, which previously has been found to be a variable affecting underpricing, is not significant. Revenues and EBIT was also not significant when looking at the results from our regression analysis. This is as we expected as these variables should already been taken into account in the valuation of the IPO. When we conduct technology specific regression, we find similar results.

In this thesis, our focus has been on the short-term performance of Nordic IPOs. Therefore, a suggestion for future research would be to extend this study and also take into account the long-term performance of IPOs. By including a longer time frame, we would have increased the sample size significantly and also been subject to different market conditions and better investigate the “hot issue” theory. As we have included shares traded on secondary exchanges, we are also prone to other factors that could affect the underpricing such as larger bid-ask spreads due to lower liquidity in these markets. If future studies are able to adjust for this in some way, they could make even more robust findings on the underpricing phenomena than what we have. We also believe that including secondary markets in analysis is important, as most studies are done only on main markets so there is room for more empirics on this subject. Looking at the long-term performance on IPOs done on both main and secondary markets could be an interesting topic further research to see if listing on different markets yield different results in the long-run.

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8. Appendices

8.1 Appendix A

Exchange	Company Size	Number of shareholders and spread of ownership	Other requirements
Oslo Børs	NOK 300 million	500 shareholders each holding shares with a value of at least NOK 10.000. 25% publicly held.	A history of the company and its business activities spanning at least three years.
Oslo Axess	Market value of at least 8 NOK million	At least 100 shareholders each holding shares with a value of at least 10.000 NOK. 25% publicly held.	Submitted at least one annual or interim report. Instigated planned business activity.
Stockholm	EUR 1 million	Sufficient number of shareholders (500 in 2013). 25% publicly held.	Issuer shall have complete annual accounts for at least three years
Spotlight	No specific size requirement	At least 300 shareholders, each having a holding worth at least SEK 4.000. 10% publicly held.	At the time of listing the Company must show that it is capable of making a profit.
FN Stockholm	No specific size requirement	At least 300 Qualified Shareholders holding shares with a value of at least EUR 500. 10% publicly held.	The Issuer shall be able to demonstrate ongoing business operations.
Nordic GM	No specific size requirement	300 shareholders, each holding share worth in total approximately SEK 5,000. 10% publicly held.	The Company must demonstrate that it possesses earnings capacity.
Copenhagen	EUR 1 million	Sufficient number of shareholders (500 in 2013). 25% publicly held.	Issuer shall have complete annual accounts for at least three years
FN Denmark	No specific size requirement	300 Qualified Shareholders holding shares with a value of at least EUR 500. 10% publicly held.	The Issuer shall be able to demonstrate ongoing business operations.
Helsinki	EUR 1 million	Sufficient number of shareholders (500 in 2013). 25% publicly held.	Issuer shall have complete annual accounts for at least three years
FN Finland	No specific size requirement	300 Qualified Shareholders holding shares with a value of at least EUR 500. 10% publicly held.	The Issuer shall be able to demonstrate ongoing business operations.

Note 1: "Public hands" means a person who directly or indirectly owns less than 10 percent of the Issuer's shares or voting rights (Nasdaq , 2018).
Note 2: Rules for issuing from 2013 describes the sufficient number of shareholders as 500, but new rules only state a "sufficient number of shareholders" on the Nasdaq Stockholm/Copenhagen/Helsinki exchanges.

Table 12 - Listing requirements of the Nordic stock exchanges

8.2 Appendix B

Figures showing distributions of independent variables. Before and after adjustments.

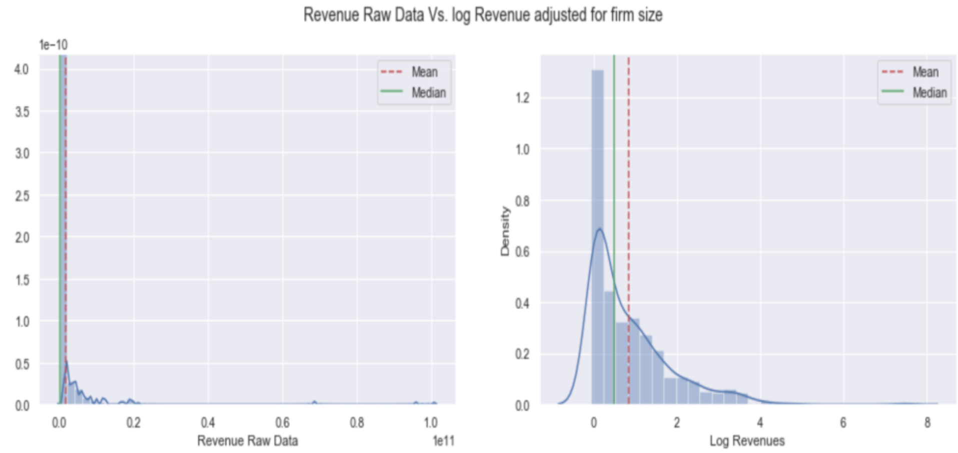

Figure 13 - Revenue raw data vs log Revenue adjusted for firm size

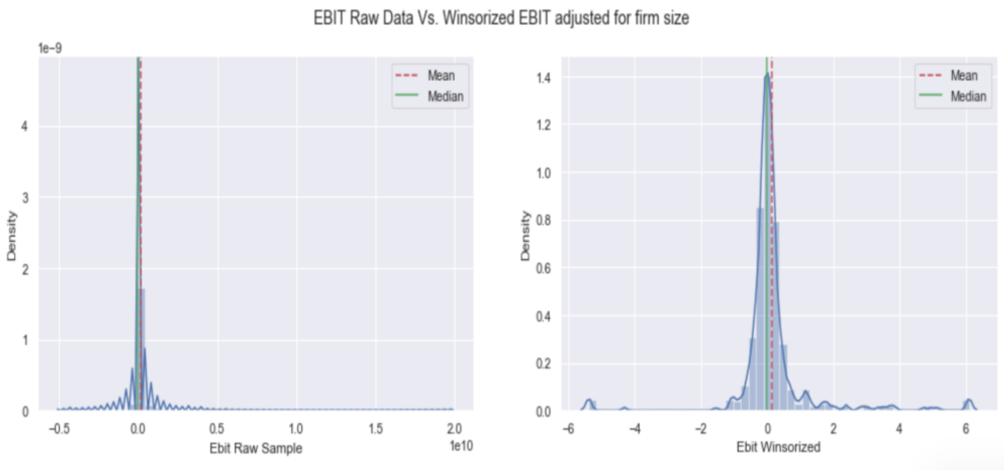

Figure 14 - EBIT raw data vs winsorized EBIT adjusted for firm size

8.3 Appendix C

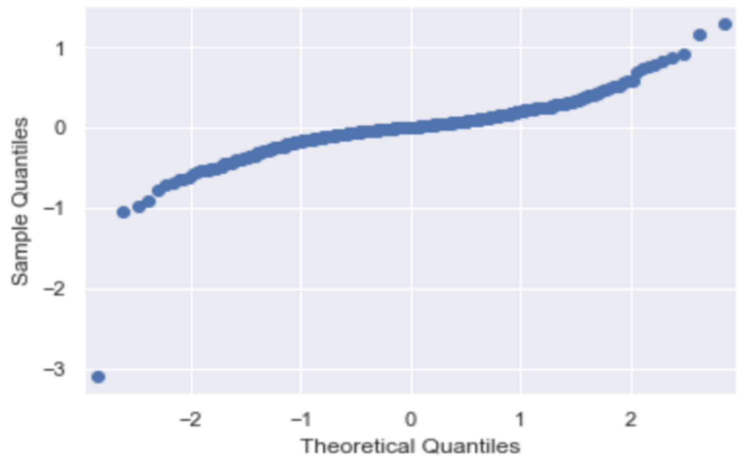

Figure 15 - Normal probability plot of raw data regression

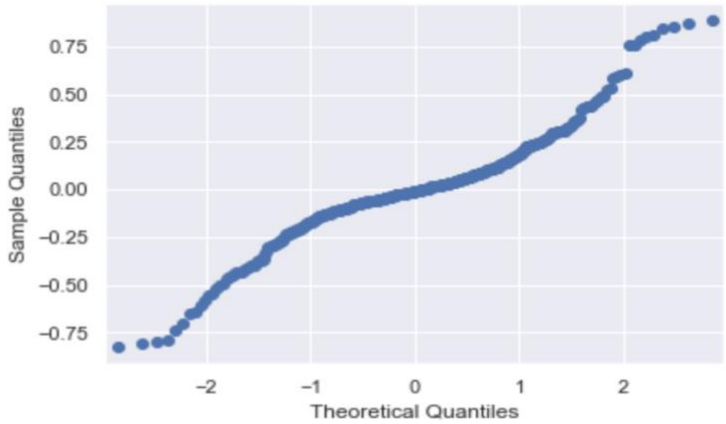

Figure 16 - Normal probability plot of winsorized data regression.

As we observe, in the second plot, the quantiles are much closer to normal compared to the first plot.

8.4 Appendix D

Regression diagnostics - these plots are related to our main regression model, presented in section 4.2.4 and 5.6. By visualizing, we can see whether OLS is a good fit for our data. In addition, we are able to observe outlier effects. For instance, EBIT is highly centered around zero and with very few observations on both sides which affects our results. If we look at figure X.X (LN Offer Size), we can observe a very smooth linear line which fits the data.

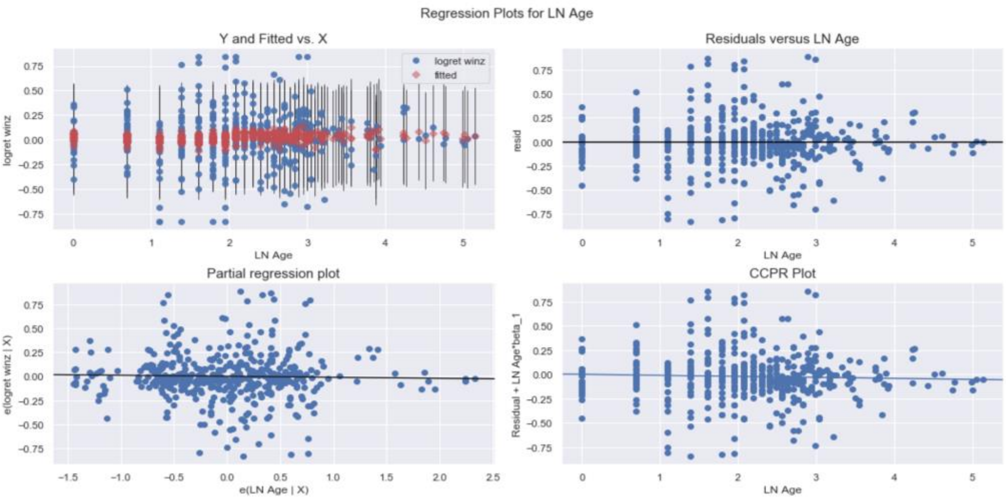

Figure 17 - Regression plots for LN Age

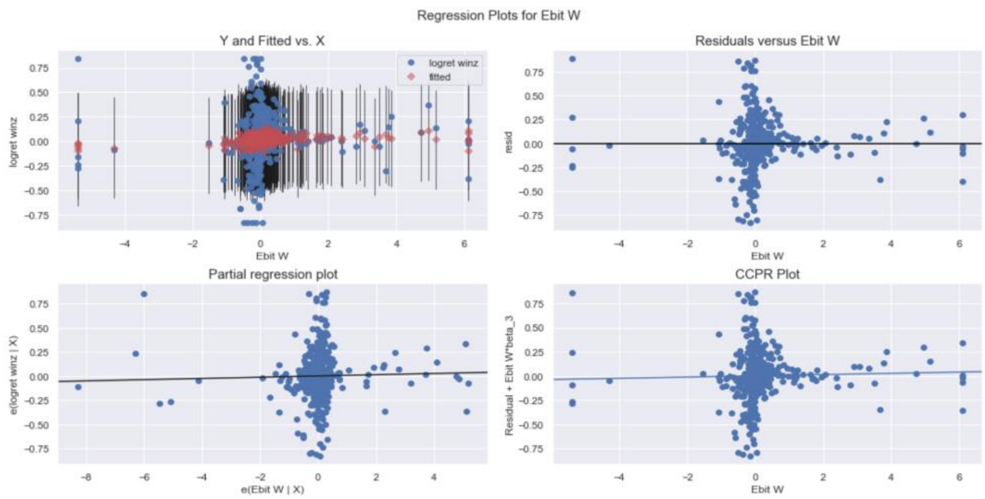

Figure 18 - Regression plots for EBIT winsorized

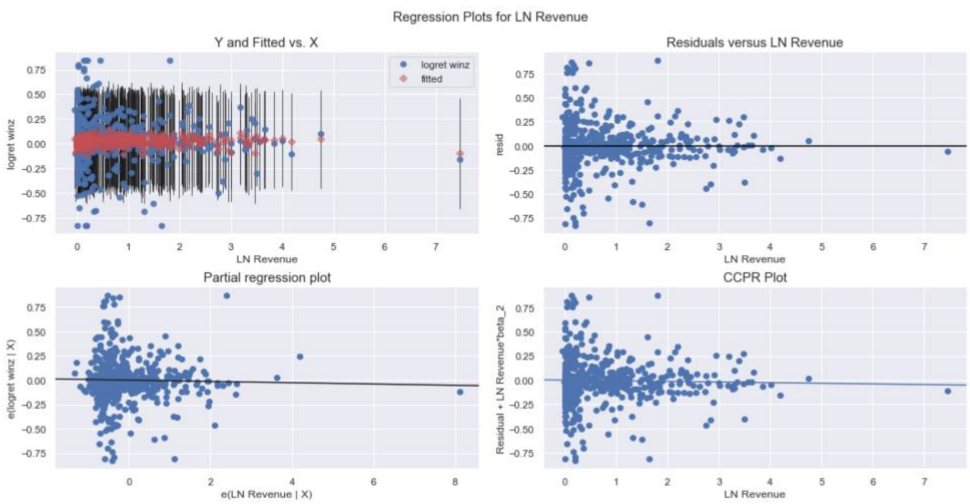

Figure 19 - Regression plots for LN Revenue

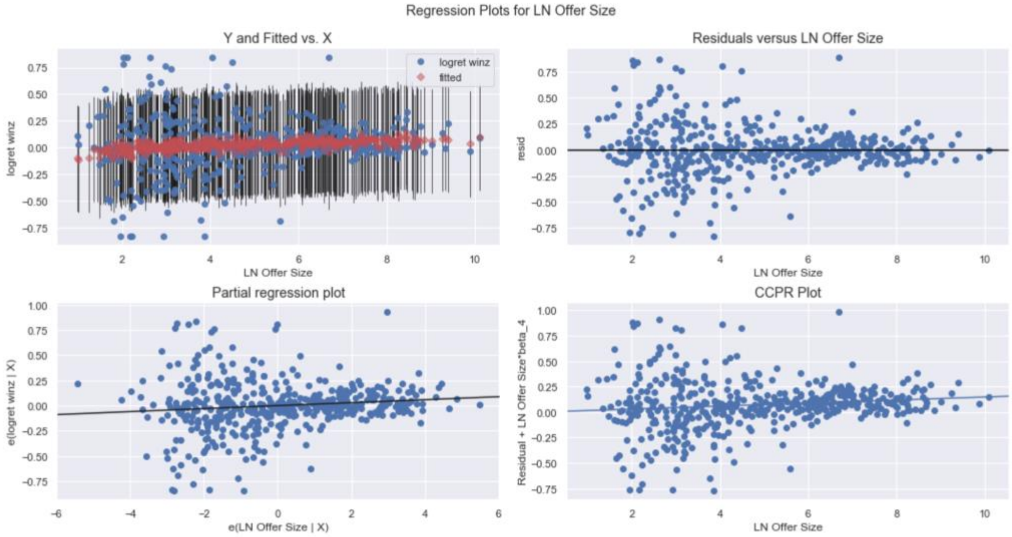

Figure 20 - Regression plots for LN Offer Size