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IPO underpricing in Norway

Empirical evidence from 2010-2021

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Abstract

This master thesis investigates the underpricing of 172 initial public offerings (IPO) listed on the Norwegian stock market from January 2010 to December 2021. The sample is distributed among 123 non-sponsored IPOs (NS), 27 private equity-backed IPOs (PE), and 22 venture capital-backed IPOs (VC). Our analysis shows that Norwegian IPOs, on average, are underpriced and have a first-day return of 6.33%. Furthermore, we find that PE-backed IPOs experience less underpricing than VC-backed and NS-IPOs on average, but we do not find any statistically significant evidence. The results reveal that PE-backed companies are older on average and may imply that older companies have less ex-ante uncertainty. We also found that IPOs listed during "hot" markets experience significant underpricing, which aligns with previous studies.

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Abbreviations

BO = Buyout

GP = General Partners

IPO = Initial Public Offering

LP = Limited Partners

NVCA = Norwegian Venture Capital & Private Equity Association

OLS = Ordinary Least Squares

OSEBX = Oslo Benchmark Index

PE = Private Equity

VC = Venture Capital

VIF = Variance Inflation Factor

Part I. Introduction

1.1 Introduction

Every company needs capital to start up its business, expand or finance new projects. An initial public offering (IPO) is one of the methods a company can use to raise capital. In 2008, Visa set a record for the amount of money raised in an IPO of 17.9 billion USD. The world's largest credit card processor sold 406 million shares for 44 dollars a share, which were closed at 56.5 dollars a share the same day. The IPO was regarded as a massive success around the financing world. Jay Ritter, on the other hand, had different views on the IPO. He saw the IPO as Visa missing out on a historical amount of money. Ritter said, "By selling shares for $44 that were worth $56.50, the sellers left a record $5.1 billion on the table" (Krantz, n.d.). Ritter (2022) defines the money left on the table "as the difference in the closing price on the first day of trading and the offer price, multiplied by the number of shares sold." The difference between the offer price and the closing price constitutes a transfer of wealth from the shareholders of the issuing firm to the investors (Ritter, 2022). This phenomenon is referred to as underpricing.

According to Solomon (2011) IPOs have been underpriced by 16.8% on average in United States over the last 50 years. Hence, numerous research studies have reported the existence of underpricing worldwide, as they note that the distribution of initial returns is positively skewed (Lowry et al. 2010).

There is not a universal consensus on the causes of the underpricing phenomenon. However, information asymmetry is often referred to as the underlying explanation for underpricing (Jamaani & Alidarous, 2019). Previous studies have shown that PE-backed IPOs experience significantly lower underpricing than non-PE-backed IPOs. Consequently, we would like to investigate if PE-backed IPOs are less underpriced than venture capital (VC)-backed and non-sponsored (NS) IPOs and whether asymmetric information and "hot" and "cold" markets could explain the difference.

Scholars have developed many different theories on why underpricing occurs worldwide. Nevertheless, this phenomenon has only been investigated and documented in a limited number of Norwegian studies. We will therefore examine the stock performance of 172 IPOs in the Norwegian stock market with an IPO

during the period from January 2010 to December 2021 to answer the following question:

Are private equity-backed IPOs less underpriced than non-private equity-backed IPOs in the Norwegian stock market?

We have made six hypotheses to test previous theories and answer our research question. Our study contributes to previous literature in various ways. The thesis focuses on PE-backed IPOs in the Norwegian stock market, a market only a limited number of studies have examined. Furthermore, our study contributes to previous literature by providing results from a more recent time.

Part II. Theory

2.1 Private equity

Cendrowski (2012) defines *Private Equity* (PE) as a "medium or long-term equity investment that is not publicly traded on an exchange". Active ownership is one of the main characteristics of a PE. Unlike other investment vehicles such as hedge funds, PE funds invest financially and involve themselves in the operational side of the business.

PE firms seek to acquire companies they believe have potential for improvement or provide a strategic fit with their current portfolio companies. The PE funds often demand lengthy holding periods, long enough to increase the value of the portfolio company and sell it with a profit. Both publicly traded and privately owned companies can serve as potential targets. PE firms primarily operate outside the public market and do not need to disclose as much information as public companies do. PE is typically categorized into two different types: Buyout (BO) and VC, and we will elaborate further on these in section the next section.

2.1.1 Buyout

PE firms use BO to acquire firms with dependable operating cash flows, and which also have good structure and management. However, they can also acquire distressed companies in promising industries if they see the potential for higher resale prices. Buyouts can be divided into Leveraged Buyouts (LBO) and Management Buyouts (MBO).

LBO transactions involve PE funds acquiring companies using debt as their primary financing source (Kenton, 2022). In some cases, the debt makes up 90% of the transaction.

"A management buyout (MBO) is a corporate finance transaction where the management team of an operating company acquires the business by borrowing money to buy out the current owner(s)" (Corporate Finance Institute, 2022).

The PE funds purchases companies to add value through financial, operational and, governance engineering (Ostergaard, 2020). Operational improvements might, among other things, include changing the company's management team, selling off assets to unlock value, or acquiring new assets to improve efficiency. The goal of the buyout is to get a higher return generated by

the acquisition that outweighs the interest paid on debt, gaining a high return compared to the capital committed (Wall Street Oasis, n.d.).

2.1.2 Venture Capital

VC is a type of PE investment that involves early-stage financing to companies looking for equity capital to expand and improve operations (Hayes, 2022). Although this type of investment is only relevant for a small group of firms, VC is critical for the success of firms deemed to be innovative. It is a typical investment class used to acquire technology related companies.

Small and mid-sized firms encounter difficulties when trying to find external financing through loans, capital markets, and other financial markets. According to Zider (1998), the problem of finding external financing sources is due to the short operating history and risks associated with the firm's future earnings.

Besides providing liquidity to the portfolio company, VC can also add value in terms of managerial and technical expertise. Companies at early stage have substantial risk related to them. Hence, investors expect a payoff above-market average return, to compensate for the risk.

"Technically, venture capital (VC) is a form of private equity" (Johnson, n.d.). The main difference between BO and VC is that BO prefers stable companies, while the latter is usually involved during the early stages of a company. Considering the significant differences between BO and VC transactions, we have chosen to study PE and VC separately. Which is consistent with previous studies.

2.1.3 Structure of private equity funds

The following illustration shows how PE funds are typically structured.

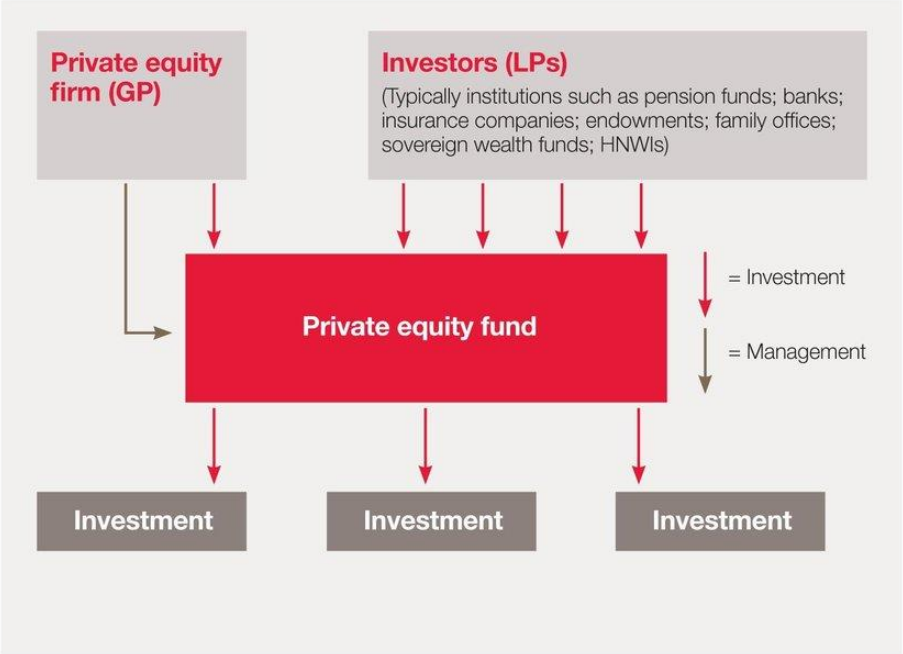


Figure 1.1) *Structure of Private Equity fund (Bolton, 2015)*

The managers of the PE funds are generally known as the general partners (GPs), while the investors are referred to as the limited partners (LPs). GPs oversee the fund and its operation, whereas LPs may only provide capital to the fund. The limited partnership signifies the limited liability for the investors. In case of bankruptcy or insolvency, the LPs liability is restricted to the amount of investment they have made. While GPs, on the other hand, has unlimited liability for the debt. Typically, PE funds require a significant investment to participate. The clients of PE firms tend to be institutional investors such as pension funds, hedge funds, insurance companies, and high net individuals. The LPs commit a fixed amount of money over the fund's lifetime; this is called committed capital. The GPs can perform a capital call when further capital is needed to invest.

Instead of directly investing in several private companies, the LPs indirectly invest in them through the PE fund. For the LPs, this provide the benefit of having the diversified portfolio of the PE fund, and managerial expertise of the PE firm which has been proven to add value to the portfolio companies

The GP`s are compensated by two different sources (A. deRoos & Bond, 2019):

1. The GPs receive “carried interest,” around 2% of the capital raised from the LP's investment. They also earn around 20% of the profits after meeting the preferred return, which serves to align the interests of both parties
2. The GPs can also earn fees depending on the different services they provide, such as fundraising, acquisition, asset management, finance, and guidance property management fees.

2.1.4 Lifespan of a private equity fund

A PE fund usually has an average lifespan of roughly ten years. If the fund has scouted prospective deals beforehand, the fund may have a shorter lifespan. Typically, there are four stages of a fund's lifespan: organization/fundraising, investment, management, and harvest.

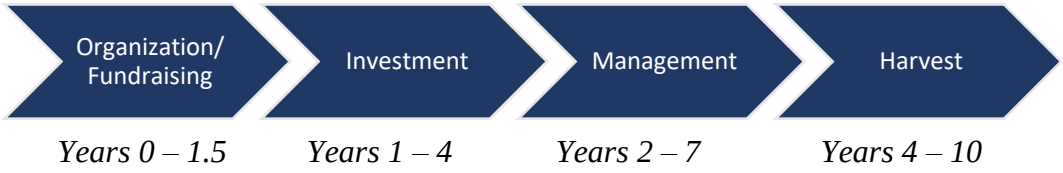


Figure 1.2) *Life span of Private Equity Funds (Cendrowski et al., 2012)*

Organization/Fundraising:

The organization phase allows a PE fund to recruit investors, determining its strategy and market to target. The fund focuses primarily on the company's stage, industry, and geography. Within the 10-year life cycle of a PE fund, the organization phase usually takes about 18 months. The time depends on the macroeconomic environment and the demand from the investors for PE assets (*Cendrowski et al., 2012).*

Investment:

Following the organization/fundraising phase, the investment phase begins with general partners scouting for investment opportunities and creating a “deal flow”. It is imperative to find deals or companies where the GPs can add value through investments or managerial expertise. This stage generally covers the three years following the fundraising period (*Cendrowski et al., 2012).*

Management:

After investing, the PE fund will start to manage the companies they have acquired within the portfolio. It is common for professionals within the PE fund to replace the acquired firm's management. There are also possibilities to form syndicate investments where other funds invest in the same portfolio firm. Syndicate investment benefits the funds by having relationships with counterparts, diversified risk, more capital, and exit opportunities (*Cendrowski et al., 2012).*

Harvest

The last stage, which usually starts from the fourth year and throughout to the tenth year, is called the harvest period. GPs will try to realize their profits as quickly and as effectively as possible. The GPs also need to evaluate whether the companies are ready to be harvested or need further funding. Common ways to exit (harvest) companies are through IPOs, buybacks by the founders, or selling to a third party, which we will elaborate on further in the next section (*Cendrowski et al., 2012).*

2.1.5 Traditional Exits Strategies

We have seen that PE funds acquire a firm to either benefit from potential synergies it creates within the portfolio or implement changes within the firm to make it attractive to possible buyers. The main goal of a PE fund is to generate returns to the GPs and LPs, and this subchapter will explain the exit strategies of PE firms. According to Povaly (2006), the most traditional exit routes for PE funds are trade sales, secondary buyouts, and IPOs.

Sale to a third party

Selling to a third party is one of the most common exit strategies for a PE fund, which is done in two ways: trade sales and secondary buyout.

A PE firm may exit through a trade sale to a strategic buyer to realize their gains on their investment. The buyer does not necessarily need to be another PE firm. Nevertheless, the buyer acquires the portfolio firm for strategic purposes, particularly synergies with other investments, innovative products, patents, and market growth.

A secondary buyout is when a PE fund sells one portfolio company to another PE fund. The PE fund managers use this type of exit strategy when they

believe another PE fund could add more value than themselves, which will further help the portfolio company develop. Sometimes, a PE fund cannot continue financing a business regardless of whether it is ready to be sold through an IPO or a trade sale. If so, selling the company to another PE fund that sees the potential in developing the business could be the most cost-effective strategy (Folus & Boutron, 2015).

2.1.6 Partial exit

A complete exit is not always the best strategy for all types of businesses, and partial exits can act as a good middle ground. Leveraged dividend recapitalization is a partial exit strategy where the portfolio company issues debt to pay a special dividend to the investors, allowing investors to exit through dividends partially. The equity holder reduces their claim to the equity and receives cash in compensation.

Folus & Boutron (2015) argue that the main advantage of a leveraged dividend recapitalization is that the PE firms still have partial control of the portfolio company while still receiving dividends and tax benefits from the considerable tax shield. However, this can lead to the company overleveraging, such that they cannot meet their obligations to the bank and ultimately go bankrupt.

2.2 Exits through Initial Public Offering

Ritter & Welch (2002) describe an IPO as a private company entering public trading by listing on a stock exchange. There are several advantages of going public, but the most important ones are greater liquidity and better capital access through IPOs and subsequent offerings. Moreover, IPOs allow investors to diversify their investments (Berk & DeMarzo, 2016). According to Zingales' (1995) study, he observed potential acquirers could spot potential targets for takeovers much easier when they were public. Furthermore, entrepreneurs realized that acquiring companies may be able to impose more pressure on companies' pricing than outside investors. As a result, going public enables entrepreneurs to sell a company for a higher price than they would receive from an outright sale. Taking part in an IPO has both significant advantages and disadvantages. When shareholders diversify their holdings, the corporation's equity holders become widely dispersed. Consequently, it impairs the investors' ability to monitor the

company's management. The investors may discount the price they will pay to reflect the lack of ownership control (Berk & DeMarzo, 2016).

When a company decides to go public, the managers work with an underwriter, who manages the deal and its structure. The underwriter has two primary purposes when managing the structure; choosing the type of stocks to offer and method to sell.

A primary offering is when a firm issues new shares in an IPO, while if they sell existing shares, it is known as a secondary offering. The lead underwriter is in charge and creates a "syndicate", a group of underwriters to market and sell the stocks. Along with managing the deal, the most crucial work is determining the offer price. Underwriters use three common pricing mechanisms for IPOs: best effort, firm commitment, and auction IPOs. The best effort method is commonly used for smaller firms when the underwriter cannot assure selling all the stocks but tries to sell them for a price high as possible. It is typical for such deals to have clauses stating that the deal is off if the underwriter is unable to sell all the stocks at once.

A firm commitment is when an underwriter commits to sell all stocks for a specific price, which entails greater risk for the underwriter. If the investors purchase stocks slightly lower than the offer price, the underwriter must bear the resulting loss.

Auction IPO is a mechanism that allows the market to set the price of a stock by auctioning the stocks. The auctions determine the price of stock offered by taking all bids into account to arrive at the highest possible price. In this type of auction, investors offer their bids based on the quantity and price they are willing to pay (Berk & DeMarzo, 2016).

2.2.1 Advantages and disadvantages through IPO exit

Lande (2011, p.3) discusses several advantages of IPO exits. These potential advantages are mentioned below.

Higher exit valuation

Lande (2011, p.3) argues that sponsors usually prefer IPOs since they usually result in higher valuations for portfolio companies than other types of exits. Even though IPOs rarely result in complete exits for funds, they can still reap the benefits of any subsequent increase in a company's value after an IPO. As a result,

the sponsor can better time a future exit by using a readily ascertainable valuation rather than relying exclusively on private valuations.

Increased liquidity

Once a company goes public, Lande (2011, p.3) further argues that the company must produce public disclosures on financial information so that all parties have equal access to the same information. Consequently, the sponsor may achieve a complete exit from its investment in a brief period. The increase in post IPO liquidity contributes to enhancing the value of a firm and reducing its cost of capital. As a result, it improves the firm's ability to access capital markets in the future, namely by attracting investors and reducing transaction costs in future equity raisings (Ibbotson & Ritter, 1995).

Management support

The author claims that the management team's support is essential for a successful IPO, as it makes it easier for the sponsor to exit. Since the management's positions are less likely to be threatened, they are more likely to support an IPO than a sale to a third party.

Even with the mentioned benefits of an IPO exit, IPO's may also have several disadvantages. These potential disadvantages are outlined below.

Timing

IPOs are typically lengthy according to Lande (2011, p.4) and can take up to six months. The underwriters typically require a lock-up period of 180-days where the PE fund is not allowed to sell any shares following the IPO. This is because an early sale, in a situation where the PE fund after the IPO owns a significant amount of the company’s equity, may put excessive negative pressure on the stock price. Underwriters may require a limited number of shares to be sold over a fixed period to limit such effects. Consequently, a complete exit connected with an IPO can be a lengthy process since subsequent offerings can take up to four months.

Cost

Conducting an IPO can be expensive and can divert the company's management's attention away from their more important task of running the portfolio company. Many aspects of the IPO process need attention from the portfolio company's top management and other important employees, such as determining the offering size and timing of the IPO. Furthermore, they need to participate in roadshows and oversee the registration process. There are other significant costs associated with an IPO such as the underwriters' compensation, financial printing costs, accounting and legal fees, and listing fees.

2.3 Underpricing Theory

Underpricing is one of the puzzles of the IPO market in which issuers undervalue their shares while investors reap the reward. A positive first day return of an IPO signals a share price below its market value. The first-day return is defined as the difference between its offering price and its closing price on its first day of trading (Booth & Chua, 1996). Ibbotson (1975) describes underpricing as a puzzle and fails to offer any definitive explanation for the underpricing. Following this, we will present some theories that could explain these anomalies.

2.3.1 Asymmetric Information

IPO literature has used asymmetric information to rationalize underpricing. Beatty & Ritter's article in 1986 about asymmetric information theory examines investors' uncertainty and underwriters' reputation.

Ritter & Beatty studied IPOs over 22 years in their empirical analysis from 1960 to 1982. Their hypothesis is based on the finding that larger amounts of ex-ante uncertainty for the issue value are associated with greater anticipated underpricing. Given the uncertainty regarding the issue, well-informed investors can use the information to their advantage.

Furthermore, the paper examines to what degree an underpricing benefits the underwriter. The authors found that underpricing preserved the underwriter's reputation. Mispricing could represent a risk for the underwriter, as they could lose some of their market shares. Their reputation and revenue would be affected as a result. If the issuance is underpriced excessively, the issuer will be left with significant money on the table. However, if the underpricing is insufficient,

investors will be less likely to participate since their expected returns are not high enough (Beatty & Ritter, 1986).

In the same study, the authors also noted a negative relationship between the reputation of the underwriters and underpricing. More recent studies by Booth & Chua (1996) support the negative relationship. Companies planning to go public hire well-known underwriters to decrease underpricing. The relationship between underpricing and underwriter reputation has been examined by Carter & Manaster (1990). They found that underpricing is observed to benefit underwriters, but it can also be quite costly as discussed in section 2.2. Companies classified as moderate risk can differentiate themselves by appointing themselves more prestigious underwriters, which in turn conveys a positive message to investors as a form of reduced risk and asymmetric information. The study found that a higher reputation of the underwriter equates to lower risk when issuing stocks. The deal size was also considered a measure of underpricing by the authors. From what we can deduce there is yet to be a collective established wisdom regarding the impact of an underwriter's reputation in the finance literature.

2.3.2 Ex-ante uncertainty

According to Beatty & Ritter (1986), ex-ante uncertainty is the most significant determinant for underpricing in IPOs. Rocks' (1986) theory explains that underpricing is an outcome of the difference in asymmetric information between informed and uninformed investors regarding information about a stock's intrinsic value. The paper argues that uninformed investors may buy stocks oblivious to the stock's intrinsic value. In contrast, informed investors have an insight into the value and will buy stocks, thereby giving them an excess return. The uninformed investors are the only investors of an overpriced stock, ultimately. These losses may lead to uninformed investors leaving the IPO market if they occur frequently. Thus, the underwriter begins with a lower opening price so that both informed and uninformed investors remain in the market and purchase the stock, resulting in stock underpricing (Rock, 1986).

2.3.3 Syndicate members

The size of the underwriter syndicate may also contribute to the underpricing of an IPO. The findings of Corwin & Schultz (2005) indicate that the accuracy of the

offering price increases, the larger the syndicate size is. The authors contend that larger underwriter syndicates will decrease the underpricing of IPOs. By reducing asymmetric information (as discussed in the section above) or helping to verify the quality of an offering, non-managing syndicate members and co-lead managers can reduce underpricing (Corwin & Schultz, 2005).

2.3.4 Hot market issues

Apart from asymmetric information, market cycles are among the factors that help explain and determine the level of underpricing alongside other market characteristics. “Hot” and “cold” IPO markets describe the different cycles. Ibbotson & Jaffe (1975) argues that the degree of IPO underpricing can be cyclical. The aforementioned authors found that periods of extreme underpricing led to many new issues and used the term "hot issue" market to describe the phenomenon. Ritter (1984) further documented "hot issue" markets. Ritter characterized the market by an abnormally high volume of new offerings, severe underpricing, and frequent oversubscription. "Cold" markets, on the other hand, are described as a time with fewer offerings, instances of underpricing, and oversubscription.

The window of opportunity hypothesis should also be considered in light of “hot” and “cold” markets. The hypothesis argues that companies are likely to experience overvaluation if they go public during “hot” IPO markets (Ritter, 1991). High volumes during such periods may indicate investors who are optimistic about future growth prospects. Issuers aim to capitalize on this investor optimism and sell their shares at a suitable time in such market conditions, thus maximizing their returns.

2.4 Empirical result of underpricing

In response to the discovery, many authors have documented the phenomenon of underpricing in different markets worldwide, resulting in numerous pieces of literature documenting its existence:

Table 2.1 Summary of previous literature on underpricing

An overview of initial public offerings from earlier studies is presented below. Specifically, we provide information on the sample period, the estimated average underpricing (mean), the market/region studied, and each initial public offering classification. These IPOs are classified according to their ownership structure into four categories: The term "All" IPOs refers to all IPOs regardless of ownership structure. "NS" refers to non-sponsored IPOs. "VC" refers to venture capital-backed IPOs. "PE" refers to private equity-backed IPOs. "BO" refer to buyout-backed IPOs, including VC and PE-backed offerings. It should be noted that "BO" includes reverse leveraged buyouts (RLBOs).

Study	Sample period	Estimated underpricing (mean)	Market	Classification
All IPOs				
Reilly & Hatfield (1969)	1963 - 1966	9.9%	US	All
McDonald & Fisher (1972)	Q1 1969	28.5%	US	All
Ibbotson (1975)	1960 - 1969	11.4%	US	All
Ibbotson (1975)	1960 - 1970	16.8%	US	All
Ritter (1984)	1960 - 1982	18.8%	US	All
Ritter (1984)	1977 - 1982	26.5%	US	All
Ritter (1984)	1980 - 1981	48.4%	US	All
Beatty & Ritter (1986)	1981 - 1982	14.1%	US	All
Chalk & Peavy III (1987)	1975 - 1982	21.7%	US	All
Miller & Reilly (1987)	1975 - 1982	9.9%	US	All
Ibbotson et al. (1988)	1960 - 1987	16.4%	US	All
Ibbotson et al. (1994)	1960 - 1992	15.3%	US	All
Ibbotson et al. (1994)	1960 - 2006	18.7%	US	All
Booth & Chua (1996)	1977 - 1988	13.1%	US	All
Van der Geest & Van Frederikslust(2001)	1985 - 1998	16.0%	Netherlands	All
Lowry & Schwert (2002)	1985 - 1997	13.9%	US	All
Schertler (2002)	1997 - 2000	49.2%	Germany	All
Schertler (2002)	1997 - 2000	9.2%	France	All
Loughran & Ritter (2004)	1990 - 1998	15.0%	US	All
Loughran & Ritter (2004)	1999 - 2000	65.0%	US	All
Loughran & Ritter (2004)	2001 - 2003	12.0%	US	All
Westerholm (2006)	1991 - 2002	17.0%	Nordic	All
Hesjedak (2007)	2004 - 2006	3.2%	Norway	All
Vu & Laird (2008)	1996 - 2007	57.8%	Australia	All
Ferretti & Meles (2011)	1998 - 2008	4.7%	Italy	All
Levis (2011)	1992 - 2005	18.6%	UK	All
Falck (2013)	2001 - 2012	3.2%	Norway	All
Shulzhuk & Ismanova (2014)	1993 - 2008	4.5%	Norway	All
Non -sponsored IPOs				
Hamao et al. (2000)	1989 - 1994	12.7%	Japan	NS
Van der Geest & Van Frederikslust(2001)	1985 - 1998	17.0%	Netherlands	NS
Bergström et al. (2006)	1994 - 2004	14.7%	UK	NS
Bergström et al. (2006)	1994 - 2004	9.5%	France	NS
Vu & Laird (2008)	1996 - 2007	70.7%	Australia	NS
Ferretti & Meles (2011)	1998 - 2008	6.6%	Italy	NS
Levis (2011)	1992 - 2005	21.1%	UK	NS
Venture capital backed IPOs				

Vu & Laird (2008)	1996 - 2007	32.1%	Australia	VC
Levis (2011)	1992 - 2005	14.9%	UK	VC
Private equity-backed IPOs				
Hamao et al. (2000)	1989 - 1994	19.2%	Japan	PE
Van der Geest & Van Frederikslust(2001)	1985 - 1998	13.0%	Netherlands	PE
Schertler (2002)	1997 - 2000	52.0%	Germany	PE
Schertler (2002)	1997 - 2000	16.0%	France	PE
Bergström et al. (2006)	1994 - 2004	10.3%	UK	PE
Bergström et al. (2006)	1994 - 2004	4.2%	France	PE
Vu & Laird (2008)	1996 - 2007	39.6%	Australia	PE
Ferretti & Meles (2011)	1998 - 2008	1.9%	Italy	PE
Levis (2011)	1992 - 2005	9.1%	UK	PE
				PE
Buyout-backed IPOs				
Muscarella & Vetsuypens (1989)	1983 - 1987	2.0%	US	BO
Holthausen & Larcker (1996)	1983 - 1988	2.0%	US	BO
Cook & Officer (1996)	1983 - 1991	1.9%	US	BO
Hogan et al. (2001)	1986 - 1998	7.6%	US	BO
Ang & Brau (2002)	1981 - 1996	5.5%	US	BO
Schöber (2008)	1990 - 2006	9.9%	US	BO
Cao & Lerner (2009)	1986 - 2002	15.4%	US	BO

(Aas S.C & Seljeseth K.A,2018)

The level of underpricing ranges from 1.9% to 70.7% in the overlapping periods. Even though underpricing is highly cyclical, we find an average of 18.3%. Non-sponsored (NS) IPOs have an average of 21.8% and are accordingly more underpriced than PE-backed IPOs at 18.4% and BO at 6.3%.

Table 2.2 National studies on Underpricing

An overview of initial public offerings from earlier studies from Norway is presented below. Specifically, we provide information on the sample period, the estimated average underpricing (mean), the market/region studied.

Study	Sample period	Estimated underpricing (mean)	Market
Ruud and Ullevoldsæter (1987)	1982 - 1986	14.80%	Norway
Nærland (1994)	1984 - 1994	12.03%	Norway
Håland (1994)	1982 - 1994	19.30%	Norway
Sættern (1996)	1982 - 1996	13.46%	Norway
Emilsen and Pedersen (1996)	1982 - 1996	17.40%	Norway
Gabrielsen et.al (2001)	1982 - 1999	16.70%	Norway
Ardø (2001)	1990 - 2003	12.90%	Norway
Emilsen and Enger (2003)	1982 - 2002	18.50%	Norway
Edvardsen (2004	1997 - 2004	11.25%	Norway
Kyllo and Skaar (2006)	1985 - 2005	13.44%	Norway
Samuelsen and Tveter (2006)	2004 - 2005	2.21%	Norway

(Moe, 2007)

For Norwegian studies, the average level is 13.82%, with a standard deviation of 4.47%. Nationally documented underpricing has declined over the years according to Moe (2007). The presence of abnormal initial returns soon after an IPO is a widespread and recurring indicator of underpricing in almost all studies both national and international.

Part III. Methodology and data

3.1 Research Questions

The main objective of this thesis is to examine whether PE-backed IPOs are less underpriced in the Norwegian stock market than VC and NS-IPOs. Therefore, our main research question is:

"Are private equity-backed IPOs less underpriced than non-private equity backed IPOs in the Norwegian stock market?"

3.2 Research Hypothesis

To empirically answer the question above, we used a statistical approach. As a result, we have developed several testable hypotheses that may explain why non-PE-backed IPOs suffer more from underpricing than PE-backed ones. According to prior studies, IPOs are underpriced on average. We would like to start by checking and quantifying this, using updated data from the Norwegian stock market. Hence, our first hypothesis is:

Hypothesis 1: *IPOs in the Norwegian stock market experience underpricing.*

According to previous studies, PE-backed IPOs experience less underpricing than non-PE-backed IPOs. Accordingly, our second hypothesis would be:

Hypothesis 2: *PE-backed IPOs experience less underpricing compared to VC-backed IPOs and NS-IPOs in the Norwegian stock market.*

The issuing period of the IPO could be another factor to explain the level of underpricing. Previous research from Ibbotson (1988) suggests a higher level of underpricing during periods of high IPO activity ("hot" markets). Prior literature (Levis, 2011) also states that NS-IPOs are more susceptible to underpricing than PE-backed IPOs. We have therefore made the two following hypotheses to test the previous findings:

Hypothesis 3: *IPOs experience a higher degree of underpricing during "hot" markets compared to "cold" markets.*

Hypothesis 4: *PE-backed IPOs experience less underpricing during "hot" markets compared to VC-backed and NS-IPOs.*

Furthermore, a study conducted by Lee & Wahal (2004) suggests that VC-backed IPOs encounter higher underpricing. Therefore, we would like to test whether VC-backing influences underpricing, and our following hypothesis is:

Hypothesis 5: *VC-backed IPOs have a positive relationship with underpricing.*

As discussed in 2.3.3, syndicate size may also be a factor affecting IPO underpricing. The findings of Corwin & Schultz (2005) indicate that the larger the syndicate size, the more accurate the price becomes. They believe it is due to a bigger market representation, thus representing the value of the market more. We therefore want to test this implication in our last hypothesis.

Hypothesis 6: *A larger number of underwriters equates to lower degree of underpricing.*

3.3 Dataset

This section discusses the data collection process and the development of regression variables. We will discuss how the data has been collected and processed to construct the variables needed for the multivariate regression analysis.

3.3.1 Data collection process

The final sample of the thesis consists of 172 IPOs listed on Oslo Børs and Euronext Growth Oslo. The initial data sample was gathered from the Bloomberg Terminal's equity data. It contains information about the issuing company's name, listing date, offer price, first-day closing price, underwriters, and total assets before offering. We defined our sample to consist of IPOs offered in the period from January 2010 to December 2021. It is worth mentioning that missing observations from Bloomberg Terminal were retrieved from Refinitiv Eikon regarding first-day closing price and total assets before offering.

We have excluded secondary listings from the sample as these shares may create bias because they have been priced previously in the market. Furthermore, companies with missing ownership structure pre-IPO were also excluded from the dataset to reduce bias when comparing the underpricing of PE-backed IPOs and non-PE-backed IPOs.

Our final sample is divided into three groups, which depend on pre-IPO ownership: PE, VC, and NS-IPOs. We used CB Insights, Bloomberg Terminal, and Refinitiv Eikon database to identify the companies' pre-IPO ownership and cross-checked their pre-IPO ownership displayed on their websites. Furthermore, our sample does not have a minimum limit of ownership by the PE/VC firms, and the reason for this is because of how the PE and VC funds are structured.

3.3.2 Private equity and venture capital classification

A challenge for this thesis has been the classification of PE-backed and VC-backed IPOs. This is due to the overlapping nature of the sponsors' involvement in both VC and PE transactions (Levis, 2011, p. 258).

Levis (2011) defines an IPO as PE-backed when the PE firm has a controlling interest at the time of the buyout, and VC-backed IPOs as a company that has received VC-backing at one stage before going public. We define PE-backed IPO and VC-backed as an initial offering in which one of the sellers is either a PE firm or VC firm.

When extracting data from Bloomberg Terminal, we used the filter "PE-backed" or "VC-backed" IPO to classify the companies in our sample. However, Bloomberg Terminal did not classify every company; therefore, we used both CB Insights and Refinitiv Eikon for the missing classifications. CB insights defined whether the companies were PE/VC backed-firm pre-listing or NS. For the rest of the companies that were not classified, we used Refinitiv Eikon to check the ownership pre-IPO.

We present the final sample in Table 3.1. PE-backed IPOs contribute 15.7% of the total sample, but we can see that they raised 27.66% of the total market capitalization. Furthermore, VC-backed IPOs contribute 12.79% of the whole sample but only raised 5.34% of the total capital.

Table 3.1 Yearly observations of IPOs and market capitalization

Table 3.1 presents the yearly observations of the IPOs and the market capitalization for each investment class. The total sample consists of 172 initial public offerings (IPOs) listed on the Norwegian stock market from January 2010 to December 2021. They are distributed among 123 non-sponsored IPOs (NS), 27 private equity-backed IPOs (PE), and 22 venture capital-backed IPOs (VC).

	Number of firms listed				Market cap (MNOK)			
Year	All firms	PE	VC	NS	All firms	PE	VC	NS
2010	11	0	2	9	20 622.39	0	338.39	20 284.00
2011	6	0	0	6	25 958.17	0	0	25 958.17
2012	2	0	0	2	2 201.62	0	0	2 201.62
2013	12	0	3	9	9 126.64	0	1 159.99	7 966.65
2014	10	4	0	6	12 349.88	4 350.41	0	7 999.47
2015	9	3	1	5	9 664.45	3 972.59	575.00	5 116.86
2016	3	1	0	2	2 949.21	2 057.42	0.00	891.79
2017	15	4	2	9	12 590.66	6 279.00	707.03	5 604.63
2018	9	2	1	6	12 407.93	8 884.14	134.69	3 389.10
2019	8	1	0	7	8 967.65	3 15.00	0	8 652.65
2020	37	6	7	24	29 499.70	6 334.00	4 865.94	18 299.77
2021	50	6	6	38	55 921.20	23 757.78	3 017.33	29 146.10
Total	172	27	22	123	20 2259.5	55 950.33	10 798.37	135 510.81
Average	14.33	2.25	1.83	10	16 854.9	4 662.53	899.86	11 292.57
Median	9.5	1.5	1	7	12 378.9	3 015.01	236.54	7 983.06
Percentage	100%	15.70%	12.79%	71.51%	100%	27.66%	5.34%	67%

3.4 Criticism of the data

Despite the validation efforts of the sample, our data might still suffer from some missing IPOs.

First, we might have overlooked some IPOs from January 2010 to December 2021 as we only used the Bloomberg Terminal when collecting data. We could, for instance, manually collect all the IPOs from the Oslo Stock exchange. However, it would be highly time-consuming as the Oslo Stock

exchange did not report the variables we needed for the regression. Furthermore, we cross-checked the IPOs in Refinitiv Eikon and added missing IPOs in the sample.

Secondly, the main criticism of our sample is identifying the ownership pre-IPO and correctly placing them in one of the three subgroups (PE-backed, VC-backed or NS). To mitigate this, we used information from CB insights and Refinitiv Eikon, as mentioned in section 3.3.2. Furthermore, we cross-checked the information on the PE and VC firms' websites. However, some IPOs might still be wrongly classified, creating bias in our sample.

Lastly, due to the relatively small sample of PE-backed and VC-backed IPOs, the result of our analysis can be affected by extreme outliers. The results from our regression would be more trustworthy with a larger sample size of PE-backed IPOs and VC-backed IPOs.

3.5 Development of regression variables

3.5.1 PE and VC

Some publications claim either high or low underpricing of PE/VC-backed IPOs. The dataset contains information on whether the companies, prior to the IPO, were backed by PE or VC firm, or NS. For each IPO, we created two dummy variables based on the sponsors' list. The first dummy variable, referred to as PEdummy, declares if an IPO is PE-backed, whereas the second dummy variable, referred to as VC, declares if an IPO is VC-backed. Either variable is set to 1 if they are sponsored respectively and 0 if they are not sponsored. The dummy variables are denoted to as *PEdummy* and *VCdummy*.

3.5.2 Number of underwriters

The dataset contain deal-specific information regarding the number of underwriters in each syndicate. The number of underwriters is used to examine asymmetric information. Corwin & Schultz (2005) indicate that larger syndicate groups result in more accurate offer prices and less underpricing. This number represents the total of the underwriting firms involved in the offering. The variable is referred to as *Nrofunderwriters*.

3.5.3 IPO activity

To examine whether IPO underpricing is affected by the "hot market issue", we use a dummy variable that equals 1 if the year is regarded as "hot" and 0 if the year is regarded as "cold". The average IPOs per year in our sample is 15, thus the threshold for being in a hot market is 15 or more IPOs in the period. Therefore, we classify the "hot" period as 2017, 2020 and 2021. The rest of the periods are classified as "cold" periods. Furthermore, we will divide the three subgroups into either "hot" or "cold" markets to check whether PE-backed firms experience less underpricing during "hot" periods than VC-backed and NS firms. The dummy variable for "hot" IPO activity is referred to as *HCdummy.*

Covid-19 and IPO activity

The Covid-19 pandemic significantly impacted the number of IPOs issued during 2020 and 2021. In the first weeks of the Covid-19 pandemic, many deals were cancelled due to the market's uncertainty. However, the effect of the pandemic only lasted a brief period for the IPO market, and the IPO market started to lead the growth in number and value of deals (Bugge & Shergill, 2022). According to Bugge & Shergill (2022), there was also an increase in PE presence in 2021.

A reason for the increased activity of Norwegian IPOs during the pandemic is that the Merkur Market offered a fast and flexible listing process, which was one to two weeks rather than one to two months (Thommessen, 2020).

"Many of these companies were not planning IPOs", said the first banker. "They have accelerated their listing planes because the window was there. It is like a new market opening and is frequently an alternative to the companies being bought by private equity". (Raitano, 2020)

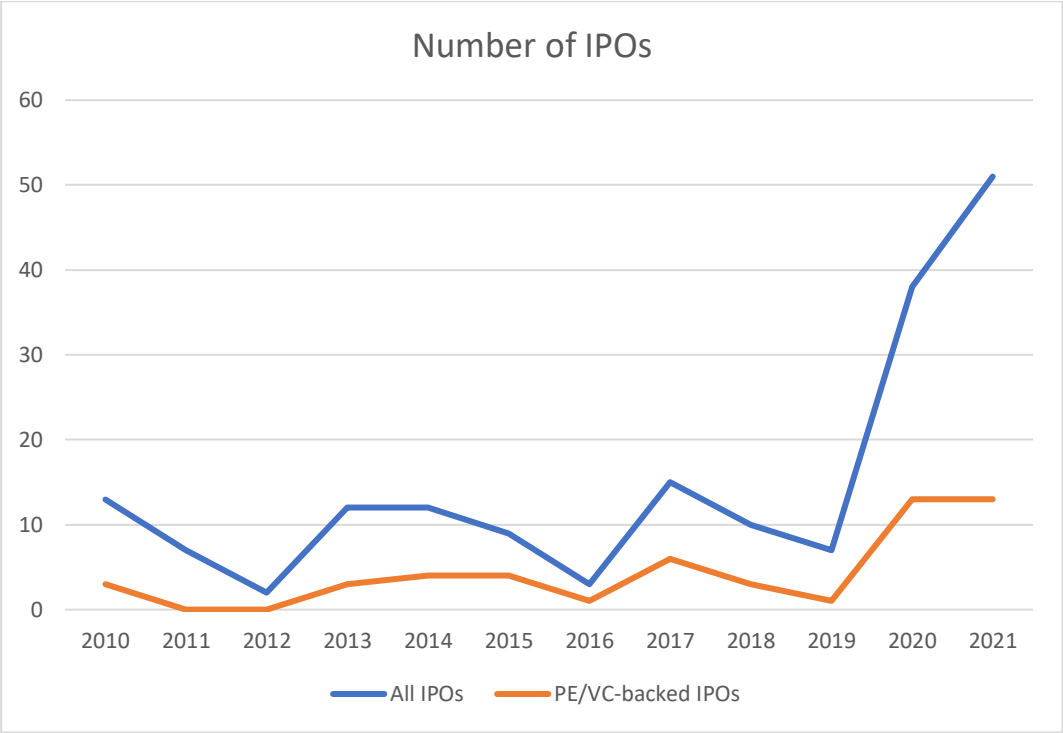


Figure 3.2 *Number of IPOs from 2010 to 2021*

Norwegian PE funds are primarily involved in IT, oil and gas, and consumer goods retail, according to NVCA (Hammerich & Heistad, 2021). The oil and gas industry has not been affected by Covid-19 as much as other industries. While other industries suffered, the IT industry has prospered due to the expanded work from home policies and generally increased demand (Hammerich & Heistad, 2021), which could explain the increase in IPOs by PE/VC firms in 2020 and 2021.

However, there is a significant difference in the number of IPOs issued by NS-firms and PE/VC. This difference could be explained by the volatility of consumer goods and other market investments, leading to the fund postponing its divestment or choosing other exit methods.

Furthermore, Uddin & Chowdry (2021) examine PE strategy during the pandemic. Firstly, asymmetric information is one of the most used theories to explain PE exit strategy. As PE managers are profit-maximizing agents, they select an appropriate exit strategy to maximize profit (Uddin & Chowdry, 2021), making it particularly important during an exogenous shock, such as Covid-19. During an exogenous shock, asymmetric information is high and IPOs are therefore unsuitable as an exit strategy. Cumming and MacIntosh (2003) also hypothesize that an exit through IPOs is accompanied by significant asymmetric

information. Thus, Uddin & Chowdhury (2021) finds that PE firms prefer to exit via trade sales during exogenous shock because this helps PE firms to minimize the asymmetric information.

3.5.4 Assets

We use the firm's total assets pre-IPO as an indicator for the firm size. Larger firms tend to be less underpriced because they usually have more information available to the public. More information reduces the ex-ante uncertainty. We use the natural logarithm of the total assets pre-IPO to correct the skewness of the data. The variable is referred to as *LNassets*.

3.5.5 Age

The Age variable is used to examine asymmetric information. According to Ritter (1984), more established firms experience less underpricing and are easier to value. It is anticipated that more information is available to older and more well-established firms, which may reduce asymmetric information and levels of underpricing. Therefore, younger firms can be associated with higher risk and, consequently, higher underpricing. We use the natural logarithm of 1 + age of the firm. The firm's age is measured by the period between the year of listing and the year it was established. The variable "age" is referred to as *LNage.*

3.5.6 Tech

Ritter (1984) assumes riskier IPOs will experience more underpricing than less-risky firms. Furthermore, tech firms are typically riskier compared to non-tech firms. Consequently, investors require higher returns because of higher risk and thus increasing the level of underpricing (Beck, 2017). Therefore, we have included Tech, a dummy variable equal to 1 if the firm belongs to the tech industry and is equal to 0 otherwise. The dummy variable is referred to as *Techdummy.*

3.6 Methodology

In this section, we will present the methods used to evaluate underpricing. Furthermore, we will be describing the statistical tests used to test the hypothesis presented in section 3.2.

3.6.1 Measuring initial return

When measuring underpricing of an IPO, various literature and research have used the metric "initial return". Ritter & Welch (2002) state that academics use the terms *initial return*s and *underpricing* interchangeably. Thus, we define the *initial return* as the percentage change between the first-day closing price and the offer price. The initial return is calculated as follows:

$$IR_i = \frac{P_{i,t+1} - P_{i,t}}{P_{i,t}}$$

Where IR_i is the initial return for security *i*, $P_{i,t+1}$ is the first closing price of security *i*, and $P_{i,t}$ is the offer price of security *i*. We could alternatively calculate the initial return using the opening price instead of the closing price. However, Ritter & Welch (2002) states that the results are insensitive to whether the opening or closing market price is used. The majority of the empirical work has used the first-day closing price. Accordingly, we use the first-day closing price.

3.6.2 Adjusted initial return

The initial return should be market adjusted if markets are highly volatile. Hence, we adjust the initial return by subtracting this from a relevant market index. This method is supported by Logue (1973). Furthermore, we believe that the adjusted initial return is a better measure because it considers the market movements that can influence prices.

We will be using the OSEBX (Oslo Benchmark Index), as this index reflects the alternative investment. The adjusted initial return is calculated as follows:

$$AR_i = \frac{P_{i,t+1} - P_{i,t}}{P_{i,t}} - \frac{OSEBX_{i,t+1} - OSEBX_{i,t}}{OSEBX_{i,t}}$$

It is worth mentioning the risk of the IPO and the market. For the index to act as an alternative investment, the security and the index should have the same risk. By including a beta value, we can assess the volatility of a particular stock in comparison with the systematic risk of the market (Kenton, 2021). However, the stocks have no historical price, so beta cannot be measured. Therefore, we chose to use Logue's (1973) method.

All the firms are equally weighted when calculating the average adjusted initial returns for the sample. The equally-weighted average adjusted initial returns is calculated as follows:

$$AR_s^{ew} = \frac{1}{n_s}\sum_{i=1}^{n_s} AR_i$$

Where AR_s^{ew} is the equally-weighted average adjusted initial return for the whole sample, and *n* is the number of observations for the whole sample.

3.6.3 Statistical tests for hypothesis testing

First, to test whether Norwegian IPOs experience underpricing, we use a one-sample t-test of whether the initial returns are statistically different from zero[1]. Secondly, we use a two-sample t-test to check if the average initial return is statistically significant from zero, testing whether PE-backed IPOs experience less underpricing than non-PE-backed IPOs[2]. Finally, we test if PE-backed IPOs experience less underpricing during "hot" markets[3], we use a two-sample t-test to determine whether the difference between the samples are significantly different from zero.

3.7 Multivariate regression model

A multivariate ordinary least squares (OLS) regression analysis is performed to test hypothesis 3, 5 and 6. We construct two different regressions that includes variables that have shown to have an influence on underpricing. We use market adjusted initial return (AdjustedInitialReturn) as the dependent variable.

The regression includes whether the issuing firms was backed by PE firm (PEdummy) or VC firm (VCdummy). Dummy variables that express whether the issuing firm was a tech firm (Techdummy) and if the issuing firm was listed during a "hot" market period (HCdummy) are also included in the model. Furthermore, the logarithm of assets pre-IPO (LNassets), the logarithm of age of the company (LNage) and number of underwriters (NrofUnderwriters) are included in the model.

Model 1 includes the research variables for our hypothesis. However, to better assess the research variables, we include control variables that have shown

[1] Hypothesis 1
[2] Hypothesis 2
[3] Hypothesis 4

an effect on underpricing in model 2. Further, this will reduce the omitted variable bias problem.

Schöber (2008) has documented that most authors use initial returns unadjusted for market movements. To analyse the difference between unadjusted initial return and market adjusted initial return, we run a third regression with unadjusted initial return as dependent variable.

$$AdjustedInititalReturn_i = \beta_0 + \beta_1 HCdummy + \beta_2 PEdummy + \beta_3 VCdummy + + \beta_4 NrofUnderwriters + \varepsilon_i \quad (1)$$

$$AdjustedInititalReturn_i = \beta_0 + \beta_1 PEdummy + \beta_2 VCdummy + \beta_3 LNage + \beta_4 HCdummy + \beta_5 LNassets + \beta_6 NrofUnderwriters + \beta_7 Techdummy + \varepsilon_i \quad (2)$$

$$InititalReturn_i = \beta_0 + \beta_1 PEdummy + \beta_2 VCdummy + \beta_3 LNage + \beta_4 HCdummy + \beta_5 LNassets + \beta_6 NrofUnderwriters + \beta_7 Techdummy + \varepsilon_i \quad (3)$$

Table 3.3 Regression variables

An overview of the variables and their expected effect on underpricing is presented below. The term reduce refers to lesser underpricing, whereas the term increase refers to greater underpricing of IPOs.

Variable	Explanation	Expected effect on underpricing
AdjustedInitialReturn	Initial return minus the return OSEBX Index	Dependent variable
InitialReturn	Closing first day price minus the offer price	Dependent variable
PEdummy	IPOs backed by private equity firm	Reduce
VCdummy	IPOs backed by venture capital firm	Increase
LNage	Natural logarithm of age	Reduce
HCdummy	Companies issued during "hot" market	Increase
LNassets	Natural logarithm asset pre-IPO	Reduce
NrofUnderwriters	Total number of underwriters that were active in the offering	Reduce
Techdummy	Tech companies	Increase

3.7.1 Validity of the model (econometric issues)

We perform a multivariate regression to identify the linear relationship between IPO underpricing and the explanatory variables. The validity of the model relies on the assumptions of the classical linear regression model being met. In this subpart, we will be discussing if the assumptions are violated.

3.7.2 Heteroscedasticity

One of the assumptions is that the variance of the errors is constant – This is known as the assumption of homoscedasticity (Brooks, 2020). We perform White's test to identify if there is a presence of heteroscedasticity in our model.

Appendix 6.1.3 shows White's test for heteroscedasticity. The test displays a p-value of 0.1216, indicating that the error terms are not heteroscedastic.

3.7.3 Multicollinearity

Another implicit assumption when using the OLS estimation is that the explanatory variables are not correlated with one another (Brooks, 2020). The assumption is violated if the explanatory variables are highly correlated. We check for multicollinearity by looking at the correlation matrix that includes the explanatory variables. The correlation matrix is shown in appendix 6.1.1. The highest correlation coefficient is between the dummy variable *HCdummy* and *LNassets*, with a coefficient of -0.3106. The explanatory variables are therefore not highly correlated with one another.

We can formally check for multicollinearity by calculating the variance inflation factors (VIF). This method estimates the extent to which the variance of a parameter increases because the explanatory variables are correlated (Brooks, 2020). As a rule of thumb, a VIF value less than 5 indicates that there is not an issue regarding multicollinearity. The results from calculating VIF are displayed in appendix 6.1.1. The average VIF is 1.11, with the highest value of 1.17. Thus, multicollinearity is not an issue for our model.

3.7.4 Normality

The normality assumption is required to validly conduct a hypothesis test, either a t-test or F-test. Furthermore, normality assumption refers to the normal distribution of the residuals.

The distribution of the errors, Kernel density plot, standardized normal probability plot, and normal quantile plot are shown in appendix 6.1.2. The normal quantile plot indicates signs of non-normality at the upper tail. Moreover, the normal probability plot indicates signs of non-normality in the upper-middle range. However, according to the central limit theorem, the distribution tends to be normal if the sample size is large enough. As our sample size consists of 172 observations, the violation of the normality assumption should not significantly influence the regression results.

Part IV: Analysis and presentation of results

In this section, we will present and analyse the results from underpricing.

4.1 Distribution of first-day return

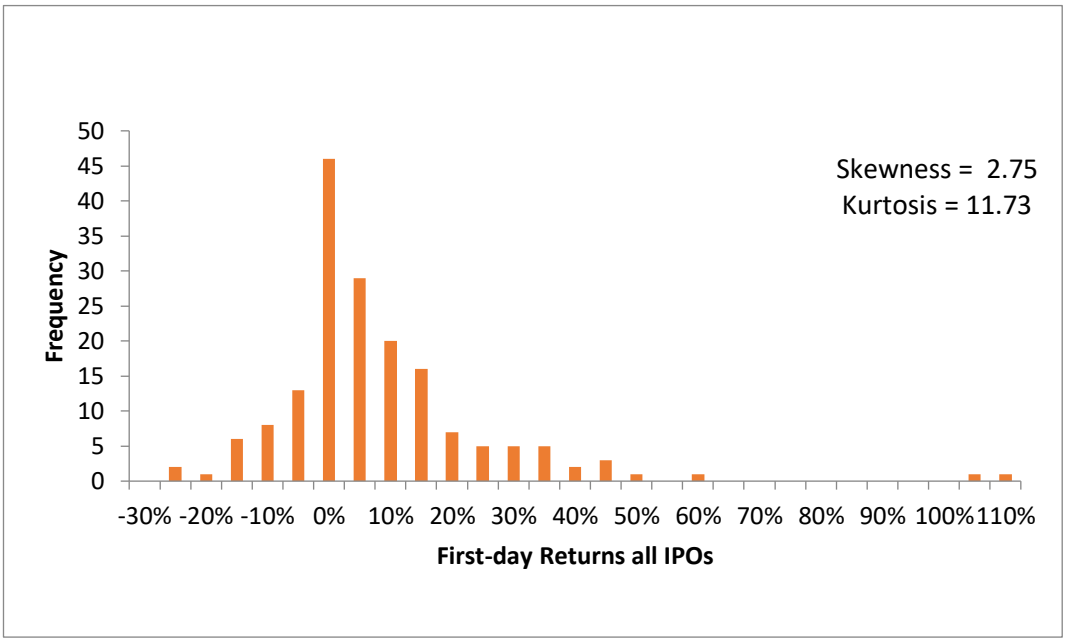
Figure 4.1 shows that the distribution of the initial returns is positively skewed, with skewness of 2.75 and kurtosis of 11.73. Moreover, the average first-day return is 6.33%, significantly higher than the median value of 1.20%. A Jarque-Bera test confirms that the distribution of first-day returns is non-normal[4]. Skewness explains the symmetry of the distribution, where a normal distribution has a skewness of zero. Some large first-day returns of VC-backed IPOs can explain the skewness in the distribution. The maximum first-day return is 114.06%.

Moreover, kurtosis explains the presence of outliers in the distribution, where a normal distribution has kurtosis equal to three. From figure 4.1, we can observe that the distribution is leptokurtic, meaning there is a high probability of outliers. The distribution is consistent with Ibbotson's (1975) paper, where he argues that drawing a random IPO from a similar distribution has a higher chance of resulting in high initial returns than low initial returns.

[4] Rejects the null hypothesis at any significance level.

Figure 4.1 Distribution of first-day returns

Figure 4.1 displays the distribution of first-day returns. It reports a skewness of 2.75 and kurtosis of 11.73. The distribution is positively skewed, which can be explained by large first-day returns. The lowest initial return observed is -27.27%, whereas the highest is 114.06%.



4.2 Statistical tests of first-day returns

The descriptive statistics are shown in Table 4.2. Firstly, we observe that the average initial return of the different subgroups and all IPOs are positive. This indicates that underpricing exist in Norway during the period 2010-2021. Furthermore, the median of the different subgroups and all the IPOs are closer to zero compared to the average market adjusted return. Additionally, table 4.2 shows that the maximum initial return of PE-backed IPOs is 23.14%, whereas the maximum of VC-backed IPOs and NS IPOs are 114.06% and 100.76%, respectively. This indicates that the distribution is positively skewed.

The average market adjusted first-day returns show an average underpricing of Norwegian IPOs in period of 2010-2021, which strongly supports our first hypothesis[5]. A one-sample t-test shows that the average market adusted returns of *all firms* are statistically significant from zero at the 1% level, as shown in table

[5] Hypothesis 1: All IPOs in the Norwegian stock market

4.2. The whole sample reports an average underpricing of 6.33%, consistent with previous literature, such as Ritter (1984), and Loughran, Ritter & Rydqvist (1994). Furthermore, Ibbotson et al. (1994) argues that short-run underpricing exists in every country with a stock market. We test the subsamples to see if the average is statistically significant from zero. PE-backed, VC-backed, and NS-IPOs report an underpricing of 2.46%, 14.37%, and 5.74% respectively. NS is the only statistically significant result at any significance level, while PE-backed is not statistically significant, and VC-backed is statistically significant at 10%.

Table 4.2 Descriptive statistics

*Table 4.2 presents descriptive coefficients that summarize our collected data. A two-sided t-test is used to test whether the average market adjusted initial return differ from zero. The total sample consists of 172 initial public offerings (IPOs) listed on the Norwegian stock market from January 2010 to December 2021. They are distributed among 123 non-sponsored IPOs (NS), 27 private equity-backed IPOs (PE), and 22 venture capital-backed IPOs (VC). * Indicates a significance level of 10%, ** indicates a significance level of 5%, *** indicates a significance level of 1%.*

	PE	**VC**	**NS**	**All firms**
Observations	27	22	123	172
Average market adjusted return	2.46%	14.37%*	5.74%***	6.33%***
Median	0.08%	1.21%	1.53%	1.20%
Max	23.14%	114.06%	100.76%	114.06%
Min	-25.59%	-27.27%	-20.59%	-27.27%
Standard deviation	11.35%	36.91%	15.75%	19.36%
Kurtosis	2.754	2.754	10.292	11.731
Skewness	-0.113	1.765	2.309	2.757

Continuing with the different ownerships prior to the IPO, we can observe that the PE-backed IPOs report an average underpricing of 2.46%, which is lower than VC-backed IPOs and NS-IPOs[6]. However, we do not reject the null hypotheses when testing hypothesis two. PE-backed IPOs are not statistically different from the subsamples. However, they still experience the lowest degree of average underpricing which partially support our second hypotheses[7].

[6] Table 4.3 shows the statistical tests of the subsamples.
[7] Hypotheses 2: PE-backed IPOs experience less underpricing compared to VC-backed IPOs and non-sponsored IPOs in the Norwegian stock market

The lower underpricing of PE-backed IPOs is consistent with the findings of Levis (2011); Bergström et al. (2006); Sieradzki & Zasępa (2016). The average age of PE-backed IPOs can explain the lower underpricing. PE-backed IPOs have a mean age of 12.81 compared to VC-backed IPOs and NS IPOs with a mean age of 11.50 and 9.79, respectively. Firm age measures how established the firm is, making an older firm easier to value (Ritter, 1984) and may also be considered as less risky. Another explanation of the underpricing can also be the aggressive pricing of the PE firms (Levis, 2011).

Table 4.3 T-tests of difference in the average first-day returns between selected subgroups

*An overview of the average first-day returns for the different subgroups. The panel tests hypothesis 2 using a two-sided t-test to check whether the initial returns of the subgroups differ from each other. Table 4.3 present the standard deviation and p-value for the corresponding sample. The total sample consists of 172 international initial public offerings (IPOs) listed on the Norwegian stock market from January 2010 to December 2021. They are distributed among 123 non-sponsored IPOs (NS), 27 private equity-backed IPOs (PE), and 22 venture capital-backed IPOs (VC). * Indicates a significance level of 10%, ** indicates a significance level of 5%, *** indicates a significance level of 1%.*

Subgroups	**PE**	**NS**	**PE**	**VC**	**VC**	**NS**
Number of listings	27	123	27	22	22	123
Mean	2.46%	5.74%	2.46%	14.37%	14.37%	5.74%
Standard deviation	11.35%	15.75%	11.35%	36.91%	36.91%	15.75%
P-value	0.3075		0.1184		0.068*	

First day returns and hot/cold periods

All IPOs as a group experience higher first-day returns, with a mean of 9.39%, during hot market activity, which is statistically significant at the 5% level. On average, PE-backed IPOs experience higher underpricing during hot market activity, however the results are not statistically significant. This supports our fourth hypothesis[8]. This is also consistent with Bergström et al. (2006), where

[8] Hypothesis 4: PE-backed IPOs will experience less underpricing during "hot" markets compared to VC-backed IPOs and non-sponsored IPOs

they report higher degrees of underpricing during hot market of all IPOs, but lower degree of underpricing for PE-backed IPOs during the same period.

Table 4.4 T-tests of difference in the average first-day returns during hot and cold market

An overview of the first-day returns of the different subgroups during the two different market cycles. The panel tests if PE-backed IPOs experience less underpricing during "hot" markets compared to VC-backed IPOs and NS IPOs using a regular two-sided t-test. The table reports the corresponding standard deviation and p-values. The total sample of 172 IPOs is comprised of 123 non-sponsored (NS), 27 private equity-backed (PE), and 22 venture capital-backed (VC) IPOs from January 2010 to December 2021 listed on the Norwegian stock market. * indicates a significance level of 10%, ** indicates a significance level of 5%, *** indicates a significance level of 1%.

	All		**PE**		**VC**		**NS**	
Subgroups	**Hot**	**Cold**	**Hot**	**Cold**	**Hot**	**Cold**	**Hot**	**Cold**
Number of listings	102	70	16	11	15	7	71	52
Mean	9.39%	1.86%	4.46%	-0.89%	14.83%	13.38%	9.36%	0.80%
Std.dev	20.79%	16.18%	13.40%	7.09%	33.83%	45.78%	18.56%	8.79%
P-value	0.023**		0.2379		0.933		0.0025***	

4.3 Multivariate regression analysis

Table 4.5 displays the results from the multivariate OLS regression. We ran several regressions for robustness checking. To begin, we explain the models' explanatory power. Model 2 and model 4 has the highest explanatory power, with an adjusted R-squared of 0.0558 and 0.0673, respectively. Additionally, the models is statistically significant, with an F-statistic of 3.02 and 2.76. The regression models, shown in Table 4.5, confirm that some of the variables used to explain underpricing in prior studies are also relevant in our regression model. Since we focus on market adjusted initial return, the results and discussion regression (3) in section 3.7 are given in appendix 6.2.

Model 2, 3 and 4 reports a positive constant term, which is statistical significant at the 5% level. Given the positive constant term, we find evidence that the Norwegian stock market experience underpricing.

There is a positive relationship between underpricing and IPOs listed during high IPO activity. The positive coefficient suggests that underpricing increase during high IPO activity. Model 1 and 4 in table 4.5 shows that the coefficient is statistically significant at 5% level, while model 2 and 3 show a significance at 10% level. This result is expected and is consistent with previous research on underpricing (e.g., Ibbotson & Ritter, 1995; Bergström et al., 2006). Moreover, the results strongly supports hypothesis 3, stating that IPOs experience higher underpricing during high market activity.

The negative relationship between LNassets and underpricing proves to be significant at the 10% level in model 2 and 4. This finding indicates that larger firms experience less underpricing, as anticipated. We expect that larger firms have more information available to the public, thus reducing asymmetric information and underpricing (Beatty & Ritter, 1986).

The variable LNage has a negative relationship with underpricing, indicating that older firms experience lower underpricing marginally but not statistically significant. Even though the variable is insignificant in model 3 and 4, the negative relationship with underpricing is consistent with previous research (Lowry et al., 2010). Furthermore, age is used as a proxy for uncertainty. Thus, younger firms should experience a higher degree of underpricing than older firms.

Regarding hypothesis 5[9], the results show a positive relationship between underpricing and VC-backed IPOs in all the models. However, the result is statistically significant only in model 1 and 4, and at a 10% significance level. The result is in contrast with the results of Megginson & Weiss (1991), where the authors argue that large post-offering holdings of venture capitalists can be used as a sign of credibility and hence less underpricing. However, Lee & Wahl (2004), and Gompers (1996) show that VC-backed IPOs experience greater underpricing than non-VC-backed IPOs, which is consistent with our result. An explanation may be that VC firms invest in younger firms, and therefore harder to value. A possible explanation why VC dummy becomes insignificant in model 2 and 3, is because we add variables that reduce the level of underpricing.

The number of underwriters seems to reduce the underpricing[10] on all the models, but the variable is not statistically significant. However, the coefficient is consistent with the research done by Corwin & Schultz (2005).

[9] Hypotheses 5: VC-backed IPOs has a positive relationship with underpricing
[10] Hypotheses 6: A larger number of underwriters equates to lower degree of underpricing

An interesting observation is the negative effect of tech companies on underpricing in model 4. The result is significant at a 10% level. Our result does not align with the changing risk composition hypothesis, which assumes that riskier IPOs will be more underpriced than less risky firms (Loughran & Ritter, 2004). Tech companies included in our sample have a mean age of 9, which is younger than PE-backed, VC-backed, and NS-IPOs. Therefore, the negative effect of tech firms is surprising.

Furthermore, we hypothesized that PE-backed IPOs are less underpriced than non-PE-backed IPOs. Previous literature suggests that the relationship between PE-backed IPOs and underpricing should be negative (e.g. Bergstrøm et al., 2006; Levis, 2011; Buchner et al., 2019). The dummy variable carries a negative coefficient but is not statistically significant in any of the regression models. We therefore do not find statistical evidence that PE-backed IPOs are less underpriced than non-PE-backed IPOs. However, the negative coefficient partially supports our hypothesis.

Table 4.5 Multivariate regression with first-day return as dependent variable

*The table reports the regression results of first-day returns with up to seven explanatory variables. HCdummy is a dummy variable taking the value 1 if the companies issued during a "hot" market period and 0 otherwise. PEdummy and VCdummy are dummies taking the value 1 if the IPO is either PE or VC-backed and 0 otherwise. NrofUnderwriters is the number of underwriters in each transaction. LNassets is the natural logarithm asset pre-IPO. LNage is the natural logarithm of age. Techdummy is a dummy variable equal to 1 if the firm belongs to the tech industry and is equal to 0 otherwise.** indicates a significance level of 10%, ** indicates a significance level of 5%, *** indicates a significance level of 1%. *P-values are given in the parenthesis. The variables are defined and thoroughly explained in in section 3.5 and table 3.3.*

Variables	**(1)** **LNMAR**	**(2)** **LNMAR**	**(3)** **LNMAR**	**(4)** **LNMAR**
Intercept	0.0484 (0.225)	0.1270** (0.040)	0.1397** (0.0359)	0.1499** (0.024)
HCdummy	0.0683** (0.223)	0.0538* (0.081)	0.0529* (0.087)	0.0631** (0.043)
VCdummy	0.0789* (0.073)	0.0661 (0.137)	0.0711 (0.118)	0.0789* (0.079)
PEdummy	-0.0372 (0.357)	-0.027 (0.520)	-0.0246 (0.546)	-0.0081 (0.843)
NrofUnderwriters	-0.0133 (0.308)	-0.0132 (0.306)	-0.0133 (0.305)	-0.0126 (0.327)
LNassets		-0.0112* (0.097)	-0.0105 (0.124)	-0.1158* (0.089)
LNage			-0.0084 (0.594)	-0.0092 (0.558)
Techdummy				-0.0753* (0.054)
Adjusted R - squared	0.0457	0.0558	0.0518	0.0673
Observations	172	172	172	172
F - statistics	3.05	3.02	2.56	2.76

Part V: Conclusion

5.1 Conclusion

The main objective of this thesis is to answer the question: "*Are private equity-backed IPOs less underpriced than non-private equity-backed IPOs in the Norwegian stock market?"* Examining PE-backed IPOs gives us a better understanding of the already well-researched field of IPO underpricing.

Firstly, we examine whether Norwegian IPOs are systematically underpriced. Based on previous research on IPO underpricing, we expect to find that Norwegian IPOs are underpriced in the period from 2010 to 2021. Our analysis shows that Norwegian IPOs, on average, have a first-day return of 6.33%, which is in line with the previous findings.

Secondly, we ask whether PE-backed IPOs experience less underpricing than non-PE-backed IPOs. According to previous research, PE-backed IPOs experience less underpricing. Our analysis reveals that PE-backed IPOs experience an average underpricing of 2.46%, which is less compared to VC-backed IPOs and NS-IPOs. However, the difference in underpricing between the subgroups is not statistically significant. Thus, the results only partially support that PE-backed IPOs experience less underpricing than non-PE-backed IPOs. The lack of evidence may be a result of the small sample size. Thus, increasing the sample size may give better results. An explanation of why PE-backed IPOs experience less underpricing on average may be that PE firms invest in more mature companies in terms of age. Another explanation may be that the PE firm is an important client for investment banks which facilitate the IPO, which could give the PE firm influence over the IPO pricing, thus resulting in a more favourable offer price (Mogilevsky & Murgulov, 2012).

Finally, we look at the multivariate regression analysis. We found that IPOs listed during "hot" markets experience significant underpricing, which aligns with previous studies. The VC dummy also proves to have a significant positive effect on underpricing, which is in line with the research done by Lee & Wahal (2004). Furthermore, we found that larger firms, measured by total assets pre-IPO, experience less underpricing. The finding may imply that larger firms have less ex-ante uncertainty. We also found that tech companies reduced the level of underpricing, which we found interesting, as these firms are usually younger and riskier. Our regression does not find the PE dummy statistically significant.

Hence, our analysis does not find evidence that PE-backed IPO reduces the level of underpricing.

5.2 Limitation and future research

A limitation of this thesis is the limited observation of the PE-backed and VC-backed IPOs. For now, there are few PE-backed and VC-backed IPOs to study the long-run performance. A recommendation for future research would be to analyse the long-term performance of PE-backed and VC-backed IPOs in the Norwegian stock market. Moving forward, we can try to find firms that did get PE financing, compare their operational performance against firms that did not get PE financing, and use this to explain the stock performance.

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Appendix

Appendix 6.1 CLRM assumptions

6.1.1 Multicollinearity

Table 6.1: Correlation matrix

The table presents the correlation matrix of the independent variables for detection of multicollinearity. Multicollinearity would be suspected if there are high correlation between some of the independent variables. The presence of multicollinearity can be indicated when the absolute value of the coefficient is above 0.7 between two or more variables. IR is the market adjusted initial return. PE and VC are dummies taking the value 1 if the IPO is either PE or VC-backed and 0 otherwise. H/C is a dummy variable taking the value 1 if the companies issued during a "hot" market period and 0 otherwise. LNage is the natural logarithm of age. LNassets is the natural logarithm asset pre-IPO. NrofUnderwriters is the number of underwriters in each transaction. Tech is a dummy variable equal to 1 if the firm belongs to the tech industry and is equal to 0 otherwise.

	IR	**PE**	**VC**	**H/C**	**LNage**	**LNassets**	**Nrof Underwriter**	**Tech**
IR	**1,0000**							
PE	-0,0360	**1,0000**						
VC	0,1283	-0,1664	**1,0000**					
H/C	0,1962	0,0201	0,0871	**1,0000**				
LNage	-0,0939	-0,1603	0,0735	-0,0561	**1,0000**			
LNassets	-0,1997	-0,0117	0,0965	-0,3106	0,1532	**1,0000**		
NrofUnderwriters	-0,0475	-0,2555	-0,0821	-0,0817	0,0310	0,0166	**1,000**	
Tech	-0,0673	0,0864	0,0439	0,2070	0,0124	-0,1240	0,046	**1,0000**

Table 6.2: Variance inflation factors

An overview of the Variance inflation factors (VIF) for the underpricing as dependent variable. A more formal way to measure multicollinearity is the VIF. The VIF estimate indicates how much the variance of a parameter estimate increases because the explanatory variables are correlated (Brooks, 2020). A VIF larger than 5 indicates that multicollinearity may be present.

Variable	**VIF**	**1/VIF**
HCdummy	1,14	0,8759
LNassets	1,21	0,8276
PEdummy	1,12	0,8964
NrofUnderwriters	1,02	0,9802
VCdummy	1,12	0,8922
Techdummy	1,10	0,9094
LNage	1,08	0,9276
Mean VIF	1,11	

6.1.2 Normality

Table 6.3: Shapiro-Wilk test for Normality

Shapiro-Wilk test is a test to determine if the sample is normally distributed. The null hypothesis is that normality exists, and the alternative hypothesis is that the residuals is non-normal.

Variable	Obs	W	V	z	P-value
Residual	172	0,83809	21,194	6,972	0

Figure: 6.1: Normal Quantile Plot (QQ)

A quantile-quantile plot (Q-Q plot) is used to determine if the data follow a normal distribution. The points in the Q-Q plot should be on the straight line if the data is normally distributed.

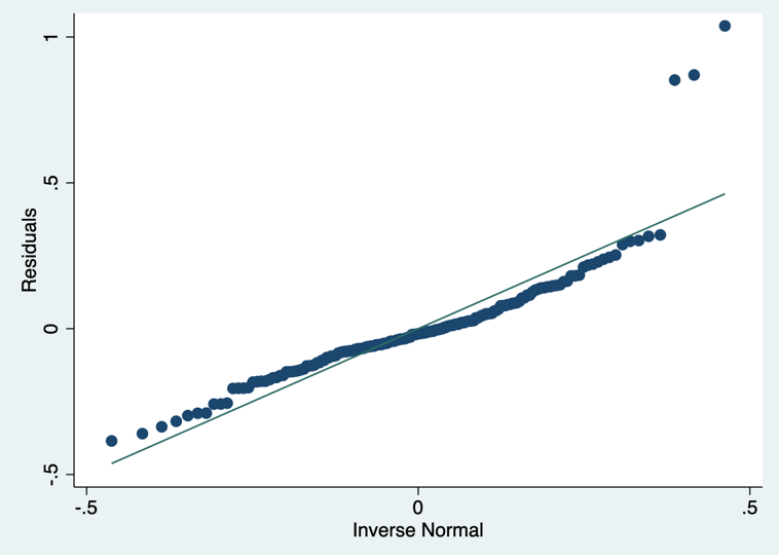


Figure 6.2: Normal Probability Plot (PP)

The probability-probability plot (P-P plot) is used to compare the data distribution with some theoretical distribution. For instance, if the Gaussian distribution fits the data well, it will plot nearly as the x=y line.

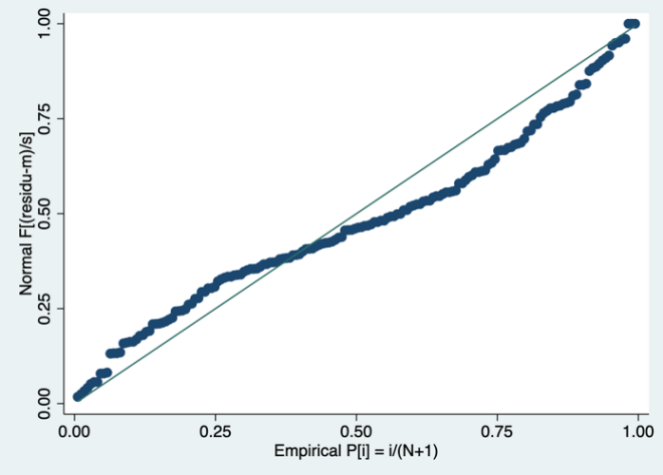
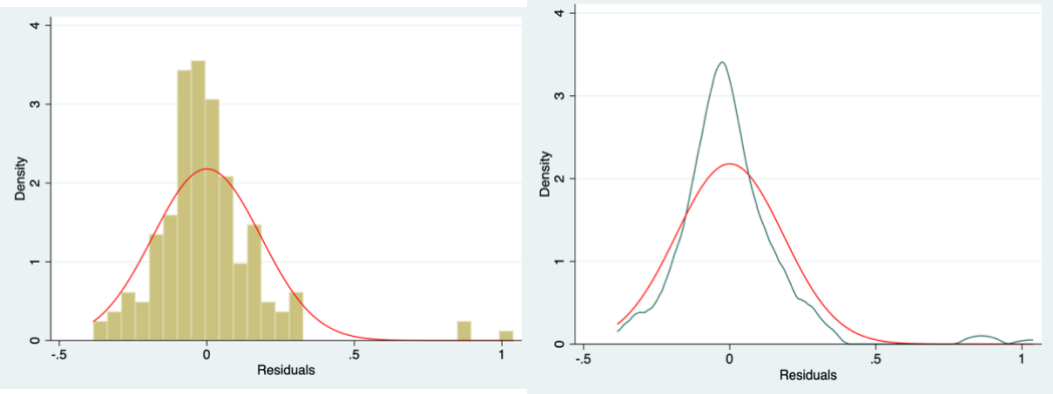


Figure 6.3: Normal density plot and Kernel density plot

The normal density plot and Kernel density plot against the residuals. By the Central Limit Theorem, the distribution of the predicted residuals approximate a normal distribution.

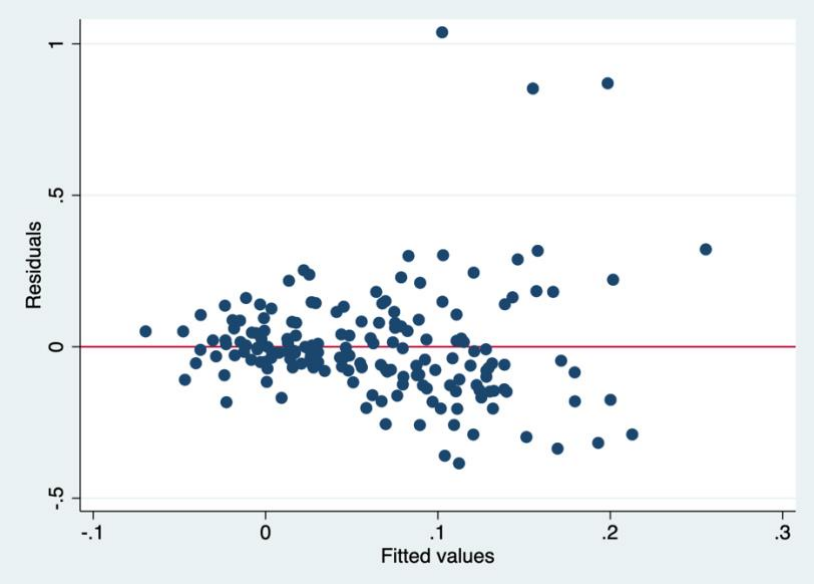


6.1.3 Heteroscedasticity

Table 6.4: Test for heteroscedasticity (White's test)

White's test is used to test for heteroscedasticity. The null hypothesis states that there are equal variance of the errors (homoscedastic), whereas the alternative hypothesis is that the variance of the errors are not equal (heteroscedastic).

Source	Chi2	df	p
Heteroskedasticity	39,19	30	0,1216
Skewness	16,350	7	0,0221
Kurtosis	2,87	1	0,0902
Total	58,41	38	0,0182



Appendix 6.2

We discuss the difference of having the market adjusted initial return and the unadjusted initial return as the dependent variable. We can observe from table 6.5 that there is marginally difference of the coefficients between model 1 and 2, and model 1 has a slightly higher adjusted R-squared. Furthermore, the relationship between the variables and the dependent variable is equal. Though, the tech dummy becomes insignificant when we use the unadjusted initial return as the dependent variable.

Table 6.5: Multivariate regression with first-day return as dependent variable

The table reports the regression results of first-day returns with seven explanatory variables. HCdummy is a dummy variable taking the value 1 if the companies issued during a "hot" market period and 0 otherwise. PEdummy and VCdummy are dummies taking the value 1 if the IPO is either PE or VC-backed and 0 otherwise. NrofUnderwriters is the number of underwriters in each transaction. LNassets is the natural logarithm asset pre-IPO. LNage is the natural logarithm of age. Techdummy is a dummy variable equal to 1 if the firm belongs to the tech industry and is equal to 0 otherwise. * indicates a significance level of 10%, ** indicates a significance level of 5%, *** indicates a significance level of 1%. *The variables are defined and thoroughly explained in in section 3.5 and table 3.3.*

Variables	**LNMAR**	**LNIR**
Intercept	0,1499**	0,1505**
	0,024	0,024
HCdummy	0,0631*	0,0643*
	0,043	0,039
VCdummy	0,0789*	0,0757*
	0,079	0,096
PEdummy	-0,0082	-0,0123
	0,843	0,766
NrofUnderwriters	-0,0126	-0,0124
	0,327	0,766
LNassets	-0,1158*	-0,1119*
	0,089	0,079
LNage	0,0092	0,0090
	0,558	0,566
Techdummy	-0.0753*	-0.063
	0.054	0.102
Adjusted R-squared	0,067	0,065
Observations	172	172
F-statistic	2,76	2,71