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Underpricing and Long-Term Performance of Private Equity-Backed IPOs in the U.S.

An empirical study of the underpricing and long-term performance of private equity- and venture capital-backed IPOs in the U.S. stock market from 2000-2022

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NORWEGIAN SCHOOL OF ECONOMICS

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Abstract

This thesis aims to investigate the underpricing and long-term performance of private equity-backed initial public offerings (IPOs) relative to non-sponsored IPOs. We use a sample of 2.509 IPOs on the New York Stock Exchange and Nasdaq over a time period from January 2000 to December 2022.

In our study, we examine the underpricing across time periods, sizes, industries, and exchanges for the different sponsor types. Furthermore, we look at factors that may explain underpricing using a cross-sectional regression model. The empirical analysis finds no support for the claim that private equity (PE)- and venture capital (VC)-backed IPOs exhibit less underpricing than their non-sponsored counterparts, on average. Our analysis only revealed one statistically significant finding: larger market capitalizations appear to be associated with increased underpricing. We hypothesize that the tendency for more aggressive underpricing in larger IPOs may be a strategy utilized to offset the higher costs associated with information acquisitions, which are inherently greater in larger offerings.

Furthermore, we investigate the long-term performance using cumulative abnormal returns (CAR), buy-and-hold returns (BHR), and a cross-sectional regression model. Benchmarked against the Nasdaq and NYSE composites, we find some statistical evidence supporting our hypothesis that private equity-backed IPOs outperform non-sponsored IPOs. The regressions indicate that PE-backed IPOs demonstrate abnormal positive returns on a six-month basis, VC-backed IPOs at the three- and five-year marks, while non-sponsored ones exhibit significant underperformance on a three- and five-year basis. Moreover, we find that a listing in a hot market has a statistically negative effect on long-term performance, across all time horizons and with all types of sponsorships. Our findings indicate a higher proportion of PE-backed IPOs during hot market periods, and that the proportion of hot market IPOs increases with market capitalization. These larger PE-backed IPOs typically perform worse in the long term, suggesting that PE-firms may be exploiting hot markets, particularly during full exits. This aligns with the windows-of-opportunity theory.

Keywords – NHH, Master thesis, IPO, Private Equity, Buyouts, Venture Capital, Underpricing, Long-term performance

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1 Introduction

In this thesis, we examine the underpricing and long-term performance of private equity-backed IPOs relative to their non-sponsored counterparts.

Private equity, a cornerstone in the landscape of global finance, represents an influential and distinctive asset class that has significantly evolved over decades, and stand behind many prominent transactions and companies. Since 2010, the assets under management in global private equity have witnessed an annual growth rate exceeding 12%, reaching nearly USD 7.5tn in 2022 (Norges Bank Investment Management, 2023).

When the private equity firm are ready to exit their portfolio company, only a few firms qualify to pursue the route of an initial public offering (IPO). Our understanding is that they typically favor listing high-quality companies, showcasing their meticulous approach and preference for firms with strong growth prospects. This underscores their role in certifying the sustainability and potential success of these businesses, and a successful listing are viewed to further enhance the reputation of the private equity firm. However, these listings are also subject to well-researched IPO phenomena that researchers find puzzling, especially the use of underpricing and the long-term underperformance among IPOs.

The use of underpricing IPOs is generally well-established. Many papers have questioned and theorized the incentives for underpricing, examining the varying degrees among different companies, industries, market sentiments, and whether different sponsor types and ownership structures make a difference. Earlier papers attribute their findings to theories of asymmetric information and conflicts of interests theories, as well as to the operational and strategic objectives that differentiate private equity-firms from their counterparts. Research on tendencies among of sponsor-backed IPOs remain inconclusive: Megginson and Weiss (1991) demonstrated that venture capital-backed IPOs exhibit relatively lower underpricing, while P. A. Gompers (1996) exhibit the opposite. Additionally, studies by, Hogan et al. (2001), Bergström et al. (2006), Levis (2011) collectively remain inconclusive when researching private equity-backed IPOs.

It is in question whether private equity fund managers actually manage to add value beyond their capital infusion with their active ownership. One way to investigate private

equity firms' ability to foster quality companies is through analyzing their long-term performance post-IPO. Papers on long-term IPO performance, like Ritter (1991), Aggarwal and Rivoli (1990), Ritter (2023b) and Loughran and Ritter (1995), evidence long-term *under*performance of IPOs, whilst flotations of private equity-backed listings seem to defy the norm (Ritter, 2023b). Most papers on venture capital-backed IPOs are inconclusive, but those on traditional private equity (buyouts) like Mian and Rosenfeld (1993), J. Cao and Lerner (2009), Ritter (2023b), and Bergström et al. (2006) suggest positive abnormal long-term performance compared to both venture capital-backed and non-sponsored IPOs.

This thesis, therefore, aim to contribute to the existing literature by providing an in-depth analysis of the impact of private equity-backing on underpricing and long-term performance, utilizing more recent data in the U.S. market over a longer time horizon. The private equity industry includes several investment strategies, and we investigate venture capital and traditional private equity (buyout) on separate terms to see if the different sponsor types exhibit any differences.

Following this, our research questions are the following:

1) Does private equity- and and venture capital-backed IPOs exhibit less underpricing compared to their non-sponsored counterparts?

2) Do private equity- and and venture capital-backed IPOs exhibit long-term overperformance relative to non-sponsored IPOs?

To answer these questions, we conduct a two-part analysis where we first examine underpricing and then long-term performance. In the analysis of long-term performance, we use cumulative abnormal returns (CAR) and buy-and-hold returns (BHR). We also use cross-sectional regressions on both underpricing and long-term performance. Our main source is Bergström et al. (2006), in addition to Levis (2011), Loughran and Ritter (2004), Loughran and Ritter (1995) and Ritter (1991).

For the thesis' objective and for all practical purposes, we will refer to the private equity industry as a whole, using "private equity", and dividing traditional private equity (PE) and venture capital (VC) according their different strategies and objectives discussed in Section 2.1.2.2. We will refer them as PE/buyout and VC/venture capital in our comparisons for consistency with previous research. Moreover, the abbreviation NS will

represent the non-sponsored IPOs.

The thesis is further structured in the following way: Chapter 2 provides background information on private equity and IPOs, as well as a review of previous literature on this topic. In Chapter 3, we will introduce our research questions and our hypotheses. In Chapter 4, we explain how we collect our data and the choices made during the data collection process. In Chapter 5, the methodology used in our analysis is described, along with a discussion on potential data quality issues. The results and discussion of the two-part analysis are presented in Chapter 6. Finally, we present our summary in Chapter 7.

2 Background

In this chapter, we discuss the background theories on private equity, underpricing and long-term performance in initial public offerings to provide background for our results.

2.1 Private Equity

In the upcoming section, we will discuss the private equity industry in depth, with additional statistics on the U.S. market. Our main objective with this chapter is to present a background which may help in explaining potential differences in both underpricing and long-term performance.

2.1.1 Introduction to Private Equity

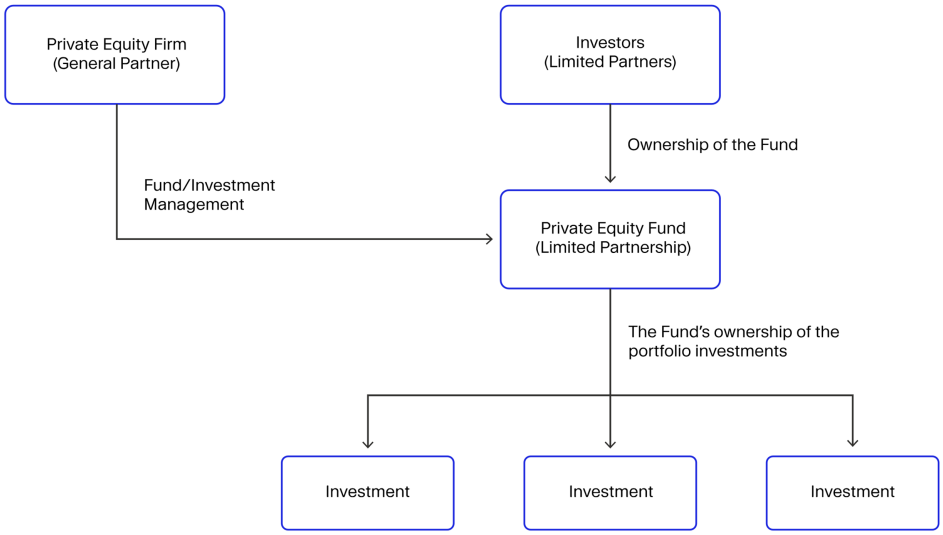
Private equity investments are characterized by capital infusions into privately held companies with the goal of enhancing value, fostering growth, and realizing returns. The appeal to invest in private equity lies in the industry's ability to generate risk-adjusted returns by facilitating transformative changes in established businesses or by nurturing companies through their formative stages (Lerner et al., 2012). The field is dynamic as it includes a wide spectrum of activities through its business cycle and investments phases, and its investments is in essence akin to a partnership between the businesses and aspirations of investors (Kaplan & Strömberg, 2009).

2.1.1.1 Fund structure and organization

To understand the private equity industry, it is necessary to understand the distinction between a *firm* and a *fund* and its whole business cycle. A private equity firm is typically organized as a limited liability, a company or a partnership (Kaplan & Strömberg, 2009). Their investments have unique characteristics that allow them to be considered a separate asset class (Espinosa, 2023). Their investments are structured through funds of pooled investments from several investors. These funds gain sufficient size which allows them to invest in a portfolio of companies to reduce risk by diversification and increase liquidity for their investors.

Private equity fund structure The fund structure is demonstrated in Figure 2.1 and involves three main entities; the *Limited Partners* (LP, the investors), the *General Partners* (GP, the private equity firm) and the *target companies* (the investments) (Espinosa, 2023). The investors include corporate and public pension funds, institutional investors, endowments, insurance companies and wealthy individuals (Kaplan & Strömberg, 2009).

Figure 2.1: Private Equity fund structure



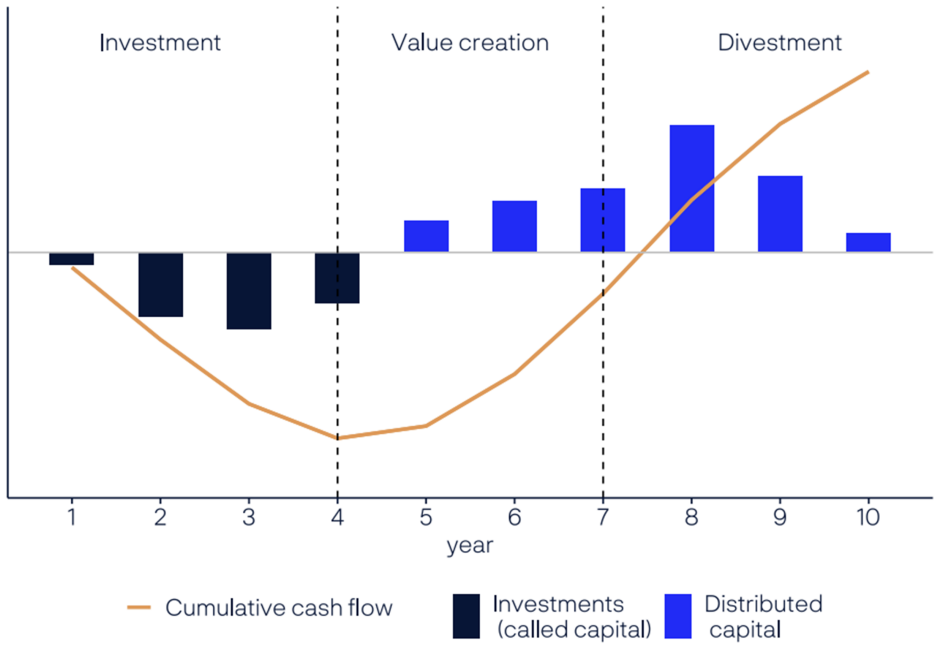
Note: *Source: Espinosa (2023)*

The fund manager, GP, has three different forms of compensation (Kaplan & Strömberg, 2009): 1) An annual management fee, usually a percentage of the committed capital, then a percentage of the capital employed when the investment is realized. 2) The GP earns a share of the profit called "carried interest", usually ~20%. 3) Some GPs charge monitoring and deal fees from the portfolio companies.

Private equity investment cycle Private equity firms sell funds with a predetermined investment strategy and duration to investors (P. Gompers & Lerner, 2001). The fundraising to the fund is often based on "word-of-mouth", meaning private equity firms' reputation is highly important. The investments entails passively and patient capital commitment as the funds are "closed-end" with an investment horizon often between four to twelve years (Corporate Finance Institute, n.d.; Kaplan & Strömberg, 2009). The private equity firm and fund manager are committed to active involvement throughout the investment period and has vested interest in the success of the supported companies. They initiate and select investments according to the funds' investment strategy and

their appointed covenants, and actively manage these investments, add value, exit the investment and return capital to the investors (as illustrated in Figure 2.2).

Figure 2.2: Illustrative life cycle of a private equity fund



Note: *Source: Norges Bank Investment Management (2023)*

2.1.2 The private equity investment phases

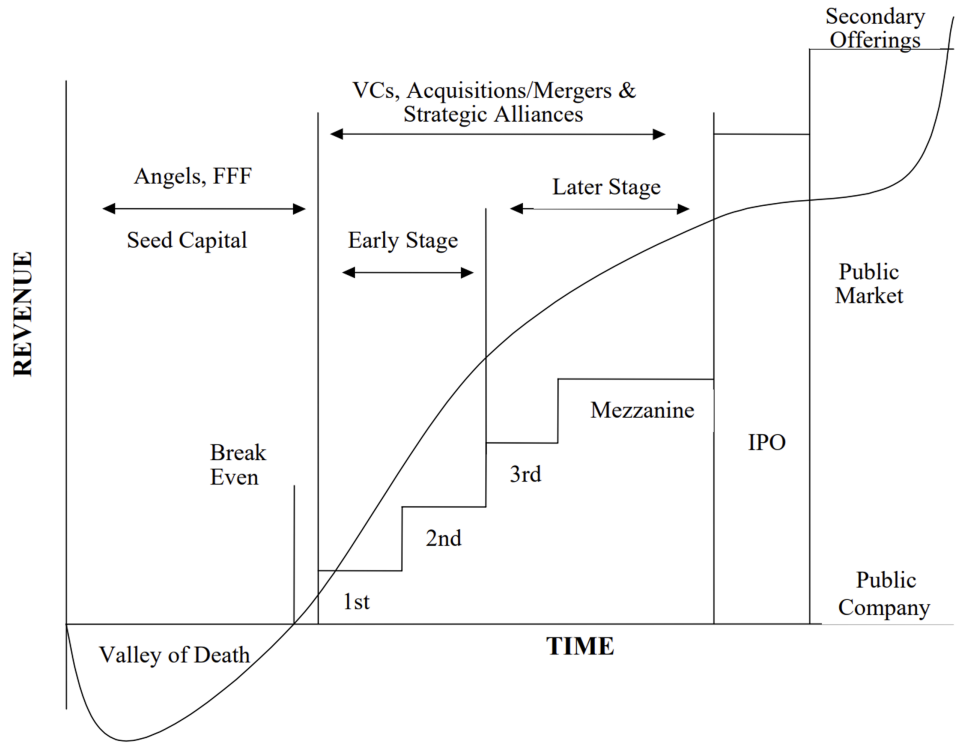
We characterize private equity into distinct funding phases, each with a set of unique considerations and activities, from initial funding to growth funding, and later the discussions of possible exit strategies, as illustrated in Figure 2.3.

Literature divides funding in privately held companies into *informal* capital funding, referred to *FFF* (friends, family, and fools), *seed* and *angel funding*, and *formal* capital funding, namely private equity (Mason, 2006). One key contrast is that informal capitalists usually invests its own funds which consequently affects the size of funding (Huang & Pearce, 2015).

2.1.2.1 Informal capital funding (Early-stage funding)

Research on informal funding is limited, and it was as early as in Prowse (1998) commented that "the angel market operates in almost total obscurity". Prior to the 1980s, business angels were almost unknown, and researchers spent the next decade researching the market

Figure 2.3: A typical funding cycle



Note: *A typical funding cycle from a startup company to a mature company that eventually goes public, as presented in 2.1.2 Other divestment alternatives also exist. Source: Cardullo (1999)*

(Mason, 2006). The literature and number of active researchers is still small compared to active research on formal capital funding.

The FFF's are usually enthusiastic individuals who holds faith in entrepreneurs' business idea, and invest small amounts based on personal relationships and trust. Family and friend funding (often referred to "love money") does not constitute a market as their funds are not accessible to others than family and friends (Mason, 2006). For them unfortunate not to have families and friends with excess capital, "business angels" are accessible individuals with available capital for startups.

As the business idea takes shape, entrepreneurs seek larger capital injections arranged by seed and angel investors. The investors are typically high-net-worth individuals who play a crucial role in the nurturing of young businesses and validation of their business concepts (Huang & Pearce, 2015).

These early funding stages are characterized by limited resources and high degree of risk, but is lays a critical foundation for business launching. Startups usually use these fundings to conduct market research, secure intellectual property (IP) rights or develop prototypes

and minimum viable products (MVPs). Furthermore, they refine their business models and begin growing a customer base.

2.1.2.2 Formal capital funding (private equity funding)

Figure 2.4) present an overview of the different investments strategies within private equity.

Figure 2.4: Private equity strategies

Type of Private Equity		Size of typical investment	Type of private equity firm	Description	E.g. industry focus	Portfolio company stage
Venture Capital VC	Venture Capital	$50.000 to $5 million	VC	Typically investments in cash negative companies where market potential often isnt proven.	Life sciences, technology, software	*Early*
	Growth Capital	$5 million to $50 million	Small – Mid Tier	Typically investments in equity and/or debt instruments as these companies are growing and require increasing amounts of WC, Capex or m&a	Most types	
	Mezzanine Financing	$5 million to $50 million	Small – Mid Tier	Typically investments in subordinated debt/preferred equity as the company falls between equity and senior debt on its balance sheet	Manufacturing, consumer products, real estate	
Private Equity PE	Leverage Buyouts	$2 million to $200+ million	Buyout (all sizes)	Acquisititon of an operating company with an significant amount of borrowed funds to create value by realizing opportunities and improving efficiencies, etc. (use debt as financial leverage)	Consumer products, food manufactoring	
	Distressed Buyouts	$2 million to $200+ million	Buyout (all sizes)	Typically investments in equity/debt securities of financially stressed companies. Usually turnaround cases that need corporate restructuring	Paper & pulp manufactoring	*Late*

Note: *A describing table of private equity strategies. Source: Input collected from Street of Walls (2013)*

Venture capital (VC) funding The VC funding-phase marks a significant phase in a business' private equity journey. Venture capitalists invest in high-growth companies and startups, which are typically young, small, with minimal revenue and a high degree of uncertainty (P. Gompers & Lerner, 2001; Street of Walls, 2013). They focus on equity or equity-linked investments, and typically only hold a minority stake in their portfolio company (Kaplan & Strömberg, 2009). The funds are operated by professional, established venture capital firms, and have grown mechanics to overcome problems that emerge in each stage of the investment process (P. Gompers & Lerner, 2001). Besides capital, investors also contribute with valuable expertise and resources, like networks, to help the companies scale rapidly.

Key characteristics in young firms, particularly technology firms, and firms with intangible assets, are uncertainty and high information asymmetry (P. Gompers & Lerner, 2001). For venture capitalist to manage their firms effectively, staged capital infusion may be the most

potent control strategy (Sahlman, 1990). This reduces potential losses from non-optimal decisions as it keeps the owner/manager on a "tight leash". The funding series/stages are usually bonded to concrete accomplishments of specific business milestones and strategic use of funds, (e.g., first stage funding is often used for market expansion). A study by P. Gompers (1995) used a sample of 794 venture capital-funded companies to examine the consequences of companies failing to meet their business milestones (i.e., negative information about future returns). He found that companies/projects were often excluded from prospective funding, and that early-stage firms received significantly less funding per round, than more mature firms. In fact, when tangible assets increased, the duration of financing increased with reduced intensity of monitoring.

After successfully navigating through the early funding stages and achieving a desired degree of market validation, several companies seek additional equity for growth—referred to as *growth equity*. Typically, growth equity investments are directed toward expanding existing operations, entering new markets, or even acquiring complementary businesses, which may result in a partial change of ownership. However, this is more applicable to businesses with a proven track record of revenue and profitability, making them less risky (Street of Walls, 2013).

Mezzanine financing is investments in subordinated debt form with additional equity often in the form of options on its common stock (Metrick & Yasuda, 2011). Within the private equity industry, the term, mezzanine, has two developed distinct meanings. The first is a (very) late-stage venture capital form (often called growth capital investing) as some venture capital funds along with other alternative investments (i.e., banks, hedge funds, insurance companies, later stage private equity firms) perform this strategy. The second meaning adds a complex layer of additional debt (subordinated debt) with equity options to highly leveraged buyouts (more categorized as traditional private equity).

What draws the supply of venture capital? With supply, we refer to the desire investors has to invest in venture capital funds. P. Gompers et al. (1998) examined the determinants of venture capital fundraising and concluded that (1) higher GDP growth and (2) increased R&D spending led to increased venture capital activity. Furthermore, lower tax rates on capital gains also increased supply of venture capital.

Private equity (PE) / buyouts As PE-funds grow, along with increased use of syndication, the PE-firms invest with different investments strategies and almost always take majority control in their portfolio companies (P. Gompers & Lerner, 2001; Metrick & Yasuda, 2011; Street of Walls, 2013). In buyouts, the private equity firm acquire established businesses or divisions of larger companies with the intent of improving operations and maximize value. The buyout stage is categorized by due diligence, financial restructuring, and implementation of strategic initiatives with the goal to drive profitability and growth.

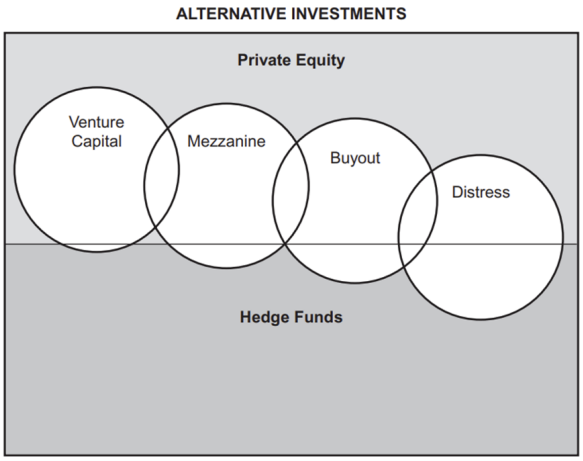
We categorize buyouts into three subcategories: (1) *Leverage buyouts* (LBO) is a significant component of private equity investments. The private equity firm finance the acquisition by issuing debt typically constituting 60-80% of the acquisition price, often including high-yield debt and mezzanine financing, using the target company's assets as collateral (Kaplan & Strömberg, 2009; Metrick & Yasuda, 2011). The goal is to increase financial gearing to maximize profit by improving efficiency and reducing costs (Koller et al., 2020). (2) *Management buyouts* (MBOs) is when the sitting management acquires the company with support from a private equity firm, whilst (3) *corporate divestitures* is when private equity firms acquire divisions/units from larger corporations with the rationale to optimize the performance of the standalone entity (Lee, 1992).

Buyout firms also invest in *middle-market* companies where private equity firms create liquidity for current owners and perform a *buy-and-build* strategy to buy growth with M&As (Metrick & Yasuda, 2011). They also invest in distressed companies which is companies in need for capital for restructuring.

The overlapping investment strategies of private equity and hedge funds

Metrick and Yasuda (2011), illustrated in Figure 2.5, describe the overlapping investments strategies and draws intersections with another alternative investment category, hedge funds (HF). Both HF and PE are flexible investment vehicles and share common interests in distressed companies, but use different investment strategies. PE-firms usually engage in distressed companies to gain control in order to operate and restructure the company, while HF-firms focus on generating profits through trading the publicly listed securities of companies.

Figure 2.5: Overlapping investment strategies in alternative investments



Note: *Source: Metrick and Yasuda (2011)*

2.1.2.3 U.S. Private Equity market and strategy

An overview of the U.S. private equity transactions by size bucket and strategy are in the appendix (Figure A.1). By size buckets, deals under USD 25m are most frequent, while deals over USD 1bn are the least frequent. In deal values, transactions within the USD 100m to USD 500m range generally holds the largest transaction share. From 2008 to Q3'2023 TTM, growth/expansion capital transactions has held a stable share of the total market by count, whilst add-ons has increasingly surpassed the buyout market. This patterns is also seen in transaction values.

2.1.3 The modern history of private equity

The history of private equity is a testament to the industry's resilience and adaptability. A niche investment approach from the late 1900s century is today noticed as a driver for economic growth and the global financial landscape. The fascinating journey spans over a century and is marked by transformation, innovation, and continuous evolution of both operational and investment strategies. To grasp the essence of this dynamic asset class, it is essential to acknowledge the historical evolution, key milestones, and the influential figures who have shaped the industry.

2.1.3.1 The 1900s

19th - early 20th century – Seeds are sown In its seed form, private equity can be traced as far back as to the late 19th century. J.P. Morgan's acquisition of Carnegie Steel Company in 1901, stands as one of the earliest documented private equity investments. They merged the target with U.S. Steel and other small steel companies, creating a global steel giant (Chernow, 2001). The completion of J.P. Morgan's transaction laid the foundation for what would later be known as LBOs.

1940s - 1960s – The birth of venture capital In 1946, a Harvard Business School professor, Georges Dorit, founded the first venture capital firm, The American Research and Development Corporation (ARDC) (Doriot, 1954). He played a crucial role in supporting the growth of technology startups, including the first major investment success in venture capital, Digital Equipment Corporation (DEC).

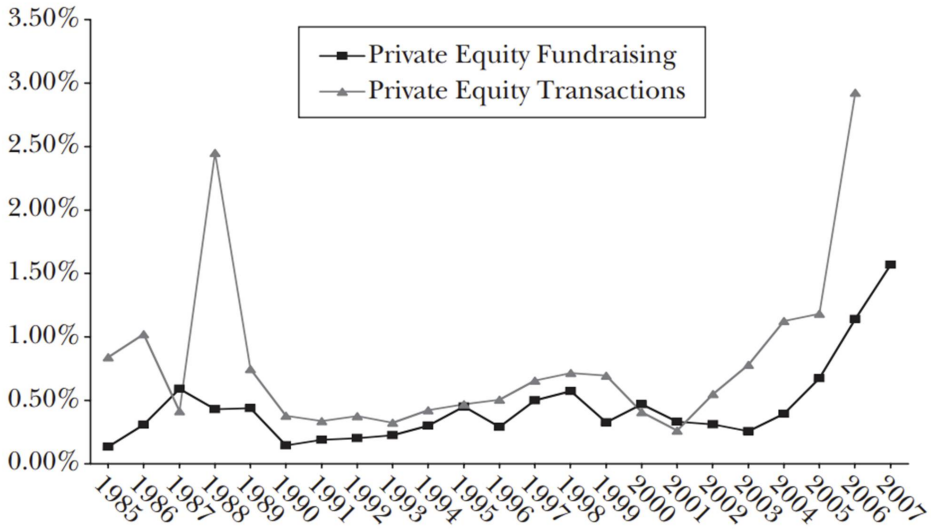
1970s - 1980s – LBO boom In a decade characterized by low interest rates, credit boom and reduced cross-border capital control, the 1970s and 1980s faced rapid expansions of LBOs (Burrough & Helyar, 1990; Versluysen, 1988). Investors like Jerome Kohlberg, Henry Kravis and George Robert at Bear Sterns initiated LBO transactions and propelled this growth. They co-founded one of the biggest private equity firms of today, Kohlberg Kravis Robert & Co. (KKR), as early as in 1976. KKR's USD 31bn LBO of RJR Nabisco in 1988, as written about in the book "Barbarians at the Gate", was the largest LBO in history at that time and became symbolic as it exemplified the scale and complexity of the era's LBOs. The 1980s LBO boom is characterized by huge, debt-funded takeovers, highly leveraged capital structures, usually with junk bond financing, and performance-based managerial compensation, transforming successfull companies (Kaplan & Strömberg, 2009).

1980s - 1990s – Private Equity funds The emergence of dedicated private equity funds began in the late 1980s and early 1990s. The fund-structure allowed investors to pool resources and gain access to large private equity investments. As seen in Figure 2.6, both transaction volume and fundraising increased in this period. Blackstone Group is a pioneer of the private equity fund-model and was co-founded by Stephen Schwarzman

and Peter G. Peterson in 1985. This shifted the industry to have a more institutionalized investment approach, rather than only focusing on single deals and LBOs.

LBO activity surged from USD 1.4 billion in 1979 to USD 77 billion in 1988, driven by a substantial number of public-to-private LBO transactions fueled by debt. These transactions were reported to pay approximately a 22% premium on their buyouts (Bharath & Dittmar, 2010). The junk bond market crashed only a few years later and many high-profiled LBOs ended in default and bankruptcy (Kaplan & Strömberg, 2009). Leveraged public takeovers (PTOs) then almost disappeared by the early 90s.

Figure 2.6: U.S. 1985-2007: Private equity fundraising and transaction values as percentage of total stock market value



Note: *As the figure shows, Private Equity activities increased during booming periods. Source: Kaplan and Strömberg (2009)*

1990s - early 2000s – Tech boom, credit crunch and private equity expansion

Venture capital played a substantial role in funding technology startups, which inherently carries risks and rewards. Starting with the successful VC-backed Netscape IPO, with a first day return of 107% and following positive long-term return, many young VC-backed tech companies saw it as a marketing event going public (Quinn & Turner, 2020). Of all the IPOs listed in 1990-2000 (dot-com bubble), 60% of was backed by VC compared to 38% in the period 1990-98. Although, showcased when we unfortunately saw the dot-com bubble burst throughout the sector, many companies failed, but unicorns like Google and Amazon survived and became two gigantic successes (Metrick & Yasuda, 2011). Furthermore, firms like Benchmark Capital, Sequoia Capital, and Accel Partners

became influential private equity players in the technology sector, and still is.

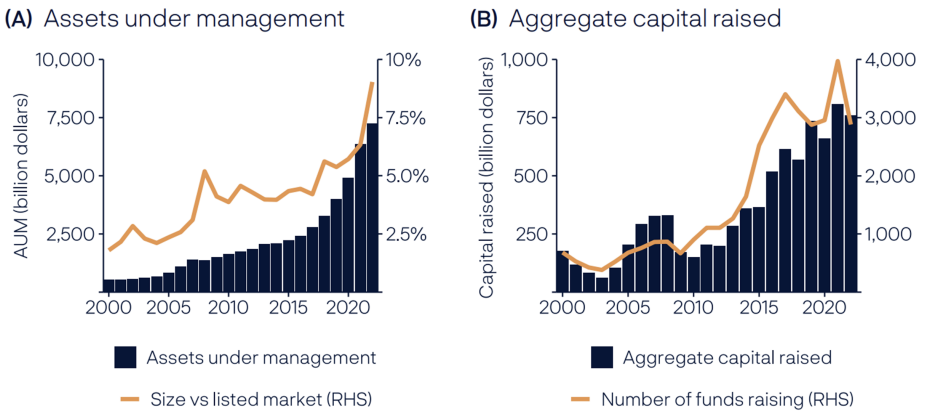
2.1.3.2 The 2000s

2000s - 2010s – Globalization, diversification, challenges, adaptation, and ascendance The 21st century has so far seen private equity gone through a global expansion and increased diversification across sectors, beyond what the traditional venture capital and buyouts previously was. Larger fundraising allowed for more extensive investments and diversification over geographies, sectors, and investment strategies to capture more opportunities both in niche sectors and emerging markets. The industry was forced to adapt after the dot-com bubble and find new growth avenues. However, the LBOs were only hiding from the burst of last century, and regardless of the *Sarbanes-Oxley Act of 2002*, aimed at improving corporate governance, the world experienced a second LBO boom in the mid-2000s (Kaplan & Strömberg, 2009). Private equity funds grew even larger attracting institutional investors like pension funds and endowments. However, the debt market, followed by the stock market, crashed in 2008, and private equity investments declined again.

2010s - today Since 2010, global asset under management (AUM) in private equity has increased over 12% annually (Norges Bank Investment Management, 2023). Private equity firms have also increased their value share of listed securities from 4% in 2010, to 9% in 2022 (Figure 2.7, (A)). In 1991, investors had only committed USD 10bn to private equity partnerships, reaching USD 180bn in 2000 (Figure 2.7, (B)) (Kaplan & Schoar, 2005). Simultaneous that the larger number of deals met larger deal sizes as the median deal value for buyouts has doubled since 1995, reaching USD 100m in 2021 (Norges Bank Investment Management, 2023). Figure 2.8 present the AUM split by strategy and region by end of 2022. A noted, the North American market holds the largest share of AUM invested in buyouts.

Why is there an increased demand for private equity investments? It is suggested that the high growth in private equity investments are due to structural market changes that has increased the availability to raise private capital (Stulz, 2020). Falato et al. (2022) have shown the significance of the valuation of intangible capital in companies that mostly holds intangibles. The public markets only value intangible assets when

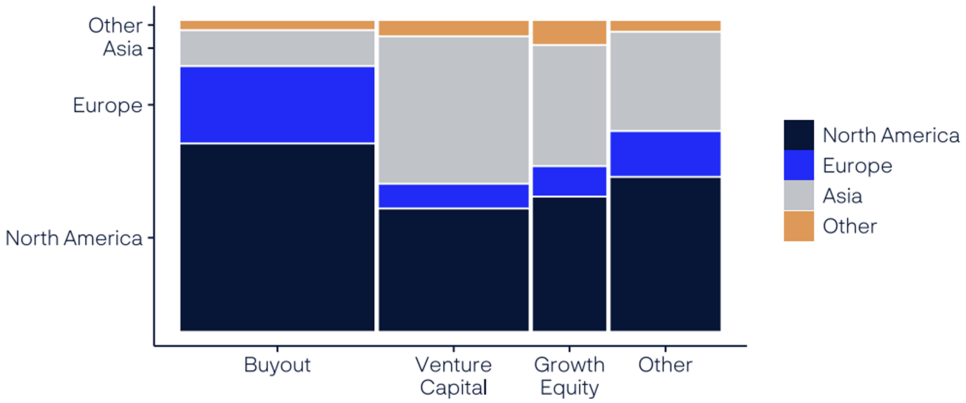
Figure 2.7: Growth of global AUM and aggregated capital raised



NOTE: Panel a) shows assets under management for all buyout, venture capital, and growth equity funds in the Preqin database. The listed market is proxied by the MSCI ACWI IMI index. Panel b) shows the aggregate capital raised each year by all buyout, venture capital, and growth equity funds in the Preqin database. Sample period is January 2000 to December 2022. Source: Preqin Inc., MSCI, NBIM calculations.

Note: *Source: Norges Bank Investment Management (2023)*

Figure 2.8: AUM split by investment strategy and region



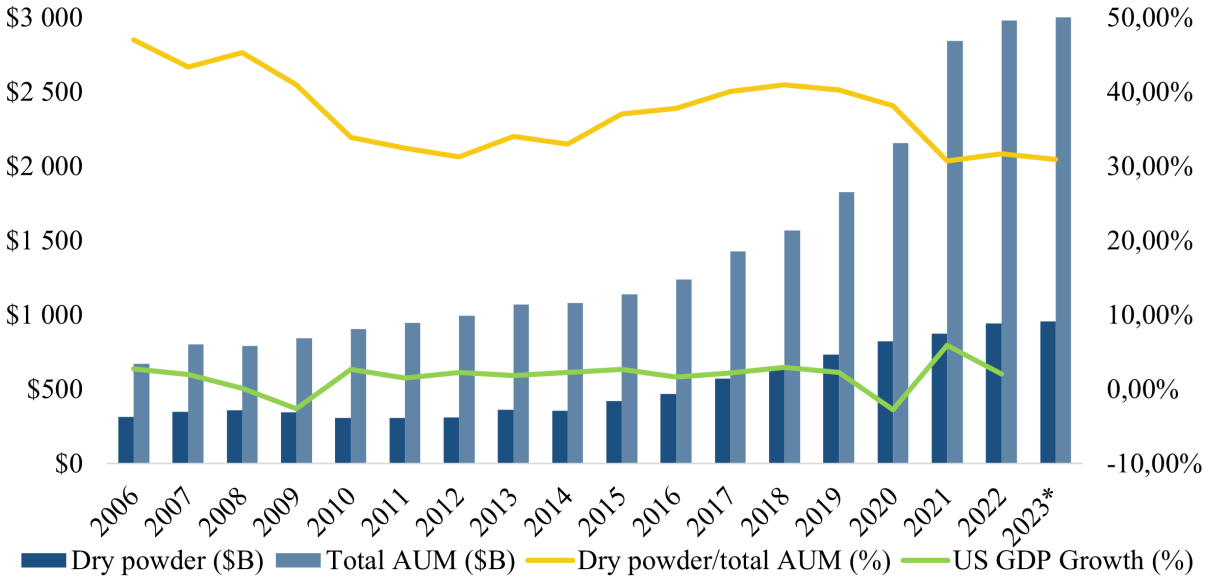
NOTE: Figure shows the share of total assets under management by region and fund type, as reported by Preqin. "Other" includes co-investment, secondary, fund of funds, balanced, and turnaround funds. Estimation date is December 2022. Source: Preqin Inc.

Note: *Source: Norges Bank Investment Management (2023)*

the company are thought to observably use the asset productively or if the company has a track record of successful investments. This, whilst also not revealing too much information to competitors when listed, increases the value of staying private (Norges Bank Investment Management, 2023). The high AUM in private equity could also be explained by the investor's perception of alternative investments performance since the 2000s. As Preqin (2022) global investor survey showed: investors cite higher absolute and relative returns as a key demand driver behind investing in private equity. Figure 2.9

shows the historical development of dry powder[1] versus total AUM in the U.S. Private Equity market.

Figure 2.9: Dry powder vs total AUM historical split in the U.S. Private Equity market

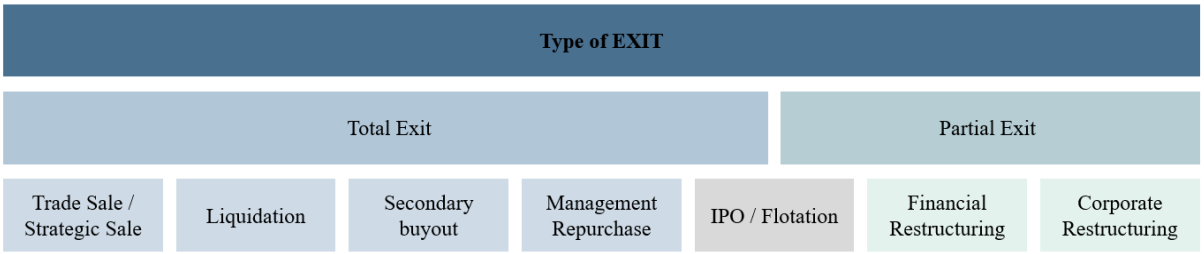


Note: *Source: Data from PitchBook (2023) and The World Bank (2023)*

2.1.4 Exit Strategies in Private Equity

The alternative exit strategies serve unique options and objectives based on the investment's specific circumstances, and the fund's success is highly determined by the exit's success. The choice of exit strategy depend on several factors subject to due diligence to assess true business valuation, and to ensure that the deal aligns with both the seller and buyer's objectives. IPOs will be discussed in depth in Section 2.2.

Figure 2.10: Main Exit Strategies



[1]Cash reserves on hand for the private equity firm (i.e. uninvested funds) (Hayes, 2020)

2.1.4.1 Total Exit

A *strategic/trade sale* is when the portfolio company is sold to another company in the same industry. The acquirers objective is often to grow inorganic, leverage synergies, or/and eliminate a competitor. In a *management repurchase*, the management team buys (back) the ownership from the private equity firm and the management team gain more control over the company they know so well. This exit may also be partial as an MBO. A *secondary buyout* (also sponsor acquisition) is when a private equity firm sells its portfolio company to another private equity firm who often believe in increased/better value creation usually through synergy realization, operational improvements, and/or financial restructuring. E.g., a VC-fund divesting its portfolio company to a larger buyout fund.

In a *liquidation*, a company's assets are sold, creditors are compensated, and any remaining proceeds, if available, are distributed to investors (Jensen, 1986). Funds resort to liquidation when a portfolio company encounters insurmountable challenges or fails to meet expectations. The process entails ceasing operations, which is often both costly and complex. Some business entities may be divested to optimize returns. This option is typically pursued when no viable alternatives remain, and it is acknowledged as the least favorable exit strategy for investors, as they usually incur significant losses.

2.1.4.2 Partial Exit

Financial restructuring, or recapitalisation, is when the portfolio company's financial structure is restructured. It is rational to provide partial liquidity by returning a portion of the investment to the investors with dividends (often on borrowed funds) while maintaining a ownership stake in the company (Damodaran, 2012). The additional debt tolerance is a critical consideration in refinancing and the firm need consent from existing creditors and other investors. Corporate restructuring can also act as a partial exit for the investors by for example selling entities.

IPO is the process of taking a private company public by listing the company's shares on a stock exchange. This provides liquidity to existing investors (e.g., a private equity firm) by selling existing/new shares to the public (Pagano et al., 1998). Private equity firms often only partial exit in the listing and later use flotation to fully exit the company

(may also fully exit at listing). As reputation is highly important for the private equity company (P. Gompers & Lerner, 2001), the IPO exit strategy is often only an option for bigger or/and mature companies, with a track record of revenue, profit growth, and have reached a level of market presence and stability. This naturally adds a *selection bias* to all private equity-backed listings. Market conditions also significantly influence the decision as favourable market terms often lead to a higher valuation, more successful offering and aftermarket trading. An IPO process is a highly complex regulatory process, and the biggest owners may be restricted from selling shares for a period after the listing, aligning with long-term IPO goals.

2.1.4.3 U.S. Exit Patterns

Data from PitchBook (2023) (visualized in Figure A.2) shows that the most used exit strategy in the U.S. private equity market is corporate acquisitions which represents an average of 45,9% of all exit values and 53,5% of all exits in the period from 2008-Q3'2023 TTM.

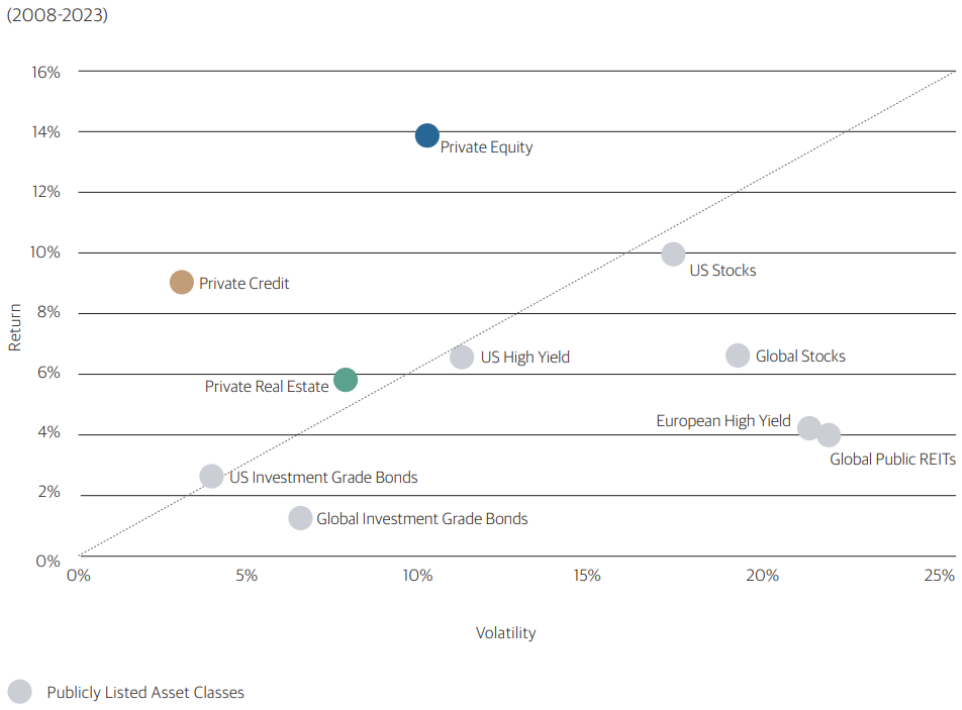
2.1.5 Is private equity a superior form of investment organization?

Blackstone, the world's largest alternative asset manager, claims private equity outperformed public equities with an 12% annualized return versus 6% from 2007-2023 *with* lower volatility in the long run (Blacstone, 2023). They state it is due to the potential private equity managers has for higher and more extensive value creation capabilities while investors trade off liquidity to pursue its *illiquidity premium*. As Figure 2.11 presents, private equity served double returns on ~half the volatility of global stocks from 2008-2023.

Furthermore, Beath and Flynn (2023) present a comprehensive study of investment allocations across aggregate asset classes and realized performance using a dataset of over 200 private and public sector pensions over from 1998 to 2021. Figure 2.12 lists private equity with the highest average gross and net return of ~14,6% and ~12,4%, respectively. It was also the riskiest aggregated asset class, with an annualized volatility of 23,3% and a estimated market risk of 18,3% (the same as U.S. small cap).

It is in question whether private equity fund managers actually manage to add value beyond its capital infusion with their active ownership. The theoretical view is that private

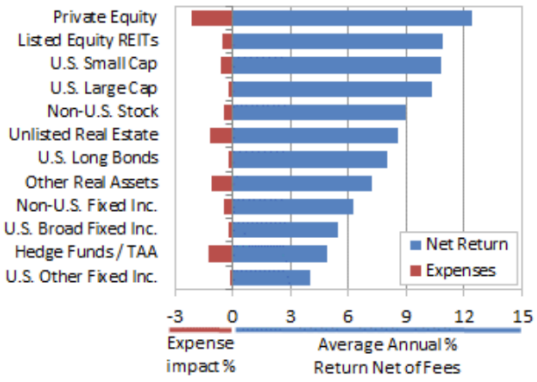
Figure 2.11: Risk-Returns of Select Asset Classes



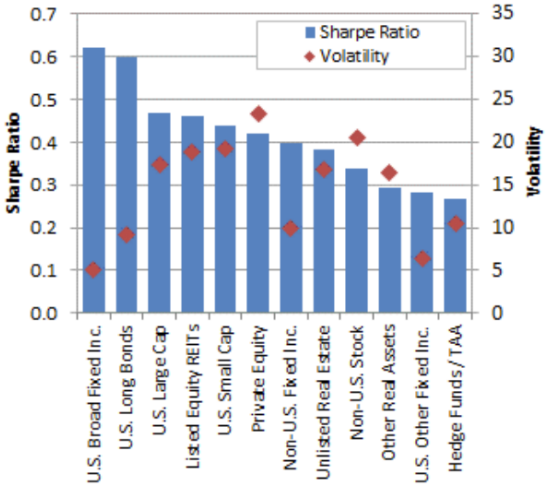
Note: *Source: Blackstone (2023)*

Figure 2.12: Fund performance and risk by asset class, 1998-2021

(a) Average annual net returns and expenses



(b) Volatility and risk adjusted returns



Note: *Source: Beath and Flynn (2023)*

equity fund managers generate excess returns in two ways, multiple expansion (increase in the the acquired companies' valuation during the holding period), and operational improvement (more efficient companies) as explained in the value bridge (Figure 2.13) (Norges Bank Investment Management, 2023).

Jensen (1989) argues private equity firms improve firm operations and generate economic

Figure 2.13: The Value Bridge

Note: *Source: Norges Bank Investment Management (2023)*

value by applying governance, operational and financial engineering to their companies. Others argue they take advantage of asymmetric (superior) information and tax breaks, and that private equity activity is influenced by market timing and mispricing between equity and debt markets (Kaplan & Strömberg, 2009). In contrast, Welch and Stubben (2018) claim cost-based accounting methods is used among private equity to understate systematic risk, creating an illusion of diversification that affects investors' risk perception and investments, further suggesting that a fair-value accounting would accurately convey the true systematic risk of private equity investments.

2.1.5.1 Corporate engineering

Value creation from financial engineering Leverage creates pressure on managers to consistently make principal and interest payments. This reduces *free cash flow problems* where management with weak corporate governance in mature industries dissipate cash flows instead of returning to investors (Jensen, 1986). Leverage also increase firm value as interest is tax deductible, but only if the leverage is not too high to increase the chance of financial distress (both hard to value accurately) (Kaplan & Strömberg, 2009). A low estimated share of firm value from tax shields implies that LBO debt is likely to be repaid in the short term, with personal taxes offsetting the benefits of corporate tax deductions. Conversely, a high share suggests a more permanent LBO debt situation, where personal taxes do not have significant offsets. Additionally, LBOs from the 1980s should exhibit a higher share of their firm value from tax deductions compared to those from the 1990s and 2000s, given the higher levels of leverage and corporate taxes during that period.

Value creation from governance engineering In contrast to private equity firms of the early 1980s, contemporary private equity firms meticulously focus on minimizing *agency costs* by aligning incentives between management and shareholders. Jensen and

Murphy (1990) state that they typically give the management a large equity upside through options and stocks (*performance-based compensation*), which was an unusual practise in the 1980s. Kaplan (1989) proposes that private equity firms actively encourage management to assume substantial ownership stakes in the company, ensuring their alignment with both potential gains and losses. Furthermore, Kaplan and Strömberg (2009) evidence that the median CEO and management team receives as much as 5,4% and 16% in equity and stock option value, respectively, in public-to-private transactions in U.S. LBOs from 1996-2004.

Furthermore, private equity firms control the portfolio companies' boards by appointing directors to be actively involved in decision-making processes and gain business oversight (Kaplan & Strömberg, 2009). Boards of private companies are also reported to meet more often than public companies, and private equity firms do not hesitate to replace a management that exhibit poor performance. Acharya et al. (2008) find that 39% of CEOs are replaced during the first 100 days of their tenure, with this number increasing over a subsequent 4-year period.

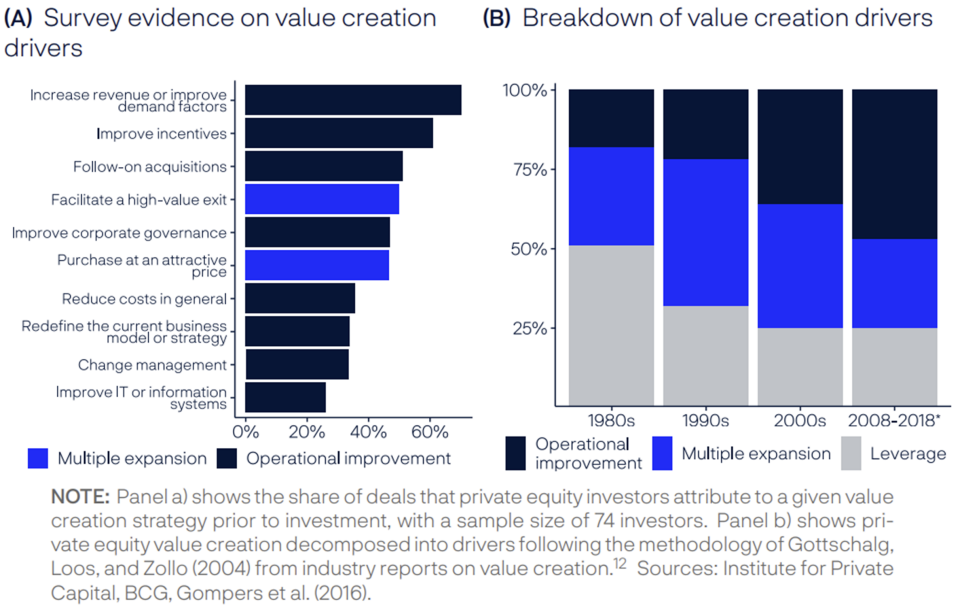
Value creation from operational engineering Today, private equity firms have added a new layer of value-creation, operational engineering (Kaplan & Strömberg, 2009). This refers to the usage of expertise within industries and operations to identify attractive investments and add value by developing and following value creation plans. These plans might include strategic changes, cost-cutting opportunities, acquisitions and more. Most private equity firms hire professionals with industry focus and operational backgrounds, and some firms are even organized to focus on specific industries.

It has been suggested that some of the value creation from operational performance could be explained by the fact that private equity firms hold superior information, or has *information advantage*, about the market, industry, and future companies' performance (Kaplan & Strömberg, 2009). Furthermore, Acharya et al. (2008) and Guo et al. (2011) found some evidence suggesting private equity firms are able to buy companies cheaper while selling higher than competitors (i.e., multiple expansion), and Bargenon et al. (2007) find that they pay a lower premium in cash acquisitions than public acquirers. This is consistent with their presumed ability to make more informed decisions and a better ability to identify underpriced industries and companies (Kaplan & Strömberg, 2009). They may

also be better in negotiations. It is noteworthy to mention that incumbent managers are aware that lucrative compensations often accompany a private equity ownership. Consequently, they might be inclined to overlook higher offers, opting instead for the anticipation of greater personal profits through the decision to sell to the private equity firm.

Empirical evidence Financial and governance engineering was more common in the 1980s (Norges Bank Investment Management, 2023). Figure 2.14 shows that private equity managers in the 1980s drove >50% of its value creation from leverage. From the 2000s, operational improvements and multiple expansion stood for ~75% of value creation, proving that their hands-on approach and thorough investment analysis matters. Acharya et al. (2010) studies the difference in performance between buyouts and similar firms and finds that governance changes and operational strategies on average stood for ~20-30% of average IRR, another ~25-35% was due to financial leverage, whilst the remaining is explained by quoted sector exposure.

Figure 2.14: Value Creation Drivers in Private Equity



Note: *Empirical evidence. Source: Norges Bank Investment Management (2023)*

Kaplan (1989) finds evidence that operating-income-to-sales ratio increased by 10-20%, cash-flow-to-sales ratio increased with ~40%, and capex-to-sales ratio declined while firm values increased (all absolute and relative to industry) in U.S. public-to-private transactions in the 1980s. Later work on Europe buyouts finds similar results and states

that LBOs are associated with significant productivity and operating improvements (Kaplan & Strömberg, 2009). Cumming et al. (2007) summarize and conclude that LBOs (especially MBOs) have significant effect on work practises and enhance performance.

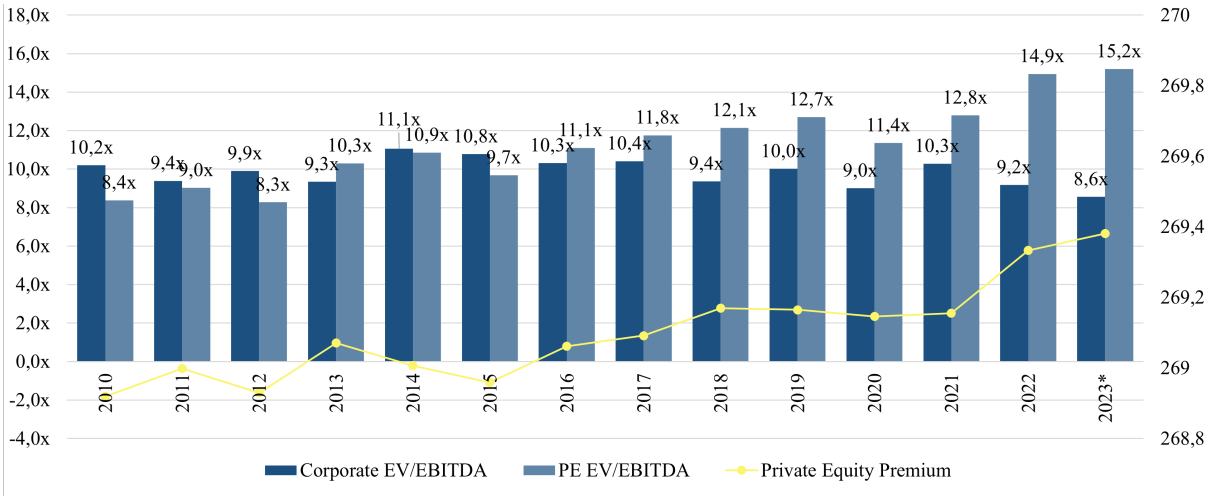
In contrast, several papers analysing the public-to-private transactions from post-1980s (˜late 1990s to 2000s) only find modest increases in cash flow and operating margin, but high investor return, adjusted for industry/market, at a portfolio company level (Kaplan & Strömberg, 2009). Overall, some empirical evidence shows significant improvements in operations for LBOs, but the data may be subject to selection bias due to its low availability of certain private firm data.

Data from PitchBook (2023), illustrated in Figure 2.15, shows that private equity transactions in North America actually paid a higher median EV/EBITDA multiple the last 13 years for its companies compared to corporate deals. Figure A.3 and Figure A.4 compares the North American market with the European, and shows an upward trend in North American private equity premiums. The increasing multiples could be a result of up-scaling in number of private equity funds and AUM, which would eventually diminish the fund returns. J. B. Berk and Green (2004) find that strong performance of actively managed funds lead to increased fund inflows. This influx, over time, becomes a destructive factor for funds, as the attractiveness of returns diminishes. The surge in fund inflows tends to elevate transaction multiples, consequently reducing overall returns.

2.1.5.2 Alternative value creation

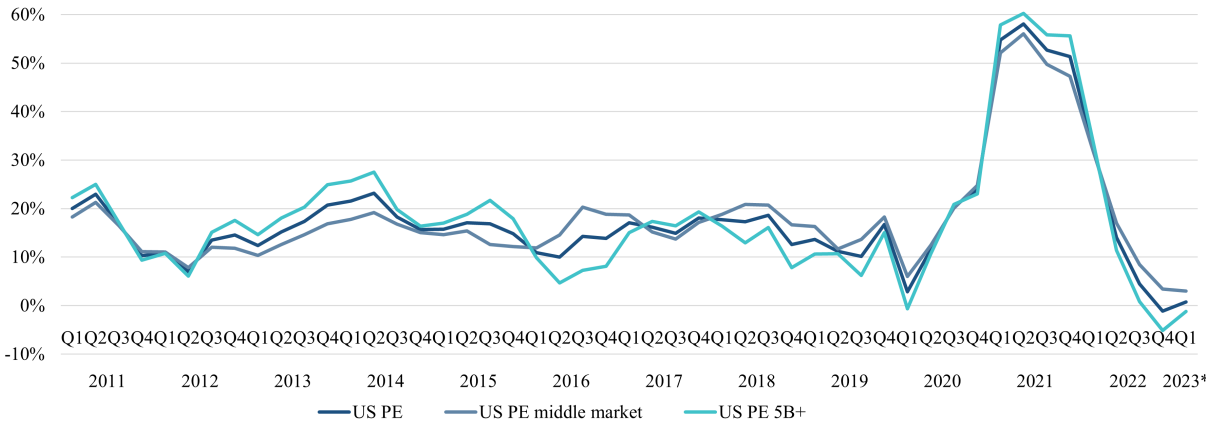
Liquidity premium Private equity investments are purported to provide a liquidity premium as compensation for the illiquidity necessitated by investors locking up capital for several years. This potentiality opens avenues for higher returns when contrasted with more liquid investments. Franzoni et al. (2012) investigates the liquidity premium in private equity with a four-factor model (excess market return, HML, SMB and liquidity factor) comparing it to public equity. They estimate that the unconditional liquidity risk premium is ˜3% annually, the total risk premium at 18%, and with the inclusion of the liquidity risk premium, alpha is reduced to not be statistically different from zero. Compared to U.S. historical rolling 1-year IRR (Figure 2.16), assuming a annual risk premium of 18%, does not leave much space for additional IRR profits.

Figure 2.15: North American Median purchase price EV/EBITDA multiples on Private Equity and Corporate transactions



Note: *Private Equity pays an average median purchase premium of 1,5x EV/EBITDA versus corporate from 2010 to *Q3'2023 TTM. Source: Data from PitchBook (2023)*

Figure 2.16: U.S. private equity - rolling 1-year performance by size



Note: **Q3'2023 TTM. Source: Data from PitchBook (2023)*

Franzoni et al. (2012) claim private equity are sensitive to credit markets liquidity through a funding channel when they refinance their debt, meaning private equity returns are depended on overall (funding) market liquidity. Figure 2.17 lists correlations among aggregated asset classes and highlight the significant correlation of 0,72 with other U.S. fixed income (Beath & Flynn, 2023). The correlations proves even higher with listed asset classes, U.S. large and small cap, non-U.S. stocks, and HF with correlation ranging from 0,79 to 0,90.

Figure 2.17: 1998-2021: Correlations between aggregate asset classes

	Stock: U.S. Large Cap	Stock: U.S. Small Cap	Stock: Non U.S.	Hedge Funds / TAA	Private Equity	Fixed Income: U.S. Broad	Fixed Income: Long Duration	Fixed Income: U.S. Other	Fixed Income: Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other Real Assets
Stock: U.S. Large Cap	n/a	0.92	0.88	0.89	0.87	0.06	-0.22	0.62	0.47	0.50	0.55	0.24
Stock: U.S. Small Cap		n/a	0.88	0.78	0.90	0.07	-0.28	0.67	0.51	0.55	0.62	0.13
Stock: Non U.S.			n/a	0.85	0.86	0.09	-0.29	0.70	0.59	0.53	0.55	0.01
Hedge Funds / TAA				n/a	0.79	0.16	-0.20	0.71	0.51	0.45	0.50	-0.10
Private Equity					n/a	0.21	-0.16	0.72	0.54	0.59	0.56	0.09
Fixed Income: U.S. Broad						n/a	0.75	0.58	0.73	0.25	0.30	-0.22
Fixed Income: Long Duration							n/a	0.04	0.34	-0.05	-0.02	-0.02
Fixed Income: U.S. Other								n/a	0.79	0.63	0.67	-0.27
Fixed Income: Non U.S.									n/a	0.40	0.51	-0.20
Unlisted Real Estate										n/a	0.90	0.03
Listed Equity REITs											n/a	-0.03
Other Real Assets												n/a

Note: *Source: Beath and Flynn (2023)*

Employee Wealth-Transfer Hypothesis *Wealth-Transfer theory* suggest negative intrinsic job quality implications post-LBOs, as private equity managers will create value by increasing job demands while not increasing (or even reducing) job resources (Shleifer & Summers, 1988). This is to the detriment of employee wealth, suggesting lower employee well-being. Although the LBO may pose as an alternative to keeping the business as it was before or even facing bankruptcy and/or liquidation Hoque et al. (2023) suggest otherwise and conduct the first U.K. assessment of intrinsic job quality in LBOs. They propose a *workforce re-contracting perspective*: As the new, external board and management team seek efficiency and will often demand higher of their employees, it is suggested that they also increase additional job resources. This is in line with *human capital matching theory*, where the private equity firm use their expertise to upgrade the newly bought firm with more efficient resources. Overall, they find no difference in employee well-being and affecting outcomes in LBOs and non-LBO deals, even though job demands are higher.

2.2 Initial Public Offering

In this section, we will introduce the mechanics behind an initial public offering, delve on the benefits and costs of going public and deep dive into the IPOs puzzles that remains subject for this thesis.

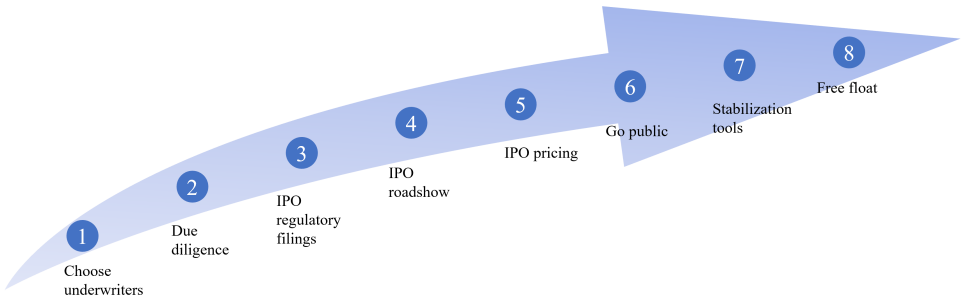
2.2.1 Introduction to IPOs

To understand the process of taking a company public, it is necessary to understand the many key steps and considerations during the process.

2.2.2 A roadmap to going public

The transition from being private to publicly available marks a significant corporate milestone. Behind every decision to go public, lies years of hard work to nurture the business idea, hours of strategic planning and financial considerations. The IPO process is a highly time- and resource- consuming process, and regulations differ across nations, marketplaces, size, and time.

Figure 2.18: The road map to going public



(1) Choose underwriters The underwriters play a crucial role in the listing process. These are typically investment banks, often chosen based on their reputation and transaction expertise (PitchBook, 2022). They manage the process and help facilitating the IPO by marketing, determining the optimal offering price, and facilitating the share sale (SEC, 2022). Underwriters usually form a syndicate to share responsibility and risks.

(2) Conduct due diligence The underwriters and legal counsels assist the issuing firm in undergoing a thorough evaluation process with the goal of understanding risks, including legal, operational, and financial scrutiny (PitchBook, 2022). They typically hire more specialised advisors like financial specialists and consultants to conduct separate parts of the due diligence. The underwriters and advisors form the IPO deal team.

(3) Submit IPO regulatory filings Public companies in the U.S. are highly regulated and undergo strict SEC regulations. The IPO process requires several

pieces of documentation that the IPO team helps compile; engagement letter, letter of intent, underwriting agreement, the registration statement (Form S-1), and Red Herring Prospectus (preliminary submissions) (J.P. Morgan, 2023). In general, companies must disclose all material information that may impact investor behaviour in a prospectus, provided to all potential investors.

(4) Go on IPO roadshow As part of the marketing process to generate interest and demand, the issuing company and its underwriters market the IPO to investors under what is called an "IPO roadshow" (PitchBook, 2022).

(5) Set the IPO price After the successful SEC approval, the underwriters set the optimal initial offer price and the number of new shares based on the order book building process and the issuing companies trading update (i.e., financials) (PitchBook, 2022).

(6) Go public on the stock exchange The underwriter releases the initial shares to the stock exchange on the day of the IPO. Nasdaq and New York Stock Exchange (NYSE) are the biggest stock exchanges among the various authorized stock exchanges offered in the U.S.. All exchanges have specific requirements that companies must meet to make the listing. More on Nasdaq and NYSE composite under Section 5.1.

(7) After-market stabilization tools Following the listing, the underwriters may use tools to influence the price with an objective to stabilize the trading (e.g., lock-up periods, quit period, green-shoe option) (PitchBook, 2022). Firms often even pay underwriters additional fees to boost the listed stocks liquidity as stock prices are earned with smaller liquidity premium (Ellis et al., 2000).

(8) Begin transition to market competition – the stock trades on its own Once the quiet period is finished, the publicly traded shares are subject to market conditions. The underwriters' job is finished, and transitions into having an advisor role where they track and evaluate the post-IPO valuation (PitchBook, 2022). Listed companies are under strict requirements on their financial reporting by the SEC. They must provide detailed financial information (balance sheets, and income and cash flow statements) quarterly and annually to ensure transparency with investors (SEC, 2023a).

2.2.3 Benefits and costs of going public

The owner and companies' strategic goal, finances and long-term vision will be viewed with the benefits and costs of going public. No single model can capture all relevant costs and benefits as it is so complex, but several theories has been derived in different models.

2.2.3.1 Benefits of going public

Liquidity and investor recognition Enabling owner to meet more potential buyers and liquidate their holdings at a cheaper cost is considered the most obvious benefit (Foucault et al., 2013; Pagano et al., 1998). A listing is also a marketing event, meaning investors may not even know that the company exist up until its listing. This is evidenced in Merton (1987) concluding stock prices increase with a higher number of investors aware of the stock.

Stock market liquidity expectations for the aftermarket is considered highly important when entering the public market (Foucault et al., 2013). As evidenced in many market microstructure models, stocks liquidity is an increasing function of its trading volume, meaning the liquidity benefit may be higher in larger firms (Pagano et al., 1998). Ellul and Pagano (2006) find that as newly listed companies' value is uncertain and subject to asymmetric information, spreads tend to be relatively high at first, but decrease as weeks from the listing date increases. In fact, some listed firms hire designated market-makers (DMMs) to increase the liquidity of the stock (Foucault et al., 2013). DMMs has grown highly in popularity, especially in the limited order books (LOB) markets where they operate with aggressive limits and thereby increase liquidity to new orders. This differentiates from e.g., NYSE, where last-mover advantage has potential drawbacks and might harm liquidity.

Access to capital and better bargaining power with banks The road to raise capital (e.g. finance alternative to bank loan) is shorter and being listed will broaden opportunities for a larger pool of external funds and future capital access (Pagano et al., 1998; SEC, 2023b). Furthermore, lower liquidity premium (discussed in the section above), often reduces the cost of equity financing (Foucault et al., 2013). The *financial constraint hypothesis* suggests the opportunity to tap funds from public markets are particularly

high for high growth and leveraged companies with large future and current investments. Pagano et al. (1998) suggest it would be positively related to an increased likelihood of listing.

Mikkelson et al. (1997) shows mature companies in the U.S. often use their improved access to equity post-IPO to reduce their debt, while young companies regularly use the access to increase investments. Some companies also use their post-IPO position to negotiate lower credit cost. Increased outside funding competition would press credit cost down, predicting companies with high interest costs and concentrated creditors are more likely to go public to increase control over leverage and profitability (Pagano et al., 1998). Furthermore, a listing lets companies exploit *windows of opportunities*. Both by going public when other companies in the same industry are priced high, and to raise cheap capital post-IPO when their equity is considered expensive.

Diversification Beyond increased access to capital and liquidity, an IPO enables more flexibility to divest shares and portfolio diversification for their investors (Chemmanur & Fulghieri, 1999; Pagano, 1989). This is achieved in two ways; through divestment and reinvestment in other assets, or indirectly by allowing the company to raise capital and acquire stakes in other companies (e.g., using the company's stock as currency for acquisition) (Pagano et al., 1998). This theory suggest riskier companies are more likely to go public and suggest their shareholders to diversify.

Corporate governance tools The stock market provides a managerial discipline device by exposing the market's assessment of management decisions and showing competitor interest by creating the danger of hostile takeovers (Pagano et al., 1998). Market valuation can be used as a valuable input to increase efficiency in managements decision-making (Foucault et al., 2013). The stock (and options) is also used to design efficient compensation schemes for managers and employees making it easier to attract and compensate personnel.

2.2.3.2 Costs of going public

Costs and regulatory compliance The SEC, the securities exchanges and the Congress added new standards with stricter requirements for the board of directors, financial disclosure and accountability following several high-profile corporate scandals during

the beginning of the 21st century (J. Berk & DeMarzo, 2013). These standards was designed to protect the investors, but adds a time-consuming and costly job for public companies (including increased administrative expenses and fees) (SEC, 2023b). Some costs are straight forward; stock exchange fees, costs of complying with requirements and underwriting fees charged by the listing advisory. More subtle costs involve the negative reactions and sanctions on fallout disclosures due to greater visibility for tax authorities and competitors, and if the regulatory requirement is not met. These costs are often a one-time cost and both direct and subtle costs usually do not increase proportionally with IPO size, meaning the costs weigh relatively more on small listings and it could even make some small companies refrain from going public. Pagano et al. (1998) find that company size is often the most important single determinant of the probability of a listing.

Loss of control Liquidity, the major advantage, is also a major disadvantage. As investors diversify their holdings, the reduced ownership concentration undermines the ability to monitor company management (J. Berk & DeMarzo, 2013). The investors will consequently value the loss of control negatively and the stock price will potentially fall.

Disclosure requirements and scrutiny – loss of confidentiality The strict governance legislation force companies to disclosure information that is possibly crucial for maintaining competitive advantage (e.g., data on ongoing R&D projects, market strategies) (Pagano et al., 1998). Increased tax control also limits their ability to engage in tax evasion and elusion compared to private companies. Campbell (1979) suggested that confidentiality acts as a deterrent for public funding, and Yosha (1995) showed that in equilibrium, companies holding sensitive information deterred from going public if the cost of going public is too high. (Pagano et al., 1998) then summarize that there is a negative correlation between an industry's R&D intensity and the probability of going public.

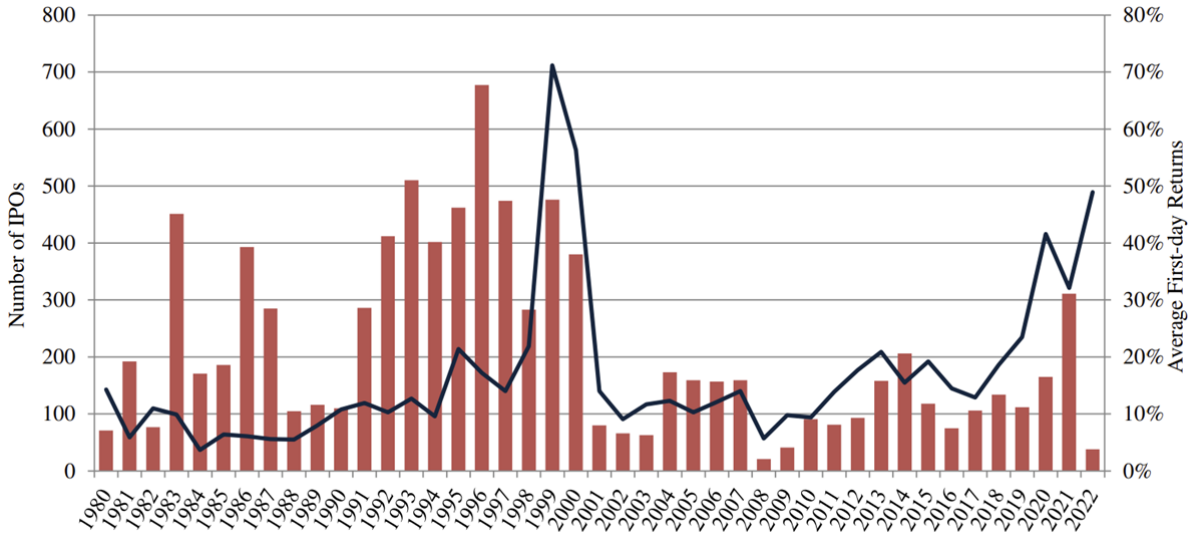
2.2.4 IPO Puzzles

2.2.4.1 Underpricing

Underpricing of new equity issues is a well-established phenomenon and refers to the incident of positive initial first-day public trading return. The topic is well documented

across markets and history, and Figure 2.19[2] graphs the average first-day returns from 1980 to 2022. Prominent scientists has over the years researched why, by whom and in which degree underpricing is used. It is important to keep in mind that the some research seem to suggest the actors has perfect foresight over the degree of underpricing used in their IPO. Although it is obvious, it is necessary to state that market factors and shocks in that period, and even on that initial day, would have impact on the resulted first-day return, and are impossible to foresight.

Figure 2.19: The number of IPOs and average first-day returns per year 1980-2022



Note: *Operating companies going public with traditional IPOs on major U.S. exchanges (excl. penny stocks, ADRs, etc). Source: Ritter (2023a)*

Asymmetric information Bergström et al. (2006) suggest *asymmetric information theory* postulates IPO underpricing as a result of information asymmetry between three parties: the issuing company, the underwriter, and the buying investors. Underpricing will in turn depend on which parties hold most information.

Assuming the underwriter is the informed

It is suggested that underwriters often set the issue price in order to obtain full subscription (Bergström et al., 2006; J. Berk & DeMarzo, 2013). To the extend the laws permit, the underwriter may even use underpricing to actively oversubscribe the IPO and allocate shares to recurrent investors to offer them positive initial return. Also, note that a too underpriced listing will put the private equity-firm at risk of losing clients, suggesting that

[2]See table version in appendix Table A.1

the underwriter should underprice to an extent where they do not lose any business.

Underpricing on Private Equity Backed listings – To stimulate repeated business?

The exiting private equity firm is assumed to hold the same amount of information as the underwriters. They are very keen to keep the IPO window open and naturally dependent on positive returns to sustain business (Bergström et al., 2006). When listing the shares of a portfolio company, the ownership structure pre- and post-IPO often force the private equity firm to evaluate gains for themselves and their investors. The degree of offering participation and the magnitude of dilution may influence the private equity firms to position themselves in regards to underpricing and the monetary gains. They gain more from increasing the underpricing when they keep a large share fraction in the IPO and less when the sell everything, which increases their incentives of reducing underpricing.

As the private equity firm normally keep a significant ownership fraction when listing (J. Cao, 2008), the incentive to reduce underpricing is lower. Although, as reputation is valuable for private equity firms, considering both the interest of minority owners and potential new investors is important, and underpricing would again be a tool to keep current investors and attract new (P. Gompers & Lerner, 2001). Consequently, they may favor underpricing to stimulate high demand, and allocate shares to the investors presumed to add long-term value.

Assuming the issuing firm is informed

We assume that the issuing firm holds the true information of its value, which is not unlikely if the issuing firm has a private equity owner. Generally, low-quality firms risk meeting resistance when issuing new capital if they use underpricing in their IPOs, making it rational for low-quality firms to reduce IPO underpricing (Bergström et al., 2006). Then, high-quality firms may use underpricing to signalize them from low-quality firms.

We would classify private equity backed listings as high-quality given the degree of capital support, industry experience, professional and active management the sponsorship usually provide. We would actually expect private equity firms to only list high-quality firms due to the importance of repeated business and successful exits. Listing a low-quality company would put their reputation at stake at a higher level, than any other exit, due the publicity surrounding an IPO. As uninformed parties often do not understand all

circumstances regarding a private equity backed listing, they are likely to believe all private equity backed listings are high-quality and reduce its spending on research.

Assuming investors are the informed

Investors are in reality less informed than issuers about the true value of a listing. This informational asymmetry will adversely affect the average quality of the companies seeking listing, effect the offered share price and determine the magnitude of the underpricing needed to sell the shares (Leland & Pyle, 1977; Rock, 1986).

By assuming some investors hold superior information, we can categorize the investors as *well informed* and *less informed*. Bergström et al. (2006) suggest well informed investors would sustain from bidding on an overpriced IPOs, while less informed investors bid on all. Underwriters may favor allocating shares to well informed investors as they trade allocations for valuable information (see section on IPO allocation theories). The less informed investors would then end up with a small fraction of attractive IPOs, and a large fraction in unattractive, overvalued IPOs. As this adverse selection implies negative first day returns for uninformed investors, the allocation must on average be positive to encourage the uninformed investors to continue bidding and underpricing may be tool to compensate for the risk they take when bidding.

The *adverse selection cost* is a bigger obstacle on IPOs of small and young companies due to its poorer visibility and track record. Pagano et al. (1998) suggest that, in presence of adverse selection, the probability of a listing is correlated with the companies size and/or age. Private equity-backing is likely to alleviate the problem of adverse selection as these IPOs are expected to be mature, high-quality companies that draw more diverse investors and *ex-ante uncertainty* is arguably lower due to higher publicity and transparency both pre- and under-IPO (Bergström et al., 2006). The greater the information on the listing, the lower is the gap between informed and uninformed investors, which probably lowers the ex-ante uncertainty about the listed firms' true value.

IPO allocation theories - Is underpricing determined by investor-underwriter collaboration?
Book-building theories suggest that underwriters use professional investors during the book-building process to trade private, informative price and interest indications from investors, which helps underwriters IPO valuation, with underpricing (i.e., *information*

acquisitions) (Binay et al., 2007). Then, the underwriter repeat this setup by promising regular clientele participation in future IPOs and lower expected underpricing. Binay et al. (2007) find that underwriters favor regular institutional investors (i.e. those they previously have worked with) when allocating shares in the IPO. They also find that IPOs with a higher (lower) relationship participation experience more (less) underpricing. Sherman and Titman (2002) investigate the importance of these *long-term relationships* in book-building theories, and find that the more expensive the information is, the underwriter experience substantially limited ability to reduce underpricing. Binay et al. (2007) suggest regular institutional investors also provide the underwriter insurance services by supporting stock prices and absorbing future issues.

Jenkinsom et al. (2018) used IPO data from 2010-2015 gathered as part of an U.K. financial regulator investigation. Their findings support *information revelation explanations* on underpricing and IPO allocations (information acquisition), and find that underwriters make favorable allocations to investors they generate the greatest revenues from elsewhere in the underwriters business, especially brokerage commissions. Relative to the bidding, the top quartile investors receive ~60% higher allocations than those who are not clients. These allocations are mainly associated with hot-IPOs, but they also find changes in the investors revenue rankings to have significant impact on their allocations.

The influence of ex-ante uncertainty Empirical evidence and theoretical reasoning (e.g. informational asymmetry models), as noted, advocates that ex-ante uncertainty influence underpricing. Bergström et al. (2006) suggest the greater the publicity and analyst coverage surrounding the IPO, the lower ex-ante uncertainty follows. They also suggest issue size (capital raised in the IPO) as a proxy for ex-ante uncertainty and expects increasing issue size to decrease ex-ante uncertainty and reduce underpricing. Larger issues are often issued by larger firms and are associated with greater visibility and information availability. They usually also hold larger fractions of institutional investors (i.e., private equity firms), reducing ex-ante uncertainty and demanded risk premium.

Possible explanations for the changing environment in the use of underpricing Figure 2.19 show how varying the degree of underpricing tendencies has been over the last ~40 years. In the 80s, the underpricing was on average ~7%, the average almost doubled the next decade, before hitting ~71% and ~56% during the dot-com bubble in

1999 and 2000, respectively. Loughran and Ritter (2004) questions the varying use of underpricing. They conclude that the main explanations behind low average underpricing is due to *dynamic information acquisition* and the *winner's curse problem*[3]. In periods with a high average underpricing they suggest three non-mutually exclusive explanations:

Changing issuer objective function hypothesis posits two reasons for increased complacent with underpricing. First, the *analyst lust hypothesis* suggests analyst coverage became a bigger factor when choosing underwriters due to increased valuations in the 1980s (Loughran & Ritter, 2004). The issuers then pay the underwriter indirectly for coverage through underpricing. Second, *the spinning hypothesis* suggest underwriters allocates share to corporate executives to influence their decision on future transactions. Loughran and Ritter (2004) suggest the executives of the issuing firms and venture capitalists were co-opted through allocations of hot IPOs on their personal brokerage accounts during the dot-com bubble. Even though they lose value by diluting their own IPOs, they gain personally from money left on the table from other listings, suggesting an increased incentive to seek underwriters with reputation for high underpricing. Loughran and Ritter (2004) find that the top-tier underwriters, which also has prominent analysts, was more associated with underpricing both pre- and under-bubble (i.e., 1996-98, and 1999-00), consistent with analyst lust and spinning hypothesis.

Changing risk composition: Loughran and Ritter (2004) conclude that a small part of the increase in underpricing can be attributed a change in the risk composition of the landscape of firms getting listed. Asset risks (e.g., measured by the age of assets) did not change in the 1980s and 1990s, but there was a high proportion of very young firms going public during the bubble period of 1999-2000 and high proportion of older firms going public post-bubble, suggesting young firms were more prone to use underpricing.

Realignment of incentives hypothesis argues that issuing firms' managers acquiesced in underpricing during the dot-com bubble, and that the increaced acquiescence was due to (1) reduced CEO ownership, (2) increased ownership fragmentation, (3) increased share frequency and allocations size to family and friends, and (4) fewer secondary shares listed in the IPO. All these was suggested to reduce the management incentives to reduce underpricing (Loughran & Ritter, 2004). Loughran and Ritter (2004) found little evidence

[3]A tendency for the winning auction bid to exceed the true value (Hayes, 2021)

to support this hypothesis. However, they found that CEO fractional ownership was lower during the bubble (substantially higher measured in dollar values) compared to pre-bubble period, suggesting increased incentives to reduce underpricing.

The influence of post-offering ownership structure

Some evidence suggest that a post-offering ownership structure including the private equity firm increases underpricing. Bradley and Jordan (2002) comprise an interesting explanation of underpricing, namely the *overhang theory*. They suggest that IPOs with high overhang degree (i.e. the ratio of pre-offering shares maintained by the private equity firm) tend to underprice more than those with less overhang. Schöber (2008) suggests this underpricing is used to compensate investors for the later downward share price pressure in future divestments by the private equity sponsor. Also, Ellul and Pagano (2006) theorizes the impact of investor expectations on after-market liquidity, which may result from post-IPO asymmetric information. They find that the lower the expected aftermarket liquidity and the less predictable the liquidity is, the larger the underpricing in the IPO will be.

Empirical evidence on private equity use of underpricing Megginson and Weiss (1991) demonstrated that VC-backed IPOs exhibit relatively lower underpricing (mean and median) compared to the non-sponsored counterparts. They attributed this to fact that the presence of VC-firms in the offering firm maximized the net cost of underpricing as their backing reduced the charged underwriting spread. They also attracted more prestigious underwriters and auditors, and elicit better interest from institutional investors compared to non-sponsored issuers, which all backs the *venture capital certification role hypothesis*. P. A. Gompers (1996) developed and tested the *grandstanding hypothesis* which state that young VC-firms tend to list their firms earlier than older, more established VC-firms with the objective of establishing a successful reputation and raise capital for new funds. Evidenced from 433 IPOs, young VC-firms do in fact list younger companies and tend to underprice more. This may also be due to poorer capital base in young VC-firms compared to older.

Hogan et al. (2001) find similar underpricing patterns for a sample of reversed LBOs (RLBOs) from 1988-1998. Bergström et al. (2006) expected lower underpricing tendencies

and with a sample of 1.522 listing on London and Paris stock exchange from 1994-2004, he found that PE-backed IPOs, on average, exhibit a equally-weighted underpricing of 9,33% compared to 12,87% on non-sponsored IPOs. A later paper, Levis (2011), uses a sample of 1.595 IPOs on the LSE from 1992-2005 and find that PE-backed IPOs were less underpriced than both VC-backed and non-sponsored IPOs. The average value-weighted (equally-weighted) underpricing was 5,7% (9,1%) for PE-backed, and 8,5% (14,9%) and 9,8% (21,1%) for VC-backed and non-sponsored IPOs, respectively. He also found that PE-backed IPOs, on average, were larger in terms of issue size, sales, assets and market capitalization, and that the underpricing pattern was not affected by hot market conditions.

2.2.4.2 Long-term performance

Papers on long-term IPO performance, like Ritter (1991), Aggarwal and Rivoli (1990) and Loughran and Ritter (1995), evidence long-term *under*performance on listings. Ritter (1991) investigates 1.526 U.S. listings from 1975 to 1984 compared to a sample of companies matched by industry and size. He finds a significant underperformance of 27,4% in a 3-year buy-and-hold period and substantial variations over both industries and year-to-year. Aggarwal and Rivoli (1990) uses a sample of 1.598 U.S. listings from 1977 to 1987 and finds evidence for 13,7% underperformance compared to the Nasdaq index. They further investigate two possible explanations: 1) that underwriters systematically underprice, and 2) that investors tend to overvalue newly listed stocks. Both explanations lead to long-term underperforming, and they find evidence on the latter explanation. They suggest IPOs might provide short-term profitable long positions, and long-term profitable short positions. Loughran and Ritter (1995) also finds an underperformance of 5% in IPOs and 7% in seasoned equity offerings (SEO) compared to non-issuing firms using a sample of 4.753 IPOs from 1970-1990. P. Gompers and Lerner (2003) investigate 3.661 U.S. listings in the period from 1935-1972 and while using several methods, finds no to very little evidence supporting the long-term underperformance.

Possible explanations for IPO underperformance Ritter (1991), Aggarwal and Rivoli (1990) and Loughran and Ritter (1995) suggest these IPO market characteristics is linked to *windows of opportunity theory*. The theory states that companies list in hot IPO

markets[4] with prices higher than rational (compared to fundamental, true company value) resulting in a long-term underperformance. Furthermore, Ritter (1991) also suggests it is due to periodically optimism about the earnings potential of young, growing companies. However, this perspective cannot be readily disentangled from periodic spikes in risk appetite.

In contrast, Fama and French (1998) support the findings of long-term underperformance but suggests the listing valuation is in line with fundamentals and that underperformance is due to diminishing information asymmetry resulting in later price corrections. Also, Fama and French (2004) show a jump in the number of newly listings from 1980-2001 and report that the cross-section of profitability of new listed stocks became significantly more negative skewed, while the cross-section of asset growth became more positive skewed after 1980. They suggested it was due to an increase in equity capital supply that allowed new listings (often risky stocks, with low profitability while high asset growth and low ex-post survival rate) more distant expected payoffs.

Bessembinder (2018) investigates the general performance of nearly 26.000 stocks in the U.S. stock market from 1926 to 2016 appeared on the Center for Research in Securities Prices (CRSP). He finds a positive skewness in the distribution of returns, and that only 42,6% of all stocks have a lifetime buy-and-hold return better than the U.S. one-month treasury bill over the same period, but also over a compounded multiple-month horizon, and the skewness increases. These results are also backed in Fama and French (2018). Bessembinder (2018) states this positive market performance is attributed to large returns driven by (1) relatively few stocks, (2) that since 1926, the ~4% best-performing stocks explained the net gain of the entire U.S. stock market in terms of wealth creation in dollars, and (3) that rates of underperformance is highest for stocks with small capitalization. More on the implication of this skewness in Section 5.1.

Empirical evidence on long-term performance of private equity-backed IPOs

The weight of IPO evidence suggests significant aftermarket long-term underperformance, whilst flotations of private equity-backed listings seem to defy the norm (Ritter, 2023b). Separating PE- and VC-backed when investigating private equity-backed IPO performance

[4]We categorize hot IPO markets based on C. Cao et al. (2015) methodology for calculating 200-day moving average. We consider a market to be hot when its trading above the 200-day moving average, whereas a cold market is identified when it falls below.

seems reasonable due to different strategies as discussed earlier.

Research on VC-backed IPOs is limited and proves somewhat inconclusive: Brav and Gompers (1997) investigated 934 VC-backed U.S. listings over 20 years between 1972-1992 and find them outperforming in equally weighted returns. Hamao et al. (2000) find no evidence of superior long-term performance while investigating 355 Japanese listings between 1984 and 1994. Rindermann (2004) investigates the U.K., Germany, and France without any statistically significant luck. Krishnan et al. (2009) suggest and finds that VC-firms with better reputations invest in companies with better long-term aftermarket performance.

There is more evidence on PE-backed/reversed LBOs, and the body of research suggest positive abnormal long-term performance. Holthausen and Larcker (1996) and Degeorge and Zeckhauser (1993) evidence better accounting performance in RLBOs before flotation in comparison with peers, and no evidence on aftermarket underperformance. Mian and Rosenfeld (1993) report positive aftermarket performance in their studies on 85 RLBOs, suggesting this to be driven by takeover activity. J. Cao and Lerner (2009) studies use a large sample of RLBOs in the period 1980-2002 and show evidence of positive industry-adjusted outperformance 5-years post-IPO, but the higher leverage posed no significant affect. Ritter (2023b) compared a total of 9.098 U.S. IPOs from 1980-2021 and divided them into buyout, growth equity-, VC-, and non-sponsored IPOs. He reported that the average 3-year buy-and-hold market-adjusted return was 0,2%, 0,6%, -13,3%, and -30,5%, respectively. Private equity-backed was collectively -8,6%. Levis (2011) also found positive performance on PE-backed IPOs while VC-backed and non-sponsored IPOs remains poor on his U.K. IPO sample from 1992 to 2005. One of our main sources, Bergström et al. (2006), found evidence that private equity-backed IPOs outformed non-sponsored IPOs on the Paris and London Stock Exchange across all time horizons (6 months, 1 year, 3 years and 5 years). They also find that large IPOs, on average, outperform small IPOs and attributes this to the fact that larger IPOs may be less subject til overoptimistic investors.

Possible explanations for overperformance in private equity-backed IPOs

Value creation

The main suggestion for this pattern reflects upon our discussion on private equity firms'

ability to create value beyond its capital infusion. Muscarella and Vetsuypens (1990) report significant profitability improvements on LBOs before returning to public markets. Katz (2009) studies indicate that private equity backed firms also perform better financially than their non-sponsored counterparts suggesting fair overperformance in the aftermarket. They generally have higher quality of their earnings, report more conservatively both pre- and post-IPO, and engage less in earnings management. J. Cao (2010) studies the role of private equity when LBOs goes public and finds that the length of private equity ownership prior to the listing is negatively correlated with industry valuation and hot market proxy. Listings with short LBO duration experience bigger deterioration after flotation, as quick flips lead to increased probability of financial distress.

Maintaining post-IPO ownership

Schöber (2008) documents that RLBOs with overhang (quoting a 47,6% post-IPO share retainment) exhibit abnormal positive returns in 1-year trading, but with a sharp share price deteriorating between 8-32 months post-IPO. He suggests the decline is explained by the private equity owner selling its shares to eventually fully exit, which poses a significant share overhang. Also, J. Cao (2008) notes buyout sponsors maintain a significant fraction of equity post-IPO (particularly the relatively larger firms) and suggest that the decision to only exit partially is based on fundamentals of the company and market conditions. The holding private equity firm also keep its active corporate governance going post-IPO.

Windows of opportunities

Bergström et al. (2006) states that PE-firms are not taking portfolio firms public during years associated with large IPO activity, suggesting they are not taking particular advantage of windows of opportunity. They further argue that private-equity-backed IPOs are probably less subject to investor sentiment due to the larger number of institutional investors being interesting in share allocations in subsequent IPOs by the same private equity-firm, advocating for later price-adjustments.

3 Research Questions and Hypothesis

3.1 Underpricing

Question 1: Does private equity- and venture capital-backed IPOs demonstrate less underpricing compared to non-sponsored IPOs?

Hypothesis A: Private equity- and venture capital-backed IPOs underprice less compared to their non-sponsored counterparts.

We expect private equity backed IPOs to underprice less compared to non-sponsored.

This is due to (1) incentives of aligning both holding and new investors interests, (2) their own objective of keeping a prestigious reputation to continue business, (3) the alignment of selling a high-quality firm, and (4) information availability on their portfolio companies reducing ex-ante uncertainty and mitigating adverse selection.

The theoretical evidence on their ability to add value (ref. Section 2.1.5), suggest they are subject to high investor demand. We also expect PE-firms to list larger companies, in terms of market capitalization, than both counterparts, and VC-firms to list smaller and younger companies, which often are inherently riskier than PE-backed IPOs. However, as VC-firms usually holds minority stake and are more subject to fully exit the company in the IPO, they would reduce underpricing. In sum, this contributes to the view that PE-backed and VC-backed does not diverge in their incentives to underprice.

3.2 Long-term performance

Question 2: Do private equity- and venture capital-backed IPOs exhibit abnormal long-term underperformance compared to non-sponsored IPOs?

Hypothesis B: Private equity- and venture capital-backed IPOs exhibit abnormal long-term overperformance relative to their non-sponsored counterparts

We expect private equity-backed IPOs to exhibit long-term outperformance relative than their non-sponsored counterparts.

We argue that private equity-backed stocks show (1) less diverging investors opinions, are

(2) subject to better operational performance post-IPO, (3) usually extract a larger number of institutional investors, (4) has higher pre-IPO visibility (reduced adverse selection), and (5) more coverage both during and after the listing (analyst lust hypothesis). We expect that point 1-5 has a higher effect on buyout companies, than VC, suggesting the performance expectations on buyout backed listings are higher compared to VC-backed.

We argue that secondary distribution overhang may outweigh the effect of the certification role posed by PE-owners and present a risk of mid-term (8-32 months) stock price depreciation, especially post-lock-up periods. We expect a recovery in the stock price after the PE-firm has fully exited.

4 Data

In this chapter, we will discuss the data collection and verification process, how the data was organized and categorized, and also address any limitations encountered during this process and the strategies employed to overcome them.

4.1 Data Collection

Our final dataset includes 2.509 companies listed on the Nasdaq and NYSE stock exchange in the U.S. in the period from January 1, 2000 to December 31, 2022. We identify a total of 616 (25%) PE-backed, 1.122 (45%) VC-backed, and 771 (30%) non-sponsored IPOs.

The total with annual volume distribution across backing and years are listed in Table 4.3, across industries in Table 4.6, market capitalization across years in Table 4.5, and visualized in Figure 4.1.

4.1.1 IPO Data

We started with a comprehensive dataset of IPOs listed on Nasdaq and NYSE using Bloomberg and SDC Platinum. The data collected included specific details about companies, such as the date of their stock market debut, the initial offering price, industry category, stock exchange, market capitalization, and whether the listing had backing from PE or VC.

Additionally, share prices for all companies, whether still trading or delisted, was listed during our study period were obtained through Datastream. This platform, managed by Thomson Reuters, offers a variety of historical financial information on various securities. This stock price information was utilized to calculate the basic returns applied in the analysis models. In a similar manner, relevant benchmark indices were also sourced from Datastream. This was done to calculate basic returns and to determine the adjustments to the IPO returns.

4.1.2 Authorized Stock Exchanges

The stock market in the U.S. is the largest in the world, where New York (NYSE) and Nasdaq, commands around 42,2% of the global market capitalization. There are over 5.000 companies listed on Nasdaq and NYSE, with a total market capitalization of over USD 47tn combined (Statista, 2023).

Nasdaq Nasdaq is an electronic stock exchange with over 3.300 listed companies with a market capitalization of ~USD 22tn (Statista, 2023) as of 2023. Being an electronic platform, it lacks a physical trading space and operates entirely via computers and telecommunication systems. It functions as a dealers' market, where brokers trade stocks through a market maker instead of directly with each other (Foucault et al., 2013). Market makers specialize in specific stocks and maintain an inventory of these stocks, enabling brokers to buy shares directly from them.

Table 4.1: Annual volume distribution of IPOs by backing on Nasdaq

Year	Private Equity-Backed	Venture Capital-Backed	Non-Sponsored	Total
2000	14	106	74	194
2001	4	18	12	34
2002	9	12	8	29
2003	7	11	9	27
2004	18	42	31	91
2005	24	32	24	80
2006	24	43	20	87
2007	12	55	15	82
2008	2	3	3	8
2009	6	7	4	17
2010	6	24	12	42
2011	5	21	10	36
2012	10	28	7	45
2013	15	47	16	78
2014	22	67	19	108
2015	14	40	14	68
2016	7	33	14	54
2017	9	28	27	64
2018	10	56	30	96
2019	8	55	24	87
2020	23	74	40	137
2021	40	119	97	256
2022	1	15	42	58
Total	**290**	**936**	**552**	**1778**

Note: *Source: Our dataset*

Nasdaq is renowned for the focus on technology and innovation, housing companies in

digital and biotechnology sectors, among others. Nasdaq is divided into three market segments: *Nasdaq Global Select Market, Nasdaq Global Market* and *Nasdaq Capital Market*(Nasdaq, 2023). The Global Select Market has the most stringent listing criteria, while the Capital Market has the least. The Nasdaq Global Select Market index comprises securities from companies that adhere to the highest financial and liquidity criteria. Companies that does not meet these criteria for the Global Select Market are included in the Nasdaq Global Market. Furthermore, The Nasdaq Capital Market Index features securities from smaller, small-cap companies listed on Nasdaq. These companies are typically seeking additional capital. The listing standards for the Nasdaq Capital Market are more relaxed compared to the other Nasdaq markets.

In table 4.1, the distribution of IPOs based on year and sponsortypes on Nasdaq is presented.

NYSE NYSE is the world's largest securities exchange with a market capitalization of ~USD 25tn as of mid 2023, hosting 82% of the S&P 500 and 70% of the globe's largest corporations (Statista, 2023). The exchange is organized as an auction market using specialists (designated market makers).

NYSE-listed companies are generally viewed as more established and stable than Nasdaq, attracting blue-chip and long-standing industrial firms. For a NYSE listing, a company must have at least 400 shareholders, 1,1 million outstanding shares, a minimum share price of USD 4, and a market value of publicly held shares ranging from USD 40-100m, depending on the type of listing. Companies must either have earned at least USD 10m in the past three years or have a global market capitalization of at least USD 200m. The cost of listing differs significantly between major stock exchanges. Nasdaq's listing fees range from USD 55.000-80.000 for the lowest capital market tier, while the NYSE's minimum fee is USD 150.000 (Nasdaq, 2023).

As previously outlined, the more stringent requirements for listing on NYSE relative to Nasdaq, may become more apparent when looking at Table 4.1 and Table 4.2 where Nasdaq had over twice as much listings over the period we observed.

Table 4.2: Annual volume distribution of IPOs by backing on NYSE

Year	Private Equity-Backed	Venture Capital-Backed	Non-Sponsored	Total
2000	4	0	11	15
2001	2	0	13	15
2002	5	3	15	23
2003	9	0	8	17
2004	17	5	15	37
2005	19	2	17	38
2006	17	4	15	36
2007	13	5	17	35
2008	0	2	4	6
2009	11	1	4	16
2010	16	10	7	33
2011	13	10	9	32
2012	20	15	8	43
2013	30	19	10	59
2014	35	23	14	72
2015	15	15	3	33
2016	15	3	4	22
2017	21	11	5	37
2018	12	11	10	33
2019	7	11	7	25
2020	10	8	4	22
2021	34	28	15	77
2022	1	0	4	5
Total	**326**	**187**	**233**	**746**

Note: *Source: Our dataset*

4.2 Data Manipulation

Out of the initial dataset comprising over 6.000 IPOs, several steps were undertaken to refine it to the final selection used in our research.

Firms not featured on CRSP (Center for Research in Security Prices), which tracks stocks on NYSE and Nasdaq, were not included in our study. This exclusion encompasses stocks traded over-the-counter (OTC) and on the pink market. Furthermore, we disregarded market transfers, IPOs not primarily listed, cross listings and IPOs that did not engage in capital raising.

We omitted firms in the real estate-sector and certain companies within the finance sectors, as designated by their SIC-codes, as seen in table 4.6. This decision aligns with prior research, such as studies by Lowry and Schwert (2004) and Chemmanur and Paeglis (2005). Consequently, IPOs in categories like general finance, specialty finance, real estate,

Table 4.3: Annual volume distribution of IPOs by backing

Year	Private Equity-Backed	Venture Capital-Backed	Non-Sponsored	Total
2000	18	106	85	209
2001	6	18	25	49
2002	14	15	23	52
2003	16	11	17	44
2004	35	47	46	128
2005	43	34	41	118
2006	41	47	35	123
2007	25	60	32	117
2008	2	5	7	14
2009	17	8	8	33
2010	22	34	19	75
2011	18	31	19	68
2012	30	43	15	88
2013	45	66	26	137
2014	57	90	33	180
2015	29	55	17	101
2016	22	36	18	76
2017	30	39	32	101
2018	22	67	40	129
2019	15	66	31	112
2020	33	82	44	159
2021	74	147	112	333
2022	2	15	46	63
Total	**616**	**1122**	**771**	**2509**

Note: *Source: Our dataset*

real estate investments and services, REITs, company bonds, debentures, loans, equity investment instruments, investment companies, and other investment entities were not considered. We also excluded american depository receipts (ADRs), unit offers, closed-end funds, natural resource limited partnerships, smaller best efforts offers and banks. The rationale is that these businesses' fundamental nature differs significantly from traditional industries. For instance, many entities within REITs and various investment entities primarily exist to hold securities or financial instruments in other companies (Lowry & Schwert, 2004). These entities usually lack significant operational activities. Hence, their stock price movements are not directly comparable to those of companies engaged in standard operational businesses (Chemmanur & Paeglis, 2005).

After implementing these criteria, our analysis concentrated on a refined sample of 2.509 companies which are visualized across backing, market capitalization and years in Figure 4.1. The figure illustrates the annual development in the number of listings and aggregated market capitalization across the sponsor types.

Table 4.4: Annual distribution of IPOs by market capitalization

Year	PE	VC	NS
2000	4,3 %	34,3 %	61,5 %
2001	3,4 %	7,6 %	89,1 %
2002	15,7 %	9,4 %	74,9 %
2003	38,0 %	5,5 %	56,4 %
2004	21,6 %	27,7 %	50,6 %
2005	53,2 %	15,7 %	31,1 %
2006	42,9 %	22,1 %	35,0 %
2007	20,4 %	42,5 %	37,0 %
2008	2,4 %	7,8 %	89,8 %
2009	54,9 %	9,1 %	36,0 %
2010	19,7 %	17,8 %	62,6 %
2011	44,5 %	46,1 %	9,5 %
2012	18,3 %	76,3 %	5,4 %
2013	57,4 %	28,3 %	14,2 %
2014	50,0 %	27,6 %	22,4 %
2015	40,1 %	44,8 %	15,1 %
2016	40,5 %	31,3 %	28,1 %
2017	40,7 %	38,8 %	20,5 %
2018	22,6 %	44,8 %	32,6 %
2019	14,5 %	69,4 %	16,1 %
2020	40,0 %	42,4 %	17,6 %
2021	27,0 %	59,9 %	13,1 %
2022	16,8 %	10,6 %	72,5 %

Note: *Source: Our dataset*

4.3 Quality of the data

Efforts were made to ensure the accuracy of the data and to minimize biases in the results. We also want to highlight potential limitations to consider when evaluating our empirical findings.

Classifying IPOs with VC- and PE-backing poses a significant challenge. This is due to the limited availability of public information about private companies and the overlapping roles of VC- and PE-sponsors in different transaction activities. It is important to recognize the fluid overlap of strategies within private equity, as described in section 2.1.2. In the U.S., most research focuses on companies that re-enter public trading as RLBOs after a period of private restructuring. For the purpose of this study, we use SDC Platinum and Bloomberg's classification of PE- and VC-backed IPOs. The databases does not go further in depth on what they categorize as "PE-backed" and "VC-backed", but given the

Table 4.5: Market capitalization across years and sponsorship

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
PE												
Mean	611	343	611	1030	602	803	930	979	333	1178	889	3 702
Median	418	256	322	544	419	464	389	830	333	537	570	1 283
Total	**10 995**	**2 056**	**8 551**	**16 486**	**21 057**	**34 542**	**38 134**	**24 474**	**666**	**20 022**	**19 568**	**66 640**
VC												
Mean	836	258	342	219	575	299	418	850	431	415	520	2 227
Median	126	208	299	165	178	235	264	412	92	295	261	692
Total	**88 577**	**4 651**	**5 137**	**2 407**	**27 048**	**10 168**	**19 652**	**50 995**	**2 155**	**3 321**	**17 681**	**69 050**
NS												
Mean	1 871	2 184	1 777	1 440	1 073	492	888	1 388	3 530	1 639	3 277	749
Median	339	528	676	508	304	234	330	401	1 030	890	411	171
Total	**159 030**	**54 596**	**40 867**	**24 479**	**49 366**	**20 171**	**31 079**	**44 416**	**24 712**	**13 111**	**62 258**	**14 226**

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
PE											
Mean	1 143	2 726	2 126	1 959	1 293	2 076	2 157	3 108	7 639	4 295	6 578
Median	843	1 525	998	1 091	1 078	1 158	1 455	1 094	4 270	3 373	6 578
Total	**34 280**	**122 681**	**121 206**	**56 800**	**28 455**	**62 288**	**47 461**	**46 621**	**252 073**	**317 814**	**13 155**
VC											
Mean	3 331	918	743	1 151	611	1 521	1 402	3 380	3 256	4 803	554
Median	365	252	358	487	357	538	516	846	1 079	1 346	564
Total	**143 223**	**60 565**	**66 901**	**63 321**	**21 985**	**59 309**	**93 908**	**223 089**	**267 013**	**706 093**	**8 307**
NS											
Mean	675	1 171	1 645	1 257	1 097	978	1 707	1 668	2 527	1 375	1 233
Median	404	286	456	635	489	245	396	324	264	261	88
Total	**10 119**	**30 439**	**54 281**	**21 361**	**19 752**	**31 312**	**68 285**	**51 721**	**111 205**	**153 987**	**56 709**

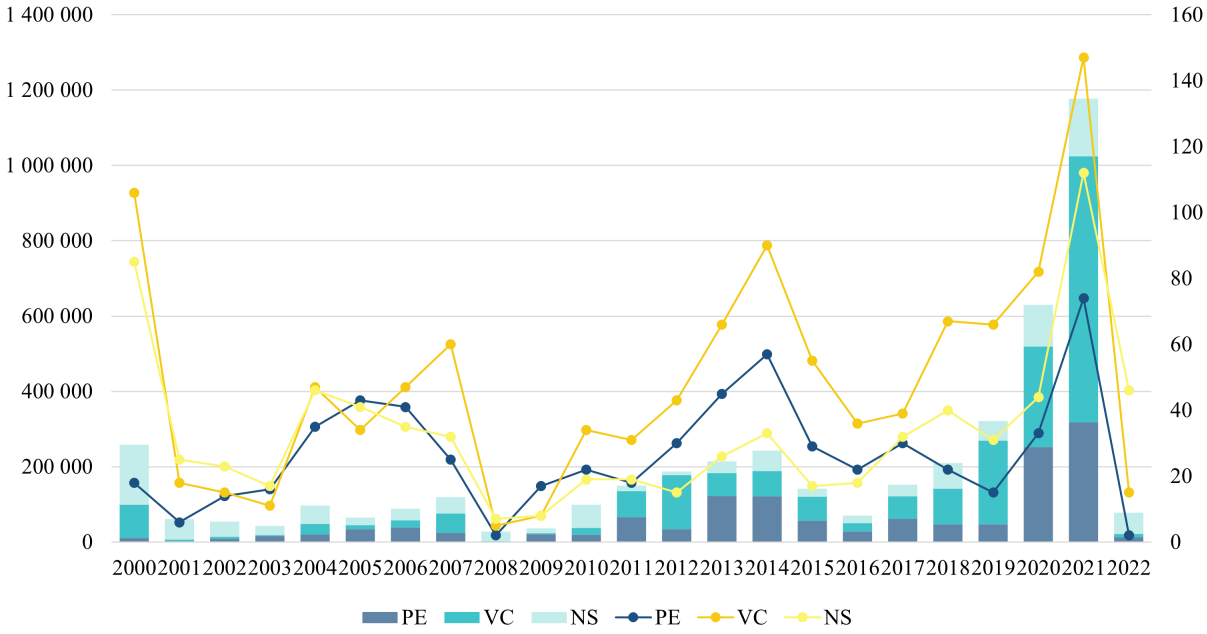
Note: *The total market capitalization for the sample amounted to USD 4.5tn, with PE, VC, and non-sponsored IPOs accounting for 30,1%, 44,5%, and 25,3% of this total, respectively. PE-backed IPOs had a mean market capitalization of USD 2.048m, compared to USD 1.264m and USD 1.550m for VC-backed and non-sponsored IPOs, respectively.*

Table 4.6: Volume distribution across industries

	PE	VC	NS
Communication	13	21	6
Consumer Discretionary	106	40	72
Consumer Staples	19	5	20
Energy	40	3	35
Financials	64	27	157
Health Care	79	556	170
Industrials	174	367	200
Information Technology	56	99	63
Materials	51	3	29
Utilities	14	1	19
Total	**616**	**1122**	**771**

Note: *Source: Our dataset*

Figure 4.1: Volume and market capitalization distribution across years



Source: Our dataset

magnitude and reputation of the databases we choose to rely on this filter. Furthermore, a thorough manual verification of all data is not possible due to time constraints. However, a list of PE- and VC-funds was used for cross-referencing when assessing the division between the sponsor types.

4.3.1 Potential issues on data quality

To address the issue of *survivorship bias*, which stems from excluding delisted companies that may have performed poorly, this study includes companies with shorter trading histories in the analysis, like Ritter (1991). This strategy aims to incorporate firms that might have underperformed before delisting. Including these stocks in longer holding periods helps achieve a more accurate representation of the real performance of IPOs. Although this method doesn't completely eradicate survivorship bias and includes stocks with insufficient trading history for some periods, it offers a balanced view of the performance of both active and inactive stocks post-listing.

Another limitation in our data is the unrecorded investment sizes (ownership percentages) of private equity and venture capital investments. Following previous methodology for financial sponsors, this study uses binary dummy variables in the cross-sectional regressions to indicate their presence (Jelic. R & M., 2005). Given the extensive size of the IPO sample in this study and time constraints, it is too time consuming to examine all prospectuses for ownership percentages. Additionally, such details may not always be publicly available. Bloomberg and Refinitiv does not specify exact ownership percentages but indicates sponsorbacking by the presence of at least one financial sponsor. The number of VC-backed IPOs in our sample which exceed the numbers reported in related literature. This may possibly be a reflection of the prominence of Silicon Valley and biotechnology in the U.S. market and/or potential data collection limitations.

Another concern to address is the potential for incompleteness in our data. Despite thorough data gathering, including cross-referencing multiple databases and manual verification, some IPOs might be missed or misclassified. For instance, a stock offering might be incorrectly labeled as an IPO, which could be detected when modeling stock price performance. However, if an IPO is not recorded in any database, it would be omitted from the study, leading to data inaccuracies. Yet, it is less likely that two independent databases would overlook the same IPO, suggesting that the issue of incompleteness is minor and not of concern in our study.

5 Methodology

This section provides an outline of the methodology used to estimate performance measures of the IPOs. Furthermore, it will also describe the methods for evaluating these metrics against suitable benchmarks and through statistical analysis.

5.1 Choice of benchmark

When calculating underpricing and long-term abnormal returns, it is essential to first define "normal" returns and select an appropriate benchmark to represent these. Studies by Ritter (1991) and Levis (2011) highlight the sensitivity of abnormal returns with the choice of benchmark, underscoring the need for careful selection. Two primary methods exist for estimating a benchmark: using a broad equity market index or employing returns from comparable firms with similar risk profiles.

Bergström et al. (2006) advocates for using broad market indices, like all-share indices, which he argues reflect the fundamental risks involved in active IPO investment strategies better than returns from comparable firms with similar risk profiles. Accordingly, this study, following Bergström et al. (2006) and Westerholm (2006), primarily utilizes all-share indices for respective markets as benchmarks. For the U.S., these benchmarks are the total return all-share indices of Nasdaq and NYSE. These indices are value-weighted gross indices, adjusted for dividends, stock splits, and new share issuances, to more closely mirror the buy-and-hold returns attainable by an average investor. Consequently, this study will employ share indices as benchmarks, in line with previous research.

One may reflect on Fama and French (2004) and Bessembinder (2018) findings elaborated in Section 2.2.4.2. As the stock market is the most used benchmark, it is important to keep in mind the bias this skewness may introduce in value-weighted markets like NYSE and Nasdaq. The implication is that we are actually benchmarking returns against large, well-established firms. The results give practically skewness in the return distribution as well, contributing to the main assumption that returns conform approximately normally distribution. The compounding effect would also imply long-term positive skewness, but this is not entirely comparable to investigating long-horizon returns which may be less skewed.

A major flaw with using indicies is its inclusion of sample IPOs, which leads to benchmark contamination as the indicies has not been adjusted to exclude companies from our sample (Loughran & Ritter, 2004). This suggests that the returns of the benchmark should be adjusted. However, the inability to extract an adjusted index means that any modifications would need to be made manually. This would require us to construct our own adjusted index, which is a process that could introduce different biases and errors in index construction. Consequently, our findings are susceptible to benchmark contamination, a factor that should be carefully considered when interpreting the results.

5.1.1 Nasdaq Composite

The Nasdaq Composite Index, covers more than 3.000 stocks, all of which are listed on the Nasdaq Stock Market. The Nasdaq Composite is as old as the exchange and is different from another popular index, the Nasdaq-100, that was launched in 1985, and is a more compact index comprising of the top 100 (hence the name) non-financial companies listed on the Nasdaq exchange.

The Nasdaq Composite is a market cap-weighted index, simply representing the value of all its listed stocks. The set of eligible securities includes common stocks, ordinary shares, and common equivalents such as ADRs. However, convertible debentures, warrants, Nasdaq-listed closed-end funds, exchange traded funds (ETFs), preferred stocks, and other derivative securities are excluded.

In terms of the industry breakdown, technology dominates almost half of the weight with close to 20%, the consumer services sector ranks second, while health care is third at almost 10% (Nasdaq, 2023). Next in line are consumer goods, financials, and industrials, with allocations of 7,61%, 6,61%, and 6,09%, respectively. Industries such as utilities, oil and gas, basic materials, and telecommunications each represent less than 1% of the index.

5.1.2 NYSE Composite

The NYSE Composite Index, has a wide array of over 1.900 stocks, all listed on NYSE. This index, unlike the more industry-focused Dow Jones Industrial Average, provides a broader view of the market by including a diverse range of companies.

The NYSE Composite is a market capitalization-weighted index, representing the aggregate value of all the listed stocks. It includes a variety of securities like common stocks, american Depositary Receipts (ADRs), and real estate investment trusts (REITs). However, it excludes instruments like convertible debentures, warrants, preferred stocks, and derivative securities. In terms of industry representation, the NYSE Composite is diverse, with no single sector overwhelmingly dominating the composition.

5.2 Time-regime considerations

The two most prevalent methods for measuring risk-adjusted returns are event-time and calendar-time. The event-time approach focuses on returns from a group of firms following a shared event, like an IPO, and calculates the risk-adjusted return for the period after the IPO. This method measures time relative to the IPO date, treating the elapsed time since the IPO uniformly, regardless of whether the IPO happened in 2005 or 2015, and compares the holding periods consistently across different years. On the other hand, the calendar-time approach aligns holding periods within the same calendar period.

One advantage of the calendar-time approach is the avoidance of having overlapping time periods that occur with the event-time method. The latter can overlook the cross-sectional dependence among IPOs, potentially exaggerating test statistics, as noted by Mitchell and Stafford (2000). However, a major drawback of the calendar-time method is the uneven weighting of calendar periods in practice, which Fama and French (1997) discuss. As highlighted in Paragraph 2.2.4.2, IPOs often cluster in certain periods, creating "windows of opportunity" that can lead to biased estimates in the calendar-time regime, in contrast to the more evenly distributed event-time method. The event-time approach is also considered more likely to accurately reflect an investor's actual returns compared to the calendar-time method, as Krigman and Womack (2000) suggest. Additionally, Loughran and Ritter (2004) posit that in cases of temporary misvaluations, an equally-weighted event-time approach could theoretically yield more robust statistical power than the calendar-time method.

5.3 Underpricing

Investigating the short-term underpricing of IPOs involves several methodological decisions. Key among these are choices related to holding period, time-regime and return metrics.

5.3.1 Methodological decisions

5.3.1.1 Holding period

The initial decision when assessing underpricing concerns the holding period, more specifically the duration over which returns are assessed. A review of prior literature reveals a shift towards shorter holding periods in contemporary research, contrasting with the longer duration favored in earlier studies. Some research, like Ibbotson (1975), has examined underpricing over extended duration, such as a month. This longer window is somewhat atypical for investigating short-term effects, with most historical and current studies focusing on shorter periods. In this thesis, we will use a one-day holding to calculate underpricing, in line with previous research from Bergström et al. (2006) and Ritter (1991).

5.3.1.2 Time-regime approach

Another consideration is whether to measure returns in event-time or calendar-time. This decision becomes of little practical value with a one-day holding period and is reserved for the discussion of long-term underperformance in Section 5.4, where multi-year holding periods are relevant.

5.3.1.3 Employed market prices

Another factor is the type of market prices employed at, such as closing, open, offer, bid or ask prices, or a midpoint of these. The initial return period we investigates spans from the first day of trading, when the closing price differs from the opening list price. The rationale behind using the opening list price rather than the offer price is because there may arise discrepancies between the opening list price and the offer price due to pre-IPO trading on the over-the-counter (OTC) market. It could be argued that the changes from offer price and up until its open price is an extension of the book-building period, that trading

before its initial listing is often only an option for professional investors. In other words, the difference between the close and the open price represents the markets assessment of the underpricing on fair market terms (including retail investors). Additionally, the time gap between setting the offer price and the stock's listing is limited to hours, while in other countries, it may extend to several days. Despite this, the price difference between the opening list price and the offer price is usually small Bergström et al. (2006).

Also, the results on underpricing are dependent upon the fact that, even though on average initial public offerings are underpriced, an investor submitting a purchase order can not be certain about an offering's true value once it starts publicly trading (Beatty & Ritter, 1986). This ex-ante uncertainty will increase underpricing, and some may be removed as we use opening list prices rather than offer prices, that can be set days and even weeks before the flotation day.

Furthermore, by aligning our methodology with that of established studies like Bergström et al. (2006) and Ritter (2023a), we ensure consistency and comparability. This approach allows for a more straightforward evaluation of our findings in the context of existing literature and provides a solid basis for any conclusions or drawn comparisons. Lastly, the availability and reliability of data regarding offer prices can be inconsistent, particularly for companies that have undergone structural changes like reverse stock splits or equity issues. By focusing on the opening list price, we sidestep these complications, ensuring that your analysis is based on more readily available and stable data points.

5.3.2 Models

5.3.2.1 Initial raw returns

We first measure underpricing for the groups of IPOs on an aggregated level, before constructing portfolios on the basis of stock exchange and year. We separate PE, VC, and non-sponsored IPOs when calculating underpricing for the various portfolios. We also classify IPOs by industry to adjust for industry characteristics. We utilize the SIC-codes (Standard Industrial Classification) from the IPO prospects to determine the the sector.

The initial raw return of IPO i is calculated with the following formula:

$$r_i = \ln\left(\frac{p_{i,1}}{p_{i,0}}\right) \tag{5.1}$$

Where $p_{i,1}$ is the opening list price at the IPO day and $p_{i,0}$ is the closing price at the end of the initial return period. Again, the initial return period spans from the IPO day to the first day when the closing price differs from the opening list price.

Benchmark-adjusted initial return We adjust the raw initial return to the movements by subtracting a benchmark return, which refers to the return of either of two broad market indices, NYSE Composite and Nasdaq Composite. These composite indices consist of the stocks listed on the exchanges, hence we find these to be the best candidates to act as a benchmark to correct for any fluctuations on the stock market on the first day of trading (see discussion in Section 5.1).

The benchmark-adjusted initial return formula is defined as:

$$ar_i = r_i - r_b \tag{5.2}$$

Where ar_i equals the abnormal return of IPO i over the initial return period and r_b is the benchmark return over the same period.

5.3.2.2 Equally-weighted returns

We calculate equally-weighted abnormal returns for all portfolios, by assigning the same weight to each return regardless of the relative market capitalization of the stock. The formula is defined as:

$$AREW_p = \frac{1}{n_p}\sum_{i=1}^{n_p} ar_i \tag{5.3}$$

Where $AREW_p$ is the equally-weighted abnormal return for portfolio p. $\frac{1}{n_p}$ is the equal weighting factor. Here,n_p is the total number of stocks in the portfolio p. By dividing n_p, each stock's return contributes equally to the overall portfolio return.

5.3.2.3 Value-weighted returns

We further calculate value-weighted abnormal returns, by assigning weights to IPO stocks in proportion to their relative market capitalization in the portfolio, for each respective stock exchange. Value weighting returns allows for detecting differences in underpricing between large and small IPO stocks. The value-weighted abnormal portfolio return formula is defined as

$$ARVW_p = \frac{1}{n_p} \sum_{i=1}^{n_p} w_i \times ar_i \tag{5.4}$$

Where $ARVW_p$ is the value-weighted abnormal return for portfolio p and w_i is the relative weight of the IPO in proportion to their relative market capitalization in the portfolio, for each respective stock exchange. We use the pre-IPO market capitalization in our analysis.

5.3.3 Hot markets

We also analyze the underpricing during times of varying sentiment. This is done to analyze whether underpricing is more prominent during periods of increased market activity. Previous research has shown that companies that go public in high volume years are associated with higher degrees of underpricing (Ritter, 1991). It is common to consider the stock market as having up and down periods, and there are several equity market indicators that can be used to define such periods. One such indicator is the 200-day moving average of a given benchmark, where trends are indicated by whether the 200-day moving average is above or below benchmark (C. Cao et al., 2015).

If the 200-day moving average is above the benchmark then it indicates a down market, and if the moving average is below, then an up market prevails. This method of defining different market trends is utilized along with the NYSE and Nasdaq Composite in order to deepen our analysis. The terms up and down will be used interchangeably with warm and cold periods throughout this thesis.

5.3.4 Regression model

We also make use of a cross-sectional regression with underpricing as dependent variable and market capitalization, year, sector, exchange and a dummy for hot market as explanatory variables.

Our equation for the regression is the following:

$$\begin{aligned}\text{Underpricing} =& \alpha + \beta_1 \times \text{PE} + \beta_2 \times \text{VC} + \beta_3 \times \text{NS} \\ &+ \beta_4 \times \ln(\text{Mcap}) + \beta_5 \times 2020 + \beta_6 \times 2014 \\ &+ \beta_7 \times \text{Health Care} + \beta_8 \times \text{Consumer Discretionary} \\ &+ \beta_9 \times \text{NYSE} + \beta_{10} \times \text{Hot Market} + \epsilon \end{aligned} \tag{5.5}$$

We use dummy-variables for each of the sponsor types and the years 2014 and 2020. Furthermore, we also use dummy variables for IPOs within health care and consumer discretionary. Additionally, we make use of a dummy for whether the IPO was floated on NYSE. Lastly, we have a dummy for when the IPO was launched in a hot market.

Prior research has often used issue size as a dependent variable. Instead, we opted for market capitalization because we wanted to see how firm size affected underpricing and long-term performance. Furthermore, including both could potentially present problems of multicollinearity (Woolridge, 2018). We transformed market capitalization to a natural logarithm as one quickly ends up with large integer values when using dollar amounts. In order to narrow the range of the variable, it can be sensible to use a logarithmic transformation. This ensures that estimates are less sensitive to extreme outliers, and the variable's values become closer to being normally distributed, while an untransformed market capitalization may be heavily skewed. However, using a transformed market capitalization alters the interpretation of the variable, as the dependent variable, underpricing, will no longer be regressed against the market capitalization as a dollar amount. Instead, the level of underpricing is now a function of percentage changes in market capitalization.

5.4 Long-term performance

Investigating the long-term performance of IPOs involves several methodological decisions. Key among these are choices related to holding period, time-regime and return metrics.

5.4.1 Methodological decisions

We use the development in the stock prices to investigate the long-term performance of IPOs, both through the comparison of the returns relative to an appropriate benchmark in the BHR- and CAR-model outlined below. An alternative measure of the performance could be operational performance metrics such as key financial figures or ratios. However, stock prices has the advantage of incorporating expectations of future earnings, thereby capturing more information than the backwards-looking accounting measures of operational performances (Bergström et al., 2006).

5.4.1.1 Holding period

Our analysis of long-run performance spans over various durations: 6 months, 1 year, and 3 and 5 years. The choice of these time frames is significant for multiple reasons. Extending the measurement period helps uncovering any abnormal performance trends and in discerning patterns that evolve over time. Typically, academic studies focus on periods of three to five years. However, by also measuring over a six-month period, we aim to explore the potential profitability of holding IPO stocks for shorter durations and to understand when investors who are prone to over-optimism begin to reevaluate their initial expectations.

5.4.1.2 Time-regime approach

Given that most prior studies on long-run performance, including works by Brav and Gompers (1997), Loughran and Ritter (2004), Schultz (2003) and Levis (2011), have employed the event-time approach, this study will also adopt the event-time method to measure risk-adjusted returns.

Additionally, we compute returns using calendar time, grouping IPOs into portfolios based on their year of flotation. For example, we might invest in a value-weighted share of

each IPO on the first trading day following the flotation. These daily returns are then compounded over various time frames, including 6 months, 1 year, 3 years, and 5 years. We also incorporate benchmarks to validate the robustness of our findings. Using calendar time, as opposed to event time, may potentially help us pinpoint periods of high and low market valuations. We explore whether companies that go public during peak periods experience inferior performance in the post-issue phase.

5.4.1.3 The inclusion of delisted stocks

Finally, we also consider delisted stocks in our study, regardless of the reason for delisting, to ensure a comprehensive and unbiased evaluation. If a stock is delisted, we reallocate its value at the delisting date among the remaining stocks in the portfolio, proportionate to their respective weights. Essentially, transactions are only executed in the event of a delisting.

In the calculations we combine all IPOs average monthly return to get the aggregated average monthly return. A month here is considered as 21 trading days. The first month's trading is adjusted if the period of initial return exceeds one day. In cases where a stock is delisted, we continue to include it in our analysis until the end of the month preceding its delisting. Bessembinder (2018) finds that the median lifetime buy-and-hold return for his sample of 9.187 delisted stocks in the U.S. stock market from 1926 to 2016 was -91,95%. Although, the skewness coefficient for lifetime returns is 55,0, which is comparable to those of still trading. And when a delisting occurs, both positive and negative share price reaction will happen.

5.4.2 Models

Generally, the academic community utilizes two methodologies for calculating long-run abnormal returns: Buy-And-Hold Returns (BHRs) and Cumulative Abnormal Returns (CARs). The selection between these methods often hinges on the assumed trading strategy.

In our analysis of long-run performance, we deliberately omit the initial return for two primary reasons. First, not every investor receives an allocation of shares during the IPO. Secondly, initial returns can be heavily influenced by short-term speculative behavior,

which may not align with the long-term fundamental value of the issuing company. By fundamental value[5] as opposed to the potentially volatile and speculative prices seen in initial returns. For instance, the initial market behavior can be disproportionately influenced by factors like investor sentiment, media attention, or market trends.

5.4.2.1 Buy-and-hold returns

The buy-and-hold returns model, commonly abbreviated as BHR-model, is a predominant method for assessing long-term abnormal returns. This model focuses on the geometric average return of a passive investment strategy. It is a way to calculate the average rate of return on an investment that is compounded over multiple periods where the we multiply the gross returns of the stock for each period from time t to T, thereby reflecting the compounding effect. This is indicative of the return an investor might expect if they were to reinvest dividends.

The formula for BHR is as follows:

$$R_{p,T} = \prod_{t=1}^{T}(1 + r_{p,t}) \tag{5.6}$$

Where $R_{p,T}$ represents the portfolio's BHR from the first trading day of the year after the flotation, over the chosen time horizon T.

Wealth-relative measure Following the methodology of Ritter and Welch (2002) and Bergström et al. (2006), we use a wealth-relative measure to compare returns against different benchmarks. This is calculated using the formula:

$$WR_{p,T} = \frac{R_{p,T}}{R_{b,T}} \tag{5.7}$$

Where $R_{b,T}$ is the daily compounded return of the benchmark over time T, and $WR_{p,T}$ is the wealth relative for portfolio p over the same time frame. Wealth relatives falling below one indicate that the IPO portfolio is underperforming the benchmark over the selected time horizon. We compute wealth relatives against all indices for the total market and for each market segment.

[5]Bergström et al. (2006) refers to a more stable and long-term perspective on the company's value.

5.4.2.2 Cumulative abnormal returns

The CAR-model, short for cumulative abnormal returns model, is another commonly utilized approach for gauging long-term abnormal returns. While it is not as widely adopted as the previously mentioned BHR model, it is extensively referenced in the literature reviewed in Section 5.3, including works by Ritter (1991), Levis (2011) and P. Gompers and Lerner (2001). A limitation of the CAR-method is the possibility of cumulative returns exceeding -100% from the initial investment. Despite this, CAR-calculations are useful for discerning performance trends and comparing different IPO groups.

Abnormal returns The formula for monthly abnormal return is given by:

$$ar_{i,t} = r_{i,t} - r_{b,t} \tag{5.8}$$

Where $ar_{i,t}$ represents the monthly abnormal return of IPO i and $r_{b,t}$ is the benchmark return for the period t.

Equally-weighted returns We opt for equally-weighted returns to highlight potential variances in management capabilities. This approach ensures that the long-run performance comparisons between PE- and VC-backed and non-sponsored IPOs are not influenced by average size differences. Instead, any performance disparities among these IPO categories can be ascribed to management. The abnormal return for an equally weighted portfolio is derived by summing the abnormal returns of n IPOs during the month t, as follows:

$$AREW_{p,t} = \frac{1}{n_p} \sum_{i=1}^{n_p} ar_{i,t} \tag{5.9}$$

Where $AREW_{p,t}$ is the equally weighted abnormal return for portfolio p in month t.

Value-weighted returns From an investor's standpoint, value weighting returns is more relevant as investors typically do not maintain equal value holdings of each stock in

a portfolio. The formula for value-weighted portfolio return is:

$$ARVW_{p,t} = \frac{1}{n_p} \sum_{i=1}^{n_p} w_i \times ar_{i,t} \tag{5.10}$$

Where w_i denotes the relative weight of stock i in portfolio p, and $ARVW_{p,t}$ is the value-weighted abnormal return of portfolio p in month t.

CAR-model The equal- and value-weighted monthly abnormal portfolio returns are then cumulatively calculated over the interval $t - T$ to determine the CAR for each weighting method:

$$CAR_{t-T} = \sum_{t=1}^{T} AR_t \tag{5.11}$$

5.4.3 Cross-sectional Regression model

We also make use of a cross-sectional regression with CAR-returns as dependent variable and market capitalization, year, sector, exchange and a dummy for hot market as explanatory variables.

The analysis is conducted on three different dependent variables, CAR.0.5Y, CAR.3Y, and CAR.5Y, each time looking at how the independent variables affect a different measure of the dependent variable, the abnormal returns over different time horizons (0.5 years, 3 years, and 5 years)

The equation for the regression is the following:

$$\begin{aligned} \text{CAR} =& \alpha + \beta_1 \times \text{PE} + \beta_2 \times \text{VC} + \beta_3 \times \text{NS} \\ &+ \beta_4 \times \ln(\text{Mcap}) + \beta_5 \times 2020 + \beta_6 \times 2014 \\ &+ \beta_7 \times \text{Health Care} + \beta_8 \times \text{Consumer Discretionary} \\ &+ \beta_9 \times \text{New York} + \beta_{10} \times \text{Hot Market} + \epsilon \end{aligned} \tag{5.12}$$

We make use of the same explanatory variables as in the regression of underpricing. This comparison helps in understanding whether the factors influencing initial underpricing

also play a role in the long-term performance of the IPOs. Furthermore, it can be useful when assessing whether the early performance (as indicated by underpricing) is a reliable predictor of long-term performance or if other factors become more significant over time.

5.5 Limitations and robustness

Each model utilized in this study has its own set of strengths and limitations, similar to any other models in use. These include factors like the choice between arithmetic and geometric means, and which biases may arise. This discussion aims to shed light on potential issues for consideration when interpreting results, rather than serving as a critique of the models themselves.

5.5.1 Geometric and arithmetic means

A central debate revolves around the choice between geometric and arithmetic means for calculating returns. This decision significantly influences the outcome of our models. The BHR-model employs geometric means, which are particularly effective in capturing the compound effect of returns over time. This approach is notable when there is a large positive return early in the holding period. Due to compounding, the BHR-model can demonstrate a substantial interest effect, as seen in the research by Barber and Lyon (1997) and Bessembinder (2018). This feature, while potentially leading to escalating returns, aligns closely with the real-world investment scenario, where investors may reinvest capital gains and dividends, thereby compounding their earnings.

On the other hand, the CAR-model utilizes arithmetic means, which may provide a straightforward average of returns but can be misleading over longer periods. One critical drawback of arithmetic means, as highlighted by Barber and Lyon (1997), is their sensitivity to volatility. In periods of high market volatility, arithmetic means tend to inflate, potentially overstating long-term returns. This is because they do not account for the compounding effects that are a cornerstone of investment growth.

Furthermore, the choice between these two means also depends on the time horizon of the investment. Geometric means, being more conservative, are generally more appropriate for longer-term investment analyses, as they mitigate the effects of short-term volatility and provide a more realistic view of long-term investment outcomes.

In contrast, arithmetic means might be more suitable for short-term or period-specific analyses where immediate fluctuations are of greater interest and the compounding effect is less pronounced. In summary, the BHR-model, with its emphasis on geometric means, offers a more conservative and arguably realistic portrayal of long-term investment returns, especially relevant in studies focusing on the long-term performance of IPOs.

5.5.2 Survivorship bias

The most significant bias in this study's long-run returns is likely survivorship bias. Brown and Ross (1992) explains this bias in performance studies, such as mutual funds, where only funds that have survived a long period are considered, excluding poorer performers and thus biasing estimates upwards. In our study, excluding returns from delisted firms could similarly introduce survivorship bias. This is addressed by including IPOs with shorter trading histories, as discussed in Section 4.3.1 regarding dataset quality.

5.6 Return metrics considerations

In evaluating abnormal performance through stock price movements, it is crucial to carefully select return metrics and understand how different methods of calculating returns and averages can influence outcomes. This study particularly examines the implications of using equally-weighted versus value-weighted averages, and the choice between simple and continuous returns.

The decision to use equally-weighted returns instead of value-weighted ones, based on firm size, can significantly affect the measurement of abnormal returns, with each method having drawbacks. Following Levis (2011), market capitalization will be used as the size proxy, a forward-looking indicator of a firm's value that is presumed to incorporate more information than backward-looking, accounting-based metrics like balance sheet size, which can be more subjective depending on the business type.

Loughran and Ritter (2004) suggest that if smaller firms are more susceptible to misvaluation, value-weighted returns would likely show abnormal returns more frequently. Conversely, if significant misvaluations are concentrated in a few large firms, this could lead to high variance and low statistical power in a value-weighted approach where these few firms dominate the sample. Brav and Gompers (1997) also note that long-run

underperformance is often confined to a small number of firms, and the results are sensitive to how sample returns are weighted. The influence of the chosen weighting method thus depends on the characteristics of the firms in the sample. Given that smaller firms tend to have more volatile stock prices, and thus are more prone to misvaluation, abnormal returns are expected to be more pronounced in an equally-weighted sample. Accordingly, this study will also focus on value-weighted returns.

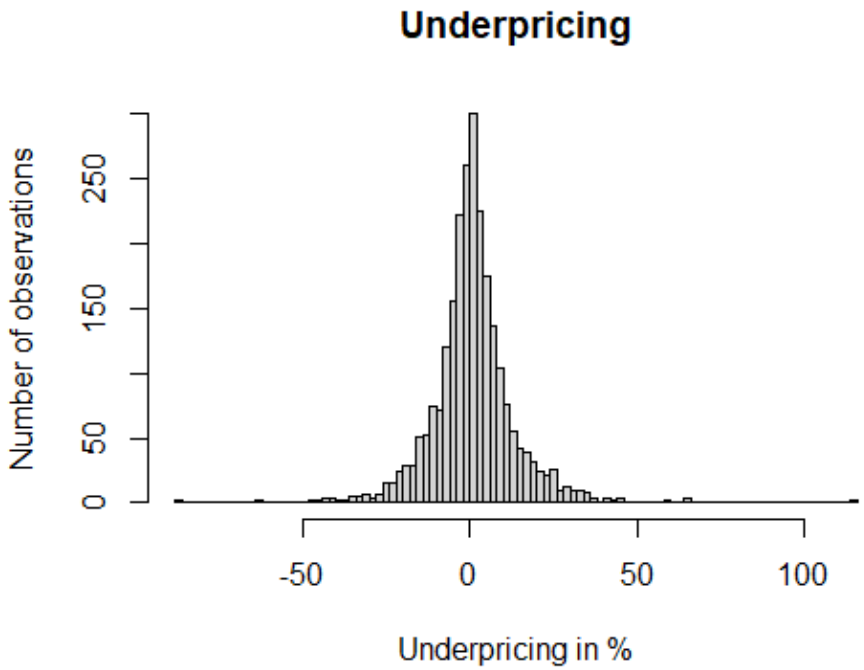
6 Analysis and Discussion

In the following chapter, the descriptive statistics and empirical results are presented. We will also discuss the implications of our empirical findings.

6.1 Underpricing

Based on previous literature, we expect private equity-backed IPOs to exhibit reduced underpricing compared to non-sponsored IPOs. This is largely due to the certifying role of PE- and VC-firms, which enhances transparency and mitigates adverse selection issues by reducing asymmetric information, as presented in Chapter 3. Furthermore, we expect larger IPOs, in terms of market capitalization, to exhibit lower degrees of underpricing. Figure 6.1 is a histogram that shows the distribution of the underpricing across our dataset.

Figure 6.1: Underpricing - histogram



Note: *Distribution of underpricing*

6.1.1 Across years

6.1.1.1 Equally-weighted

Table 6.1 shows that PE- and VC-backed IPOs, on average, exhibit underpricing of 1,17% and 0,97%, respectively. In contrast, non-sponsored IPOs (NS) demonstrated an average negative underpricing (overpricing) of -0,04%.

Table 6.1: Equally-weighted underpricing across years

Year	PE	VC	NS	Total
2000	-1,81 %	3,45 %	4,77 %	2,14 %
2001	-1,02 %	8,31 %	3,83 %	3,71 %
2002	1,52 %	3,16 %	1,26 %	1,98 %
2003	2,69 %	-2,23 %	2,59 %	1,01 %
2004	1,91 %	2,73 %	0,96 %	1,87 %
2005	1,14 %	1,37 %	1,92 %	1,48 %
2006	0,77 %	1,68 %	2,55 %	1,67 %
2007	1,54 %	3,92 %	1,10 %	2,19 %
2008	11,66 %	1,95 %	-3,14 %	3,49 %
2009	-1,32 %	1,67 %	-0,60 %	-0,08 %
2010	2,14 %	2,48 %	-0,86 %	1,25 %
2011	-0,47 %	-0,35 %	0,02 %	-0,27 %
2012	1,31 %	0,16 %	-0,60 %	0,29 %
2013	2,61 %	1,70 %	1,35 %	1,89 %
2014	-0,06 %	1,72 %	0,09 %	0,58 %
2015	0,92 %	1,51 %	-4,37 %	-0,65 %
2016	-0,39 %	0,55 %	-2,18 %	-0,68 %
2017	-0,27 %	-2,05 %	-0,07 %	-0,80 %
2018	-0,47 %	-0,46 %	1,97 %	0,35 %
2019	2,80 %	3,37 %	0,53 %	2,23 %
2020	-0,55 %	0,67 %	1,10 %	0,41 %
2021	0,27 %	-1,33 %	0,75 %	-0,11 %
2022	2,03 %	-11,62 %	-13,95 %	-7,85 %
Total	**1,17 %**	**0,97 %**	**-0,04 %**	**0,70 %**

The exhibit also displays substantial yearly fluctuations in underpricing across all sponsorship types. For example, in 2022, VC and non-sponsored NS IPOs exhibited negative underpricing, indicating substantial overpricing, whilst PE-backed exhibit some underpricing. The year of 2008, during the financial crisis, saw the highest recorded underpricing for PE-backed IPOs, likely due to negative market sentiment and a conservative pricing. However, it is essential to see these figures against the backdrop of the number of IPOs each year (See Table 4.3). For example, the extreme values observed

in certain years, like 2008[6], corresponded with a lower number of IPOs.

6.1.1.2 Value-weighted

Table 6.2 presents an overview of the value-weighted underpricing, where both PE- and VC-backed IPOs demonstrate less underpricing than non-sponsored IPOs.

Table 6.2: Value-weighted underpricing across years

Year	PE	VC	NS
2000	-3,11 %	-21,88 %	3,58 %
2001	1,10 %	7,47 %	0,42 %
2002	3,31 %	5,06 %	1,33 %
2003	3,60 %	-2,46 %	1,00 %
2004	2,77 %	2,56 %	4,12 %
2005	2,05 %	-0,69 %	3,84 %
2006	3,32 %	1,30 %	3,92 %
2007	3,23 %	4,77 %	-1,92 %
2008	17,01 %	5,72 %	-1,99 %
2009	0,64 %	0,12 %	0,97 %
2010	2,93 %	6,08 %	-3,50 %
2011	0,15 %	-0,80 %	-1,07 %
2012	1,34 %	-4,70 %	-3,29 %
2013	1,14 %	0,79 %	0,31 %
2014	0,07 %	0,50 %	2,89 %
2015	0,06 %	1,82 %	-5,61 %
2016	0,26 %	9,47 %	-1,79 %
2017	2,18 %	0,55 %	-3,87 %
2018	-0,40 %	2,29 %	3,46 %
2019	2,78 %	-1,11 %	-1,95 %
2020	-2,06 %	4,43 %	6,61 %
2021	1,25 %	-3,12 %	6,28 %
2022	1,94 %	-8,23 %	7,35 %
Total	**0,61 %**	**-1,41 %**	**2,46 %**

When analyzing the underpricing from a value-weighted perspective, we observe that PE-backed IPOs generally exhibit lower underpricing, aligning with our initial assumptions. However, VC-backed IPOs present a higher degree of overpricing compared to the equally-weighted approach. Notably, the year 2000 experienced a large number of IPOs, characterized by substantial overpricing in VC-backed IPOs[7]. When adjusting for this year, the average underpricing for VC-backed IPOs adjusts to 0,91%. In contrast, non-sponsored

[6]Only 14 IPOs in 2008, compared to the median of 101 across all years
[7]VC-backed IPOs stood for 106 of the 209 IPOs in 2000

IPOs display a pronounced tendency towards higher underpricing when viewed through a value-weighting lens.

In 2008, the underpricing for PE-backed IPOs soared to 17,01%. However, it is important to note that there was only two PE-backed IPOs in 2008[8], where both experienced substantial underpricing [9]. This highlights the potential skewing effect of a small sample size on year-specific data.

Summarizing the descriptive statistics, the overall value-weighted average underpricing for PE-backed IPOs was 0,61%, indicating a general trend towards overpricing. VC-backed IPOs exhibit negative underpricing (overpricing) at -1,41%, whereas non-sponsored IPOs show an average underpricing of 2,46%.

6.1.2 Across industries

We also looked at the underpricing across industries to adjust for industry characteristics. Table 6.3 shows the mean and median market capitalization across industries.

6.1.2.1 Equally-weighted

Table 6.4 reveals considerable variance in underpricing across the sectors, with consumer discretionary, financials, and information technology experiencing the highest average underpricing across all classes. Information technology shows an average underpricing for PE-backed IPOs at 3,57%. Furthermore, PE-backed IPOs within utilities and consumer staples exhibits a negative underpricing (overpricing) of -5,93% and -10,11%, respectively, while non-sponsored IPOs conversely exhibits substantial underpricing at 4,32% and 12,32%, respectively.

6.1.2.2 Value-weighted

Consumer discretionary exhibit substantial overpricing for VC-backed-IPOs at -14,25%, whilst VC-backed IPOs within consumer staples exhibit substantial underpricing at 18,04%. VC-backed IPOs in sectors like energy and information techonology also exhibits overpricing of -5,70% and -12,41%, respectively. In fact, information technology was the

[8] 2 of 14 IPOs.
[9] see volume distribution in Table 4.3

Table 6.3: Mean, median and total market capitalization across industries

Sector	Commun-ication	Consumer discretionary	Consumer staples	Energy	Financials	Health care	Industrials	Information technology	Materials	Utilities
PE										
Mean	2 825	1 570	1 612	2 311	2 111	2 040	3 146	1 358	1 509	3 090
Median	840	703	1 364	1 196	781	677	1 317	717	847	990
Total	**36 724**	**166 379**	**30 620**	**92 458**	**135 087**	**161 135**	**547 363**	**76 060**	**76 945**	**43 256**
VC										
Mean	1 200	3 338	1 853	2 384	1 035	661	3 497	1 604	479	558
Median	600	698	342	246	421	370	659	426	308	558
Total	**25 202**	**133 513**	**9 266**	**7 152**	**27 942**	**367 320**	**1 283 383**	**158 782**	**1 437**	**558**
NS										
Mean	14 297	1 245	2 065	742	1 716	835	1 659	1244	1 541	2 031
Median	3 306	342	772	362	343	186	369	369	398	1 689
Total	**85 779**	**89 668**	**41 302**	**25 967**	**269 385**	**141 877**	**331 829**	**78 397**	**44 697**	**38 582**

Table 6.4: Equally-weighted underpricing across industry

Industry	**PE**	**VC**	**NS**	**Total**
Communication	0,57 %	-4,14 %	-4,55 %	-2,71 %
Consumer Discretionary	1,36 %	2,42 %	2,08 %	1,95 %
Consumer Staples	-10,11 %	0,61 %	12,32 %	0,94 %
Energy	0,86 %	-0,79 %	-12,51 %	-4,15 %
Financials	1,89 %	1,14 %	3,36 %	2,13 %
Health Care	-0,82 %	1,37 %	0,59 %	0,38 %
Industrials	0,66 %	0,11 %	1,95 %	0,91 %
Information Technology	3,57 %	0,01 %	1,44 %	1,67 %
Materials	-1,85 %	1,80 %	1,74 %	0,56 %
Utilities	-5,93 %	-1,77 %	4,32 %	-1,13 %
Total	**-0,98 %**	**0,08 %**	**1,07 %**	

sector where non-sponsored IPOs exhibited the highest underpricing.

Table 6.5: Value-weighted underpricing across industries

	Underpricing			% of total market capitalization		
Industry	**PE**	**VC**	**NS**	**PE**	**VC**	**NS**
Communication	2,54 %	1,75 %	-2,30 %	24,9 %	17,1 %	58,1 %
Consumer Discretionary	3,91 %	-14,25 %	2,66 %	42,7 %	34,3 %	23,0 %
Consumer Staples	1,24 %	18,04 %	-1,11 %	37,7 %	11,4 %	50,9 %
Energy	-1,29 %	-5,70 %	-0,87 %	73,6 %	5,7 %	20,7 %
Financials	1,66 %	4,89 %	5,18 %	31,2 %	6,5 %	62,3 %
Health Care	2,23 %	1,49 %	2,06 %	24,0 %	54,8 %	21,2 %
Industrials	-0,99 %	0,13 %	1,74 %	25,3 %	59,3 %	15,3 %
Information Technology	0,18 %	-12,41 %	6,00 %	24,3 %	50,7 %	25,0 %
Materials	2,00 %	3,94 %	3,89 %	62,5 %	1,2 %	36,3 %
Utilities	-0,82 %	4,32 %	-1,36 %	52,5 %	0,7 %	46,8 %
Total	**0,61%**	**-1,41%**	**2,46%**			

6.1.3 Across market segments

The different characteristics of NYSE and Nasdaq in terms of entry requirements and size, may cause varying underpricing patterns. We therefore analyze each exchange separately below.

6.1.3.1 Equally-weighted

When equally-weighting, PE-backed IPOs show an underpricing of 0,67% on Nasdaq and 0,79% on NYSE, with a total average of 0,73%. VC-backed IPOs demonstrate a higher underpricing than PE-backed, with 1,06% on Nasdaq and 1,65% on NYSE, totaling to

Table 6.6: Underpricing across market segment

	PE	VC	NS
Equally-weighted			
Nasdaq	0,67 %	1,06 %	0,01 %
NYSE	0,79 %	1,65 %	1,24 %
Total	**0,73 %**	**1,35 %**	**0,63 %**
Value-weighted			
Nasdaq	0,37 %	-1,35 %	2,45 %
NYSE	0,77 %	-1,51 %	2,48 %
Total	**0,61** %	**-1,44** %	**2,46** %

1,35%. Non-sponsored IPOs have an almost negligible underpricing on Nasdaq of 0,01% and a higher rate on NYSE with 1,24%, leading to a total of 0,63%.

6.1.3.2 Value-weighted

For the value-weighted underpricing, PE-backed IPOs exhibit an underpricing of 0,37% on Nasdaq and 0,77% on NYSE, averaging to 0,57%. VC-backed IPOs show negative underpricing (overpricing) of -1,35% on Nasdaq and -1,51% on NYSE, indicating that, on average, VC-backed IPOs were priced above the market value on these exchanges. The total average is -1,43%. Non-sponsored IPOs are underpriced at 2,45% on Nasdaq and 2,48% on NYSE, with a total of 2,47%.

6.1.4 Hot markets

We look closer at the underpricing in times of different market regimes, up/"hot" and down/"cold" markets. Since January 2000 we can from Figure 6.2 see the development of the Nasdaq and NYSE composite and its 200-day moving average. The average underpricing in each period and market are listed in Table 6.7.

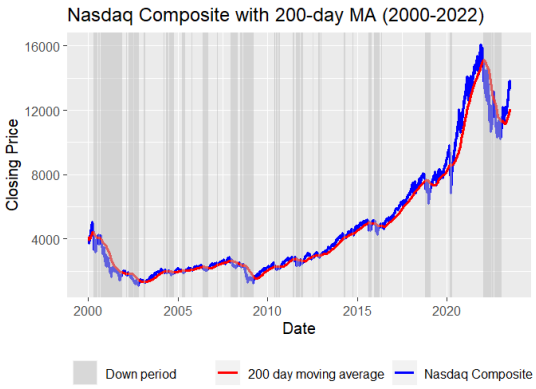
Table 6.7: Average underpricing in hot and cold markets

State of market	Nasdaq	NYSE
Hot	0,86%	0,91%
Cold	0,34%	0,16%

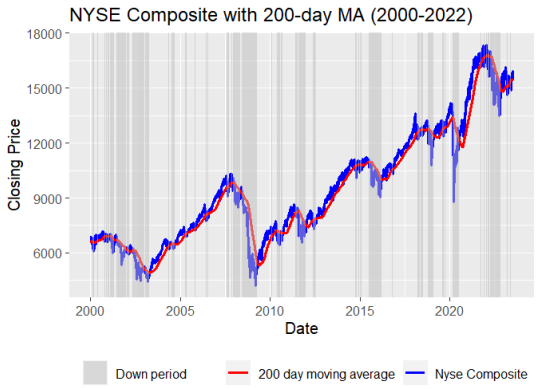
The analysis of underpricing based on market trends reveals that the average underpricing when Nasdaq is hot is 0,86%, while it is 0,34% during down-periods. When NYSE Composite is "hot", the average underpricing is 0,91% and 0,16% during a down period.

Figure 6.2: Hot and cold market periods from 2000-2022

(a) Nasdaq - 200 day MA



(b) NYSE - 200 day MA



Note: *The dark gray shading indicates periods defined as cold market, where the composite-indices is below its 200-day average, and the light gray is when the market is hot, where the composite-indices is above its 200-day average. As expected, we note cold markets at the time of the global financial crisis and the COVID-19 crisis, among others. In the sample there is a total of 194 (89) and 188 (95) hot(cold)-periods out of the 283 months in total, for Nasdaq and NYSE, respectively.*

These results suggest that the average underpricing for IPOs tends to be higher when the composites are trading above the 200-day moving average, compared to when they are trading below. This could indicate a relationship between market positivity and increased underpricing of IPOs.

6.1.4.1 The use of IPO windows

Table 6.8 illustrates the distribution of IPOs across ten size-portfolios, sponsortype and the proportion of the IPOs in its size portfolio launched in a hot market. We divide the IPOs into deciles based on market capitalization at the time of the IPO, ranging from the smallest firms in Portfolio 1 to the largest firms in Portfolio 10. Comparing the listing of size-adjusted portfolios between sponsored and non-sponsored IPOs within market tendencies may provide insight into how the sponsor types use market windows. Furthermore, Figure 6.3 show the proportions of IPOs floated by the sponsor types during up and down periods.

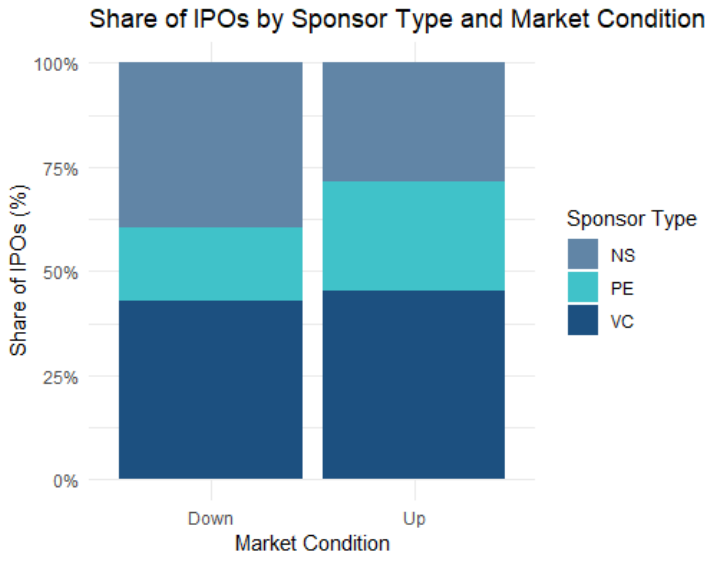
As we note that 69% and 66% of the 283 months in our dataset are characterized as hot-periods on Nasdaq and NYSE Composite, respectively. If hot-market factors did not affect the launching decision, the listing proportion should be approximately the same across different market states. However, for PE- and VC- backed IPOs, it appears that the

Table 6.8: Number of IPOs across size portfolios and proportion in hot market

	Size range	Number of IPOs			Proportion in hot market		
Portfolio	**(USDm)**	**PE**	**VC**	**NS**	**PE**	**VC**	**NS**
1	0-62	21	106	121	78 %	57 %	65 %
2	62-131	24	97	107	75 %	68 %	76 %
3	131-219	36	163	91	84 %	76 %	74 %
4	219-335	55	148	15	67 %	81 %	74 %
5	335-464	53	111	84	79 %	85 %	77 %
6	464-692	67	115	66	86 %	84 %	73 %
7	692-1 059	72	108	78	90 %	86 %	75 %
8	1 059-1 743	88	80	70	91 %	91 %	75 %
9	1 743-3 403	99	77	62	89 %	78 %	70 %
10	3 403-87 561	96	71	71	89 %	92 %	72 %

larger the market capitalization, the higher the proportion of IPOs listed in hot markets. PE-backed IPOs seem to follow the most consistent pattern, while non-sponsored IPOs are quite consistent overall. In the size portfolios from 7 to 10, the proportion is ~90% for both PE- and VC-backed. Furthermore, Figure 6.3 exhibits that there is proportionally more PE-backed IPOs in a hot market, whereas there is proportionally fewer non-sponsored IPOs in a hot market. The proportion of VC-backed IPOs does not exhibit a remarkable difference in the two market states.

Figure 6.3: Share of IPOs by sponsor type and market condition



6.1.5 Cross-sectional regression

We made use of a cross-sectional regression with underpricing as dependent variable and market capitalization, year, sector, exchange and a dummy for hot market as explanatory variables.

The exhibit does not document evidence of the underpricing phenomenon we expected. Market capitalization is the only explanatory variable that has a statistically significant positive effect on underpricing, indicating that larger IPOs are subject to more underpricing. In all three models, a 1% increase in market capitalization, the model predicts that underpricing increases with 0,011% and this result is highly statistically significant at a 1% significance level.

We run several other regressions including all industries, year and interaction variables of the sponsorship and size, with no change in results. We also acknowledge that the coefficient of determination, R^2 , is low. Note that these interpretations assume that assumptions for cross-sectional regression are met, including linearity. Tests for robustness can be found in the appendix (Figure B.1), and suggest we should exercise caution when drawing conclusions from our model. We conclude that we should be careful with drawing inference from the regression, and that higher market capitalization might lead to higher underpricing.

6.1.6 Discussion

We expected less underpricing among private equity actors and found no empirical support to suggest that sponsor type affects underpricing. In fact, exchange, year, sector, and listing in a hot market did not seem to affect underpricing either. The only statistically significant finding is that market capitalization influences underpricing positively, suggesting larger market capitalization may increase underpricing. However, our robustness analysis in Figure B.1 suggests we should be very careful interpreting these results.

The fact that market capitalization may increase underpricing poses as a supporting relationship to our background discussion and hypothesis. Considering PE-backed IPOs are generally larger in size[10], they may need to use underpricing when issuing a large

[10]In our sample, PE-backed IPOs had a mean market capitalization of USD 2.048m, compared to USD 1.264m and USD 1.550m for VC-backed and non-sponsored IPOs, respectively.

Table 6.9: Cross-sectional regression on underpricing

	Dependent variable:		
	Underpricing		
	(1)	(2)	(3)
PE	−0.010		
	(0.007)		
VC		0.009	
		(0.006)	
NS			−0.002
			(0.007)
ln(Mcap)	0.011***	0.011***	0.011***
	(0.002)	(0.002)	(0.002)
2020	−0.013	−0.012	−0.012
	(0.012)	(0.012)	(0.012)
2014	0.001	0.0003	0.001
	(0.012)	(0.012)	(0.012)
Health Care	−0.001	−0.003	−0.0003
	(0.007)	(0.007)	(0.007)
Consumer Discretionary	0.015	0.014	0.013
	(0.011)	(0.011)	(0.011)
NYSE	−0.007	−0.007	−0.009
	(0.007)	(0.007)	(0.007)
Hot market	−0.003	−0.004	−0.004
	(0.007)	(0.007)	(0.007)
Constant	−0.054***	−0.057***	−0.052***
	(0.013)	(0.013)	(0.014)
Observations	2,509	2,509	2,509
R^2	0.014	0.014	0.013
Adjusted R^2	0.010	0.011	0.010
Residual Std. Error (df = 2500)	0.147	0.147	0.147
F Statistic (df = 8; 2500)	4.316***	4.351***	4.099***
Note:			*p<0.1; **p<0.05; ***p<0.01

number of stocks to finalize the listing, although a (fully) exiting firm would want to minimize underpricing to maximize the return.

J. Cao (2008) found that private equity firms normally keep a significant ownership fraction (overhang fraction) after flotation, which is especially true for relatively larger firms, in terms of market capitalization, which Bradley and Jordan (2002) found tends to increase underpricing. Hence, our findings may support Schöber (2008)'s distribution overhang theory[11]. Increased overhang fraction conversely reduces issue size, and as larger market capitalizations tend to have a higher overhang fraction, this leads towards increased use of underpricing, in line with our model findings. This may suggest that the urge to underprice larger listings may offset the reduced underpricing effect from reduced ex-ante uncertainty by larger firms attracting more publicity, analyst coverage, and increased transparency from private equity firms on their portfolio companies pre-IPO (Bergström et al., 2006).

In addition, we found that there are proportionally more PE-backed IPOs in a hot market, while the proportion of non-sponsored diminished and the proportion of VC-backed IPOs stayed relatively consistent through the market states (Figure 6.3). We furthermore note that PE-backed company listings tend to be larger in size (Table 6.8), and that the proportion of IPOs listed in hot markets seems to increase with market capitalization. This finding opposes Bergström et al. (2006)'s research, which states that PE-firms are not taking portfolio firms public during years associated with large IPO activity. Regarding underpricing, this may suggest the issuing firm must increase underpricing to ensure book covering.

Also, from our discussion regarding underwriters' incentives (Section 2.2.4.1): Larger IPO issuers may underprice more aggressively to ensure book covering (Bergström et al., 2006; J. Berk & DeMarzo, 2013), including the fact that large IPOs may need a higher degree of information acquisitions which increases underpricing (Binay et al., 2007). An issuing firm may also use underpricing to signalize themselves as high-quality, which is expected from PE-backed and large firms (in terms of market capitalization) (Bergström et al., 2006).

[11]Schöber (2008) suggest that the selling private equity firm may use underpricing to compensate for later divestment and that they would not take harm from the underpricing themselves.

6.2 Long-term performance

In the second part of our analysis, we look at the long-run performance of PE- and VC-backed IPOs, compared to non-sponsored IPOs. We expect private equity-backed IPOs to perform better long-term than their non-sponsored counterparts due to less diverging investor opinions and better operationals, suggesting that they experience less price adjustments in the aftermarket.

6.2.1 Buy-and-hold returns

Buy-and-hold returns (BHR) represents the return an investor would have received if they purchased shares at the time of the IPO and held them over the specified time periods. Positive percentages indicate a gain, while negative percentages indicate a loss relative to the investments' initial value. Furthermore, wealth relative compares the performance of the IPOs the market index. A value greater than 1 suggests that the IPOs outperformed the benchmark, while a value less than 1 indicates underperformance.

6.2.1.1 PE

Table 6.10 show the buy-and-hold returns (BHR) and wealth relatives for PE-backed IPOs over various time horizons, broken down by year from 2000 to 2022.

The wealth relative figures fluctuate over the years, with certain years showing strong outperformance (e.g., 1.44 in the 6-month period of 2000) and others showing underperformance (e.g., 0,53 in the 5-year period of 2019). The years following the dot-com bubble (2000-2002) show high initial returns for PE-backed IPOs, which might reflect the market's correction from the bubble's burst. The financial crisis in 2007/2008 seems to have had a delayed negative impact on the 1-year and 3-year holds for PE-backed IPOs, as seen in the negative returns in 2008 and 2009.

Overall, the data indicates that PE-backed IPOs performance is not uniform across time horizons or market conditions. While there have been periods of outperformance, particularly in the short term, the long-term performance is more varied.

Table 6.10: PE - Performance in calendar time

	Buy-and-hold returns				Wealth relative			
	6m	**1y**	**3y**	**5y**	**6m**	**1y**	**3y**	**5y**
2000	27,88 %	0,09 %	-24,23 %	1,26 %	1,44	1,56	1,59	1,54
2001	-35,84 %	-48,51 %	1,21 %	38,79 %	0,68	0,68	1,12	1,39
2002	146,85 %	223,91 %	73,70 %	197,20 %	2,90	3,51	1,42	3,13
2003	-2,97 %	-12,34 %	10,04 %	0,04 %	0,89	0,79	0,86	0,61
2004	82,21 %	130,30 %	128,19 %	31,88 %	1,80	2,19	2,10	1,03
2005	22,73 %	19,57 %	25,66 %	18,00 %	1,18	1,10	0,99	1,41
2006	10,44 %	16,07 %	-26,19 %	-3,75 %	1,07	1,07	0,68	1,07
2007	7,05 %	-8,90 %	9,40 %	73,83 %	1,11	0,98	1,54	2,06
2008	15,08 %	39,75 %	18,89 %	220,22 %	0,99	1,05	0,67	1,51
2009	20,54 %	15,75 %	68,86 %	122,12 %	1,14	1,16	1,70	1,99
2010	10,77 %	3,12 %	40,83 %	128,10 %	1,01	0,94	1,21	1,52
2011	-9,57 %	-0,37 %	46,38 %	40,35 %	0,94	1,06	1,26	1,03
2012	17,01 %	35,81 %	79,52 %	131,03 %	1,18	1,31	1,37	1,80
2013	15,04 %	8,14 %	18,20 %	23,12 %	1,08	0,96	1,04	1,03
2014	2,20 %	-4,76 %	9,55 %	19,60 %	0,98	0,90	1,09	1,03
2015	5,28 %	-0,17 %	34,83 %	54,88 %	1,12	1,06	1,22	1,77
2016	9,77 %	20,03 %	26,57 %	64,07 %	1,05	1,11	1,10	1,53
2017	-9,44 %	-4,42 %	11,05 %	14,05 %	0,86	0,87	1,00	0,92
2018	12,52 %	10,53 %	26,44 %		1,16	1,13	1,21	
2019	9,16 %	19,24 %	-23,17 %		1,08	1,12	0,53	
2020	38,66 %	67,76 %			1,19	1,33		
2021	9,75 %	-21,95 %			1,07	0,77		
2022	-21,60 %				0,74			

Note: *The figures must be seen in combination with volume distribution in Table 4.3.*

6.2.1.2 VC

Table 6.12 display the buy-and-hold returns as well as wealth relative figures for VC-backed IPOs over various time horizons.

The early 2000s show substantial negative returns for VC-backed IPOs at the 6-month and 1-year marks, possibly due to the aftermath of the dot-com bubble burst. An exceptional increase in returns is observed in 2008 at the 3-year and 5-year marks, which could reflect a few highly successful IPOs or a general recovery after financial crisis. Recent years, such as 2017-2022, demonstrate a mix of positive and negative short-term returns, with some years like 2019 showing substantial positive performance at longer horizons.

In the early 2000s, wealth relative values are mostly below 1, reflecting underperformance compared to the market, which aligns with the negative buy-and-hold returns observed. The years 2008-2009 show substantially high wealth relative values, especially at the

Table 6.11: VC - Performance in calendar time

	Buy-and-hold returns				Wealth relative			
	6m	**1y**	**3y**	**5y**	**6m**	**1y**	**3y**	**5y**
2000	-13,73 %	-61,81 %	-56,89 %	-33,42 %	1,10	0,54	0,46	0,74
2001	-18,73 %	-27,06 %	18,42 %	-1,42 %	0,93	0,94	1,65	1,01
2002	-4,27 %	12,90 %	62,60 %	118,73 %	1,18	1,36	1,75	2,37
2003	4,10 %	41,76 %	54,07 %	-18,58 %	0,97	1,38	1,30	0,45
2004	0,01 %	-13,76 %	29,36 %	2,46 %	0,96	0,79	1,12	0,74
2005	3,47 %	20,80 %	5,05 %	-8,77 %	0,96	1,17	0,85	1,15
2006	-3,33 %	29,95 %	-15,10 %	21,53 %	0,93	1,19	0,99	1,47
2007	-4,44 %	-24,52 %	-11,07 %	30,94 %	0,94	0,80	1,28	1,52
2008	151,43 %	530,03 %	1307,56 %	2011,44 %	3,59	9,64	33,52	45,89
2009	-5,63 %	34,73 %	30,68 %	113,88 %	0,83	1,19	1,03	1,40
2010	3,33 %	10,30 %	72,09 %	203,69 %	0,94	0,95	1,40	1,82
2011	-27,90 %	-47,34 %	6,03 %	-21,23 %	0,81	0,54	0,89	0,54
2012	-23,45 %	-24,85 %	30,99 %	208,26 %	0,71	0,67	0,88	1,79
2013	-6,15 %	-42,34 %	-30,78 %	30,74 %	0,88	0,51	0,59	1,10
2014	-3,98 %	-4,98 %	-5,57 %	-4,03 %	0,92	0,89	0,88	0,72
2015	17,63 %	0,55 %	160,59 %	416,66 %	1,22	1,03	2,18	3,93
2016	-10,92 %	4,89 %	94,17 %	399,84 %	0,84	0,90	1,51	4,04
2017	-14,43 %	7,24 %	41,78 %	79,68 %	0,83	0,96	1,19	1,40
2018	-9,02 %	12,34 %	248,10 %		0,89	1,14	2,68	
2019	-14,38 %	30,15 %	6,74 %		0,82	1,18	0,70	
2020	-31,11 %	0,29 %			0,61	0,81		
2021	-14,49 %	-31,06 %			0,82	0,73		
2022	-31,17 %				0,76			

Note: *The figures must be seen in combination with volume distribution in Table 4.3.*

5-year mark, implying that VC-backed IPOs greatly outperformed the market average.

A clear trend is not evident throughout the years where the wealth relative suggests that the market performance of VC-backed IPOs can vary substantially from the market average.

6.2.1.3 Non-sponsored

Table 6.12 displays the buy-and-hold returns and wealth relative figures for non-sponsored IPOs.

The early 2000s show mixed results with large variability. For instance, 2000 starts with strong positive short-term returns, which suggests a favorable market response to non-sponsored IPOs during that period. The financial crisis period around 2008 is characterized by negative short-term returns, but recovery in the medium to long term, potentially indicating resilience or delayed growth potential in non-sponsored IPOs. More recent years like 2019-2021 show a mix of positive and negative short-term returns.

Across the years, wealth relative figures above 1,00 in several periods signify that non-sponsored IPOs outperformed the market benchmark, particularly in the long term and from 2000-2002. In 2008, despite short-term underperformance, the 5-year wealth relative is substantially above 1, highlighting that non-sponsored IPOs from that period outperformed the market over time.

The table indicates the short-term performance of non-sponsored IPOs is variable and often below the benchmark, however the long-term performance is generally more positive.

6.2.2 Cumulative abnormal returns

This section summarizes the long-term performance of IPOs, categorized by the type of sponsorship. The performance is measured by cumulative abnormal returns (CAR), using both equally-weighted and value-weighted averages, over different time horizons: 6 months and 1, 3 and 5 years.

Table 6.12: Non-sponsored - Performance in calendar time

	Buy-and-hold returns				Wealth relative			
	6m	**1y**	**3y**	**5y**	**6m**	**1y**	**3y**	**5y**
2000	66,91 %	42,87 %	-2,33 %	38,58 %	1,92	2,14	2,36	2,79
2001	0,31 %	-24,58 %	13,96 %	58,69 %	1,06	0,87	1,17	1,42
2002	-11,24 %	5,36 %	110,12 %	105,28 %	1,08	1,22	2,47	2,41
2003	5,07 %	11,57 %	14,35 %	-35,79 %	0,94	1,01	0,88	0,40
2004	11,15 %	66,42 %	144,87 %	76,51 %	1,03	1,62	2,19	1,46
2005	7,26 %	47,08 %	42,13 %	55,66 %	1,01	1,39	1,17	1,97
2006	-0,35 %	101,45 %	46,20 %	100,43 %	0,95	1,82	1,71	2,34
2007	71,32 %	-5,75 %	57,49 %	36,79 %	1,85	1,01	2,28	1,58
2008	3,77 %	-5,92 %	16,13 %	138,50 %	1,05	1,46	1,33	2,74
2009	55,47 %	55,93 %	139,27 %	102,30 %	1,49	1,39	1,85	1,59
2010	-9,91 %	-31,36 %	12,48 %	7,21 %	0,83	0,64	1,01	0,75
2011	-42,97 %	-18,10 %	19,25 %	-28,09 %	0,53	0,78	0,89	0,45
2012	-3,71 %	-3,02 %	12,88 %	20,99 %	0,93	0,90	0,86	1,03
2013	-29,82 %	-32,58 %	-0,02 %	57,12 %	0,65	0,60	0,81	1,29
2014	61,11 %	36,57 %	60,57 %	35,20 %	1,58	1,30	1,60	1,17
2015	13,55 %	-3,72 %	-18,28 %	-15,78 %	1,13	1,01	0,63	0,56
2016	-2,10 %	183,52 %	-8,68 %	42,14 %	0,92	2,54	0,67	1,01
2017	58,01 %	-4,87 %	64,04 %	143,27 %	1,53	0,84	1,46	1,87
2018	-8,64 %	-20,01 %	10,11 %		0,93	0,81	0,98	
2019	-12,80 %	11,73 %	-20,25 %		0,85	1,04	0,53	
2020	50,69 %	3,73 %			1,33	0,81		
2021	15,14 %	321,73 %			1,19	5,34		
2022	-11,21 %				0,93			

Note: *The figures must be seen in combination with volume distribution in Table 4.3.*

6.2.2.1 Equally-weighted

Table 6.13 shows that PE-backed IPOs consistently show higher abnormal returns across all time horizons compared to VC-backed and non-sponsored IPOs. VC-backed IPOs show a substantial increase in abnormal returns from the 3-year mark to the 5-year mark, indicating that these IPOs may take longer to realize their full potential compared to PE-backed IPOs. Non-sponsored IPOs have the lowest abnormal returns in the shorter time frames (6 months and 1 year), but show an increase at the 3-year mark. However, their performance drops again at the 5-year mark.

Table 6.13: Equally-weighted long-term CARs by backing

	6m CAR	**1y CAR**	**3y CAR**	**5y CAR**
PE	12,01 %	18,55 %	28,82 %	47,00 %
VC	2,98 %	6,58 %	25,28 %	63,92 %
NS	5,18 %	9,74 %	17,34 %	11,09 %

Table 6.14 summarizes the CARs for different industry sectors, segmented by the type of IPO sponsorship for different time frames post-IPO.

In summary, the table indicates that industry and sponsor type may affect aftermarket-performance over various time frames. Notably, VC-backed IPOs in certain sectors (e.g., consumer discretionary) show high long-term CARs, suggesting substantial growth. PE-backed IPOs generally show strong performance, while non-sponsored IPOs exhibit a mixed pattern. It suggests that while PE-backing generally indicates stronger early post-IPO performance, whereas VC-backing may yield higher returns in the long run, albeit with more pronounced volatility. Non-sponsored IPOs, while showing mixed results, often exhibit stable long-term growth.

Table 6.15 present the long-term performance of IPOs segmented by market exchange and type of sponsorship when equally-weighting the returns. The performance is evaluated based on CARs over various time periods post-IPO.

PE-backed IPOs on Nasdaq exhibit robust performance throughout all observed time periods, with notably high returns at the 5-year mark. NYSE paints a similar picture, where PE-backed IPOs show substantial growth over time, with an high 5-year CAR.

VC-backed IPOs on Nasdaq also perform positively, but show less pronounced returns compared to their PE-counterparts. On NYSE, the VC-backed IPOs initially underperform,

Table 6.14: Equally-weighted long-term CARs across industries

	PE				VC				NS			
Sector	**6m**	**1y**	**3y**	**5y**	**6m**	**1y**	**3y**	**5y**	**6m**	**1y**	**3y**	**5y**
Communication	23,6 %	10,0 %	58,1 %	61,4 %	12,9 %	0,7 %	24,9 %	-48,8 %	-17,7 %	-18,1 %	-6,6 %	-29,9 %
Consumer Discretionary	14,2 %	26,1 %	20,3 %	9,6 %	33,7 %	39,4 %	66,1 %	183,1 %	-5,7 %	-24,2 %	71,2 %	84,6 %
Consumer Staples	-13,3 %	-6,8 %	53,0 %	174,0 %	6,2 %	51,2 %	-33,0 %	210,4 %	12,4 %	-25,4 %	-2,8 %	37,6 %
Energy	-0,2 %	4,2 %	0,0 %	29,4 %	-31,0 %	27,5 %	-73,4 %	-72,9 %	-10,5 %	3,0 %	17,9 %	-21,9 %
Financials	14,9 %	38,4 %	54,1 %	33,9 %	18,3 %	-10,1 %	74,9 %	3,6 %	2,5 %	1,4 %	17,7 %	-18,9 %
Health Care	2,6 %	7,7 %	-20,2 %	-28,9 %	7,3 %	12,3 %	8,1 %	31,1 %	6,1 %	21,5 %	18,7 %	20,4 %
Industrials	11,4 %	18,2 %	39,4 %	82,2 %	-7,0 %	-1,4 %	46,2 %	127,2 %	9,6 %	11,8 %	-1,8 %	20,5 %
Information Technology	33,1 %	37,4 %	58,3 %	114,5 %	3,0 %	-1,5 %	20,1 %	13,2 %	9,5 %	28,0 %	37,7 %	3,0 %
Materials	15,6 %	4,4 %	25,0 %	51,8 %	-12,6 %	-48,6 %	-60,0 %	-70,8 %	9,9 %	2,5 %	1,5 %	0,7 %
Utilities	4,5 %	-4,8 %	5,9 %	-27,7 %	-23,0 %	-46,8 %	-30,1 %		7,7 %	10,5 %	-7,9 %	7,8 %

Table 6.15: Equally-weighted long-term performance across market segments

	6m CAR	**1y CAR**	**3y CAR**	**5y CAR**
Nasdaq				
PE	19,66 %	26,29 %	36,59 %	44,59 %
VC	5,66 %	8,59 %	16,76 %	45,73 %
NS	4,65 %	9,28 %	8,92 %	-5,19 %
NYSE				
PE	5,19 %	11,63 %	22,36 %	48,95 %
VC	-9,45 %	-2,63 %	65,19 %	141,42 %
NS	6,81 %	11,12 %	38,36 %	48,56 %

with negative returns in the short term, but experience a turnaround, resulting in high 5-year CARs.

Non-sponsored IPOs on Nasdaq show the least variance in returns across time, with modest growth that does not substantially decline or increase. However, non-sponsored IPOs on the NYSE exchange exhibit a steady increase in CARs, with a notable jump at the 3-year mark, again stabilizing at the 5-year point.

Across both exchanges, PE-backed IPOs demonstrate strong and consistent long-term performance. VC-backed IPOs show a higher degree of volatility across both markets, with an uptick on NYSE. Non-sponsored IPOs exhibit more uniform performance across different time frames.

6.2.2.2 Value-weighted

In Table 6.16, the value-weighted returns across the market segments are presented.

Table 6.16: Value-weighted long-term performance across market segments

	6m CAR	**1y CAR**	**3y CAR**	**5y CAR**
Nasdaq				
PE	25,03 %	14,71 %	-4,13 %	6,67 %
VC	-6,00 %	-6,06 %	11,65 %	41,50 %
NS	25,37 %	169,29 %	-2,66 %	-1,45 %
NYSE				
PE	1,92 %	2,03 %	6,64 %	12,43 %
VC	-37,33 %	-30,38 %	-3,33 %	19,67 %
NS	10,16 %	2,31 %	25,39 %	27,20 %

The PE-backed IPOs on Nasdaq, show a high positive return at 6 months, which declines

over time, but remains positive at 5 years. PE-backed IPOs on the NYSE exchange exhibit negative value-weighted returns at the 6-month and 1-year marks, with a shift to positive returns in the subsequent years.

VC-backed IPOs on Nasdaq fluctuate from a substantial loss at 1 year to high positive returns at 3 and 5 year. VC-backed IPOs on NYSE show negative returns at 6 months and 1 year, but this dramatically shifts to very high positive returns at 3 and 5 years.

Non-sponsored IPOs show a high value-weighted return at 1 year, which then declines, indicating that these IPOs may initially be undervalued or that they perform particularly well in the short to medium-term before normalizing. Regarding NYSE, non-sponsored IPOs display consistent positive performance, with value-weighted returns increasing over time.

6.2.3 Size portfolios

Table 6.17 demonstrates the performance of the ten size portfolios consisting of PE- and VC-backed IPOs, compared to non-sponsored IPOs. The number of IPOs in each portfolio are listed in Table 6.8. Comparing the performance of size-adjusted portfolios between sponsored and non-sponsored IPOs may provide insight into value tendencies by sponsorship.

Size appears to be an important factor in IPO performance, with different sponsorship types responding differently to size. Smaller firms, particularly those backed by PE, tend to perform well in the short term, while mid-sized firms, especially those VC-backed, show potential for high long-term returns. The performance of the largest firms shows less extreme variability, which may indicate that the size itself can provide stability in the aftermarket.

PE-backed IPOs show strong short-term performance, particularly in the smaller size ranges, suggesting that the firms are skilled at identifying and cultivating high-growth potential in smaller companies. In the long term (3 and 5 years), PE-backed IPOs show mixed results across size ranges, with some portfolios showing strong performance and others underperforming, possibly reflecting the varying success rates of PE-firms in sustaining growth post-IPO.

Table 6.17: Long-run performance of size portfolios

	USDm	PE			VC			NS		
Portfolio	**Size range**	**6m**	**3y**	**5y**	**6m**	**3y**	**5y**	**6m**	**3y**	**5y**
1	0-62	11,05 %	111,68 %	13,82 %	21,60 %	24,16 %	49,18 %	-3,05 %	-36,57 %	-61,02 %
2	62-131	1,47 %	39,36 %	-9,84 %	2,06 %	68,06 %	69,65 %	0,82 %	20,58 %	28,56 %
3	131-219	2,51 %	9,53 %	23,91 %	8,08 %	-1,26 %	9,46 %	4,71 %	36,06 %	-6,79 %
4	219-335	18,89 %	60,77 %	69,97 %	12,51 %	27,39 %	47,80 %	2,37 %	-8,57 %	5,17 %
5	335-464	7,65 %	29,24 %	48,43 %	-5,52 %	3,54 %	19,41 %	13,84 %	2,15 %	-33,17 %
6	464-692	29,54 %	35,90 %	66,82 %	-0,56 %	17,43 %	35,50 %	16,73 %	16,46 %	1,65 %
7	692-1 059	18,88 %	39,56 %	95,83 %	0,75 %	33,96 %	193,24 %	-1,14 %	48,51 %	41,01 %
8	1 059-1 743	6,39 %	25,89 %	32,87 %	10,14 %	5,47 %	114,34 %	16,59 %	35,88 %	49,67 %
9	1 743-3 403	9,54 %	10,45 %	46,54 %	-7,67 %	54,31 %	106,77 %	-5,82 %	52,12 %	67,09 %
10	3 403-87 561	7,16 %	-7,50 %	9,33 %	-15,85 %	53,55 %	60,69 %	11,50 %	21,77 %	39,40 %

Note: *Equally-weighted average performance of 10 size-portfolios. The IPOs are evenly distributed across the portfolios into 10 deciles.*

6.2.3.1 VC

VC-backed IPOs demonstrate variability across size ranges and time horizons. Some portfolios, particularly those in the mid-range sizes, sho high returns at 5 years, which may reflect the higher risk, but potentially higher reward nature of VC-investments. The performance of VC-backed IPOs also tends to be more extreme than PE-backed IPOs, which could be due to the higher-risk nature of VC-investments or sector differences within the portfolios.

6.2.3.2 Non-sponsored

Non-sponsored IPOs across size ranges show a notable underperformance, particularly at the 5-year mark, which could suggest that these companies may lack the strategic support and resources that sponsored firms receive. Interestingly, the smallest and largest size ranges for non-sponsored IPOs show less negative performance, which may imply that size can mitigate the lack of sponsorship support to some extent.

6.2.4 Cross-sectional regression

Our analysis yields empirical evidence regarding the determinants of CAR in different periods post-IPO.

6.2.4.1 6 months

We observe that PE-backing exhibits a positive and statistically significant relationship with CAR, suggesting that PE-backing may contribute positively to post-IPO performance after 6 months. Conversely, VC-backing appears to be inversely correlated with CAR, indicating a potential negative impact on returns within the same timeframe. Non-sponsored IPOs do not demonstrate a statistically significant relationship with CAR.

Furthermore, the consumer discretionary sector is statistically significant (10% level) for non-sponsored IPOs. Also, flotation on NYSE presents a significant predictor of negative CAR across all types of sponsorships. The timing of the IPO in relation to market conditions—specifically, whether it occurred during a hot market period is found to be a significant, negative factor across the board.

Table 6.18: Cross-sectional regression of CAR

	Dependent variable:								
	CAR - 6 months			CAR - 3 years			CAR - 5 years		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PE	0.148**			0.012			−0.012		
	(0.067)			(0.146)			(0.206)		
VC		−0.141**			0.229*			0.518***	
		(0.060)			(0.130)			(0.184)	
NS			0.019			−0.206*			−0.439**
			(0.056)			(0.121)			(0.171)
ln(Mcap)	0.005	0.009	0.010	0.070	0.071	0.066	0.089	0.089	0.078
	(0.020)	(0.020)	(0.020)	(0.044)	(0.044)	(0.044)	(0.062)	(0.062)	(0.062)
2020	−0.489	−0.575	−0.541	−1.263	−1.192	−1.142	−0.554	−0.382	−0.287
	(1.002)	(1.002)	(1.005)	(2.172)	(2.169)	(2.170)	(3.070)	(3.061)	(3.063)
2014	0.052	0.055	0.054	−0.146	−0.149	−0.151	−0.291	−0.300	−0.303
	(0.092)	(0.092)	(0.092)	(0.199)	(0.199)	(0.199)	(0.281)	(0.280)	(0.281)
Health Care	0.030	0.032	0.009	−0.028	−0.068	−0.035	−0.052	−0.137	−0.062
	(0.065)	(0.065)	(0.065)	(0.141)	(0.141)	(0.140)	(0.200)	(0.200)	(0.197)
Consumer Discretionary	0.132	0.158	0.173*	0.094	0.118	0.062	0.110	0.153	0.032
	(0.100)	(0.098)	(0.099)	(0.216)	(0.213)	(0.214)	(0.306)	(0.301)	(0.302)
NYSE	−0.146**	−0.142**	−0.120*	0.079	0.116	0.078	0.309	0.386*	0.299
	(0.066)	(0.066)	(0.065)	(0.144)	(0.143)	(0.141)	(0.203)	(0.201)	(0.200)
Hot market	−0.169***	−0.164**	−0.156**	−0.385***	−0.372***	−0.391***	−0.522***	−0.496**	−0.538***
	(0.065)	(0.065)	(0.065)	(0.140)	(0.140)	(0.140)	(0.198)	(0.197)	(0.197)
Constant	0.222*	0.277**	0.210	0.183	0.094	0.309	0.168	−0.034	0.435
	(0.130)	(0.133)	(0.135)	(0.283)	(0.287)	(0.292)	(0.400)	(0.405)	(0.412)
Observations	607	1078	750	454	867	636	351	678	547
R^2	0.013	0.013	0.009	0.010	0.012	0.012	0.012	0.018	0.017
Adjusted R^2	0.007	0.007	0.003	0.004	0.007	0.006	0.007	0.012	0.011
Note:									*p<0.1; **p<0.05; ***p<0.01

6.2.4.2 3 years

At the 3-year mark, the impact of VC-backing and the absence of sponsorship on IPOs are both statistically significant. The coefficient is positive for VC-backed IPOs, indicating a favorable effect, while it is negative for non-sponsored IPOs. Once again, it is observed that IPOs launched in what are termed hot markets are more likely to exhibit long-term abnormal underperformance.

6.2.4.3 5 years

After 5 years, the regression reveals that VC-backing is a statistically significant factor with a positive coefficient which indicates overperformance. In contrast, non-sponsored IPOs are also statistically significant, but with a negative coefficient. For VC-backed IPOs, floating on NYSE is statistically significant. Additionally, is the trend continues that listing in a hot market, but with a negative coefficient, pointing towards an adverse effect on performance.

6.2.4.4 Model fit

In conclusion, the R^2 values are relatively low across all models, indicating that the independent variables do not explain much of the variance in the dependent variable. Overall, the regression results indicate that while some variables show a significant relationship with the dependent variables at different time horizons, the overall explanatory power of the models is quite low. This could either mean that the key driving factors of the dependent variable are not captured in the model or that the relationship is not linear and perhaps more complex models or methods might be needed to better understand these relationships. We run tests for robustness that can be found in the appendix (Figure B.2, Figure B.3, and Figure B.4), which suggest we should exercise caution when drawing conclusions from our model.

6.2.5 Discussion

We initially hypothesized that PE- and VC-backed IPOs would be less susceptible to divergent investor opinions than non-sponsored IPOs, potentially resulting in fewer price adjustments in the aftermarket. Additionally, we expected that the expertise added by

private equity managers would contribute positively to long-term performance.

Our empirical analysis suggests that PE-backing has a positive effect on long-run performance which was statistically significant at the 6-month mark, but not statistically significant at the 3- or 5-year mark. Moreover, the analysis exhibit that VC- backing has statistically significant positive effect at the 3-year and 5-year mark, but a negative in the first six months. Non-sponsored IPOs showed statistically significant negative results at the 3- and 5-year mark.

Regarding the windows-of-opportunity theory, we previously found that there is proportionally more PE-backed IPOs in a hot market, while the non-sponsored was relatively lower and VC-backed IPO proportion stayed relatively consistent through the market states. Also, the proportion of listings in hot markets seems to increase with market capitalization (Table 6.8). Our descriptive analysis exhibits that in the larger size range, PE-backed portfolios performed more poorly in the long term (Table 6.17).

This poor long-term performance of PE-backed firms defies our hypothesis that PE-backed IPOs are subject to less divergent investor opinions. As we found no significant support for the use of underpricing among PE-backed IPOs, this finding may lean towards supporting Fama and French (1998) claim[12]. Additionally, P. Gompers and Lerner (2001) claim about the certification role of PE-firms, could also help price the listing too high, making the stock more subject to later price adjustments.

Moreover, our empirical findings suggest that hot-issue periods is very important for predicting aftermarket performance, found in Ritter (1991). In our regression, we found that a listing in a hot market had a statistically negative effect on the long-term performance, across all time horizons and with all types of sponsor types. This aligns with Ritter (1991), Loughran and Ritter (1995), and Aggarwal and Rivoli (1990) theories which suggests that companies taking advantage of windows-of-opportunity may harm long-term IPO performance as companies go public with a higher pricing than usual. This does not necessarily contradict the potential use of underpricing, as the general valuation in hot markets may be overly high.

[12]Fama and French (1998) which suggests that the initial listing valuation of IPOs aligns with the fundamental value, and that underperformance results from diminishing information asymmetry over time.

Lastly, the influence of lock-up periods imposed on current owners, typically ranging from 90 to 180 days, may be a critical factor affecting long-term performance, aligning with Schöber (2008)'s overhang divestment theory. We argued that there was a risk of stock depreciation for private equity-backed IPOs after 8-32 months (post lock-up period), followed by an expected recovery once the private equity firm fully exits. However, the lack of statistical significance at the 3- and 5-year marks for PE-backed IPOs neither confirms nor denies the presence of this phenomenon. We did observe this phenomenon in VC-backed IPOs, which showed statistically significant overperformance at the 3- and 5-year marks, but not after 6 months.

In summary, the literature review presents a mixed picture of the empirical findings on the long-run performance of PE- and VC-backed IPOs as listed in section 2.2.4.2. Finally, our empirical results must be interpreted with caution due to the lack of robustness in the model, as discussed earlier.

7 Summary

Our thesis explores the underpricing and long-term performance of PE- and VC-backed IPOs versus non-sponsored IPOs in the U.S. from 2000 to 2022, using a sample of 2.509 IPOs. Building on previous studies that have identified differences in IPO underpricing and long-term performance across sponsor types, this thesis focuses on two questions.

1) Does private equity- and venture capital-backed IPOs exhibit less underpricing compared to their non-sponsored counterparts?

Initially, we hypothesized that PE- and VC-backed IPOs would exhibit less underpricing compared to non-sponsored IPOs. Contrary to our expectations, and thus in line with previous research by Levis (2011), Bergström et al. (2006), P. A. Gompers (1996), Hogan et al. (2001), and Megginson and Weiss (1991), which found inconclusive results on underpricing in PE- and VC-backed IPOs. Our findings show no evidence of reduced underpricing in PE- and VC-backed IPOs compared to their non-sponsored counterparts.

Interestingly, our results suggest that underpricing may increase with a larger market capitalization. This might suggest that larger IPOs strategically use underpricing when issuing a large amount of stocks in order to finalize the listing. Additionally, this could be to offset the higher costs associated with information acquisitions, which are inherently greater in larger offerings.

2) Do private equity- and venture capital-backed IPOs exhibit long-term overperformance relative to non-sponsored IPOs?

We anticipated PE-backed IPOs to outperform non-sponsored IPOs. Our study finds evidence that PE- and VC-backed IPOs show statistically significant long-term overperformance within specific timeframes. Specifically, PE-backed IPOs exhibited abnormal overperformance at the 6-month mark, while VC-backed IPOs overperformed at the 3- and 5-year marks. Non-sponsored IPOs exhibited statistically significant negative abnormal returns at the 3- and 5-year marks.

Bergström et al. (2006) suggested that PE-firms are not taking portfolio firms public during years associated with large IPO activity, thereby not taking particular advantage of windows of opportunity. However, our findings indicate that the proportion of PE-backed

IPOs seems to increase during hot markets. These larger PE-backed IPOs showed a tendency to underperform in the long-term, potentially aligning with Schöber (2008)'s overhang divestment theory.

We think the most intriguing implication from our findings is the importance of hot periods in predicting aftermarket performance. In our empirical analysis, we found that listing a company during a hot market negatively affects its long-term performance across various sponsorship types and time horizons. Overall, this suggests that companies and their sponsors try leverage favorable market conditions in hot periods, which may jeopardize the long-term performance. This implies that firms, in general, should be cautious and strategic when going public during such periods. Investors should also exercise more caution when investing in companies floated in hot markets. However, we reiterate that our empirical results must be interpreted with caution due to the lack of robustness in the model, as discussed in the analysis.

While some of our findings align with existing research, such as Bergström et al. (2006) and Levis (2011) findings on long-term overperformance of PE-backed IPOs, our study does not explore the underlying reasons for this. In Chapter 3, we presented the hypotheses for our research questions, which mainly revolved around operational enhancements and other factors that are complicated to quantify. Consequently, further research is warranted to assess whether the operational enhancements and strategies implemented by PE- and VC firms could explain the observed disparities in aftermarket performance.

Acknowledging this, a deeper understanding of these operational enhancements could shed light on the reasons behind the outperformance of PE- and VC-backed IPOs. Additionally, a more thorough investigation into the measurement of value creation from PE- and VC-backing, particularly focusing on operational performance and strategic decision-making during ownership, and how this affects aftermarket trading would be highly beneficial.

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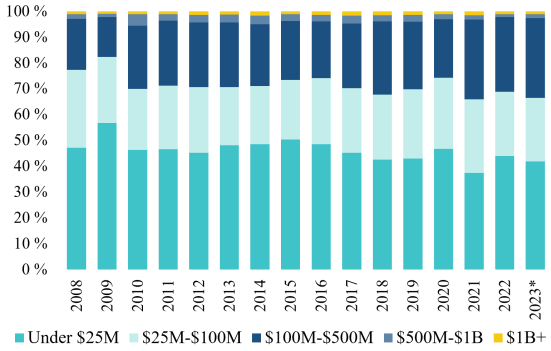
Appendices

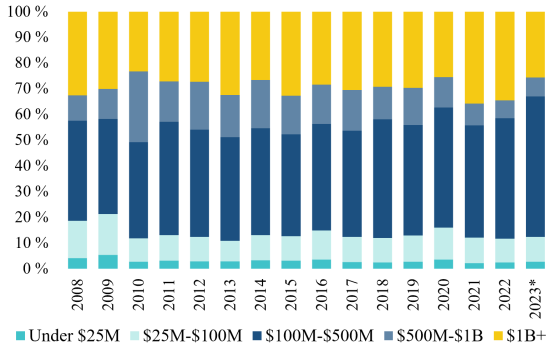
A Background

Figure A.1: U.S. Private Equity Transactions by Size bucket and Strategy

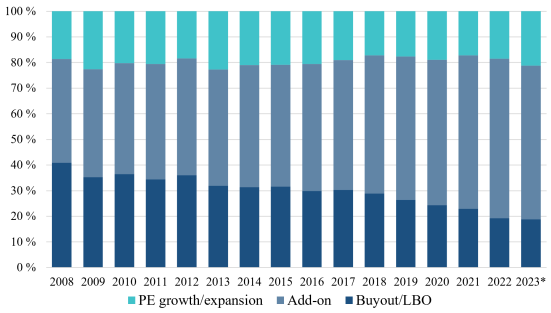
(a) Deal Count by Size Bucket



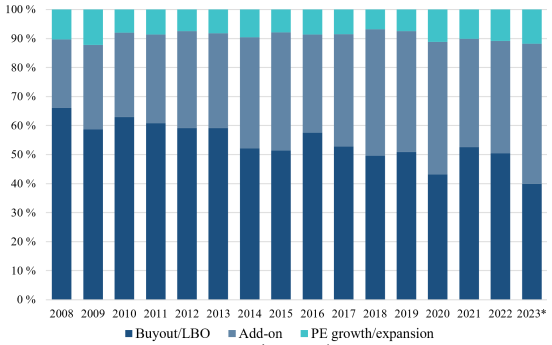
(b) Deal Value by Size Bucket



(c) Deal Count by Strategy



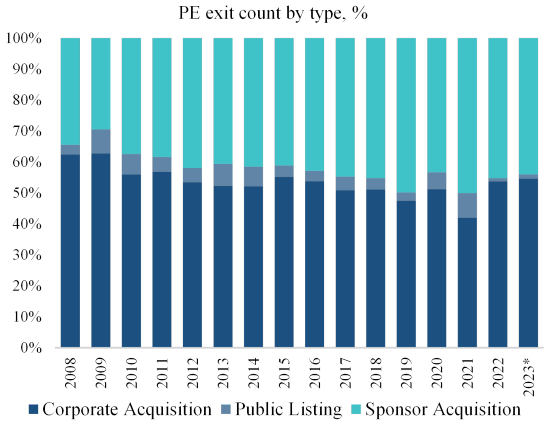
(d) Deal Value by Strategy



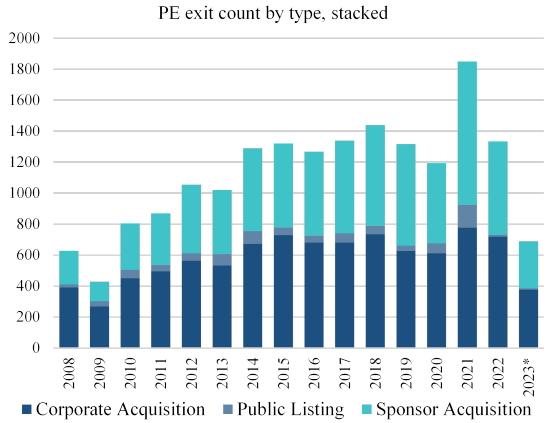
Note: **Q3'2023 TTM. Source: Data from PitchBook (2023)*

Figure A.2: U.S. Exit Patterns 2008-2023*

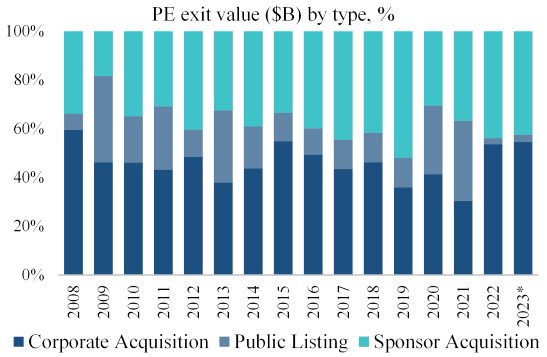
(a) Exit count by type, %



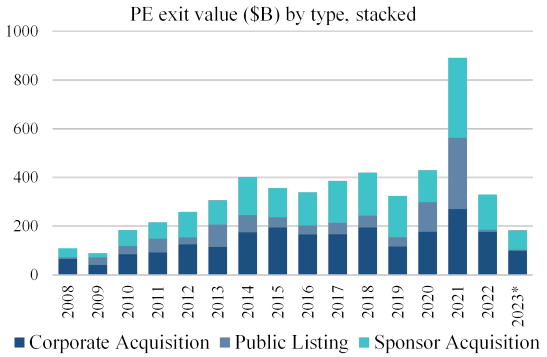
(b) Exit count by type, stacked



(c) Exit value by type, %

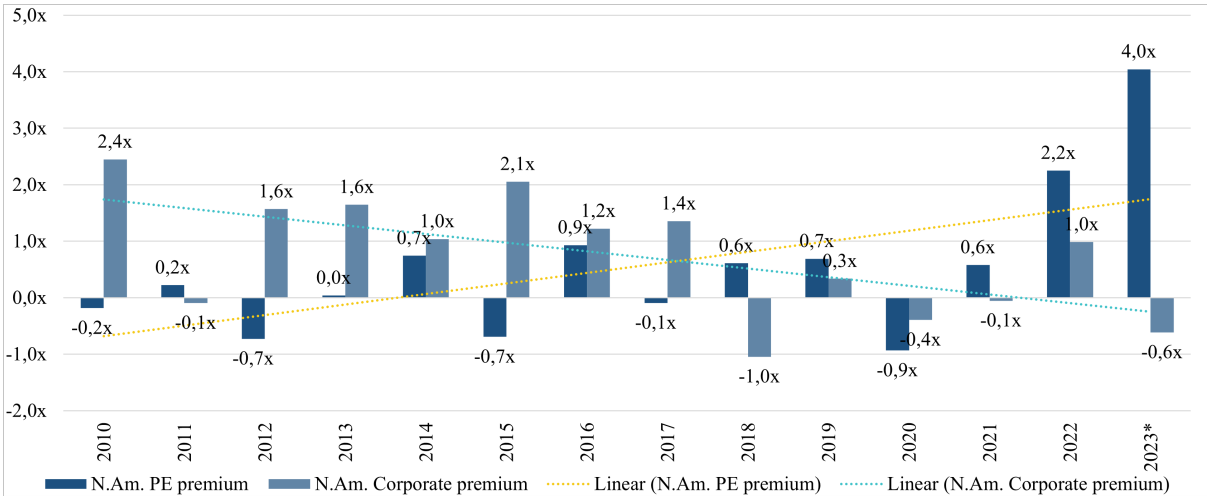


(d) Exit value ($bn), stacked



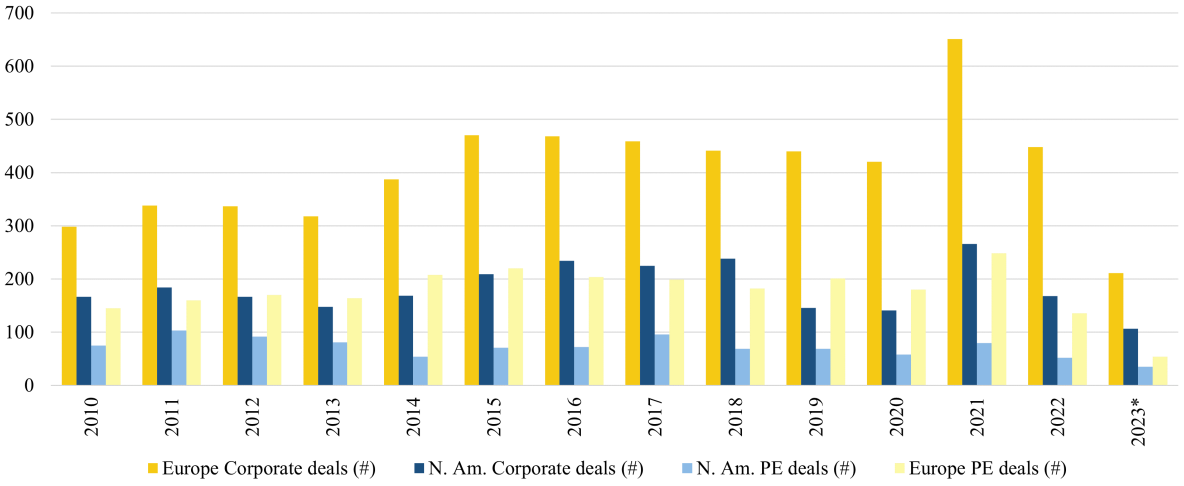
Note: **Q3'2023 TTM. Source: Data from PitchBook (2023)*

Figure A.3: Median purchase premium price EV/EBITDA multiples North America versus European on both Private Equity and corporate transactions



Note: *North American pays an average median purchase premium of 0,7x EV/EBITDA on corporate transactions and 0,5x EV/EBITDA on private equity versus Europe from 2010 to *Q3'2023 TTM. The premium paid on private equity deals are trending upwards. A deal count comparison are to be found in the appendix Figure A.4. Source: Data from PitchBook (2023)*

Figure A.4: Deal Count comparison



Note: **Q3'2023 TTM. Source: Data from PitchBook (2023)*

Table A.1: Table of mean first-day return on U.S. stock exchange

Year	Number of IPOs	Mean First-day Return		Aggregate Amount Left on the Table	Aggregate Proceeds
		Equal-weighted	Proceeds-weighted		
1980	71	14.3%	20.0%	$0.18 billion	$0.91 billion
1981	192	5.9%	5.7%	$0.13 billion	$2.31 billion
1982	77	11.0%	13.3%	$0.13 billion	$1.00 billion
1983	451	9.9%	9.4%	$0.84 billion	$8.89 billion
1984	171	3.7%	2.5%	$0.05 billion	$2.02 billion
1985	186	6.4%	5.6%	$0.23 billion	$4.09 billion
1986	393	6.1%	5.1%	$0.68 billion	$13.40 billion
1987	285	5.6%	5.7%	$0.66 billion	$11.68 billion
1988	105	5.5%	3.4%	$0.13 billion	$3.88 billion
1989	116	8.0%	4.7%	$0.27 billion	$5.81 billion
1990	110	10.8%	8.1%	$0.34 billion	$4.27 billion
1991	286	11.9%	9.7%	$1.50 billion	$15.39 billion
1992	412	10.3%	8.0%	$1.82 billion	$22.69 billion
1993	510	12.7%	11.2%	$3.52 billion	$31.44 billion
1994	402	9.6%	8.3%	$1.43 billion	$17.18 billion
1995	462	21.4%	17.5%	$4.90 billion	$27.95 billion
1996	677	17.2%	16.1%	$6.76 billion	$42.05 billion
1997	474	14.0%	14.4%	$4.56 billion	$31.76 billion
1998	283	21.9%	15.6%	$5.25 billion	$33.66 billion
1999	476	71.2%	57.4%	$37.11 billion	$64.67 billion
2000	380	56.3%	45.8%	$29.68 billion	$64.80 billion
2001	80	14.0%	8.4%	$2.97 billion	$35.29 billion
2002	66	9.1%	5.1%	$1.13 billion	$22.03 billion
2003	63	11.7%	10.4%	$1.00 billion	$9.54 billion
2004	173	12.3%	12.4%	$3.86 billion	$31.19 billion
2005	159	10.3%	9.3%	$2.64 billion	$28.23 billion
2006	157	12.1%	13.0%	$3.95 billion	$30.48 billion
2007	159	14.0%	13.9%	$4.95 billion	$35.66 billion
2008	21	5.7%	24.7%	$5.63 billion	$22.76 billion
2009	41	9.8%	11.1%	$1.46 billion	$13.17 billion
2010	91	9.4%	6.2%	$1.84 billion	$29.82 billion
2011	81	13.9%	13.0%	$3.51 billion	$26.97 billion
2012	93	17.7%	8.9%	$2.75 billion	$31.11 billion
2013	158	20.9%	19.0%	$7.89 billion	$41.56 billion
2014	206	15.5%	12.8%	$5.40 billion	$42.20 billion
2015	118	19.2%	18.9%	$4.16 billion	$22.00 billion
2016	75	14.5%	14.2%	$1.77 billion	$12.52 billion
2017	106	12.9%	16.0%	$3.68 billion	$22.98 billion
2018	134	18.6%	19.1%	$6.39 billion	$33.47 billion
2019	112	23.5%	17.7%	$6.93 billion	$39.18 billion
2020	165	41.6%	47.9%	$29.66 billion	$61.87 billion
2021	311	32.1%	24.0%	$28.65 billion	$119.36 billion
2022	38	48.9%	14.2%	$0.99 billion	$6.98 billion
1980-2022	**9,126**	**19.0%**	**20.5%**	**$231.38 billion**	**$1,128.3 billion**

Note: *Shows the mean first-day return on all IPOs excluding penny stocks, ADRs, closed-end funds, unit offers, REITs, small best efforts offers, natural resource limited partnerships, S&Ls and banks, and stocks not listed on CRSP (i.e. Amex, NYSE, and NASDAQ stocks). Proceeds excl. overallotment options. Amount of money left on table is defined as closing market quote first trading day minus offer quote, multiplied with offered shares. Source: Ritter (2023a)*

B Data and Methodology

B.1 Model testing

To ensure that we do not have problems related to our regressions, we conduct multiple tests to assess the Gauss-Markov assumptions and potential stationarity. The tests are conducted on the regressions for underpricing and long-run abnormal returns.

B.1.1 Distributions

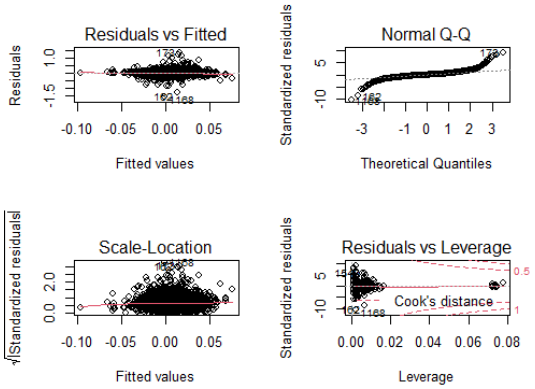
The sample size in our analysis is between 300 and 2.500 observations, which is sufficient in terms of what is required to rely on the central limit theorem (Woolridge, 2018).

The residual plot (differences between observed and predicted values) tests to assess the goodness of fit. The residuals should be randomly scattered around zero, no clear trend, and roughly constant across the levels of fitted value (homoscedasticity). The QQ-plot is used to check if the dataset follow a particular theoretical distribution, and should have a relatively straight line to indicate normal distribution. The scale-location shows the square root of the standardized residuals against the fitted values. It is used to check for homoscedasticity, where a horizontal line with equally spread points suggests homoscedasticity. In the plot "Residuals vs Leverage" we can identify influential cases (outliers that have an undue influence on the model fit). Points with high leverage can have a large impact on the slope of the regression line. A horizontal line around zero indicate unbiased model predictions.

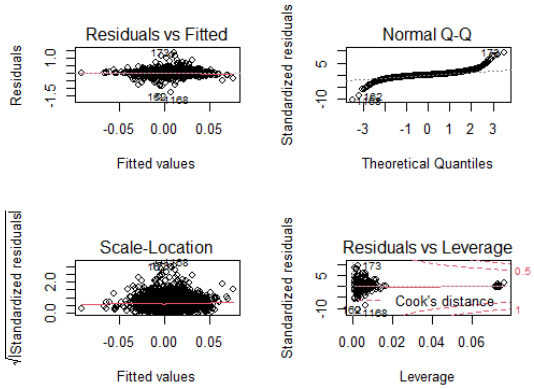
In summary, these plots are suggesting there are certain data points that are outliers or are having an undue influence on the model, and inconstistent variance and mean. These is most likely due to non-linear relationships, heteroscedasticity, or non-normal errors. Therefore, it is advisable to exercise caution when drawing any conclusions from our model results, considering the potential impact of these issues.

Figure B.1: Robustness check of underpricing regression

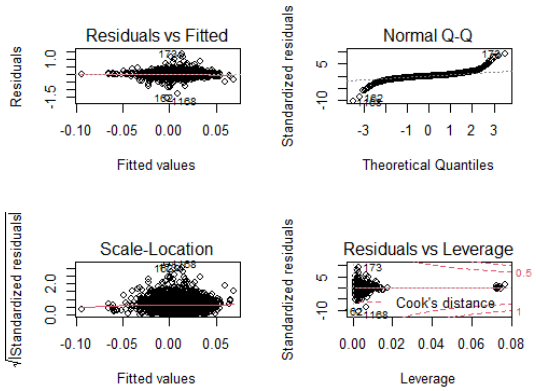
(a) PE - Underpricing



(b) VC - Underpricing



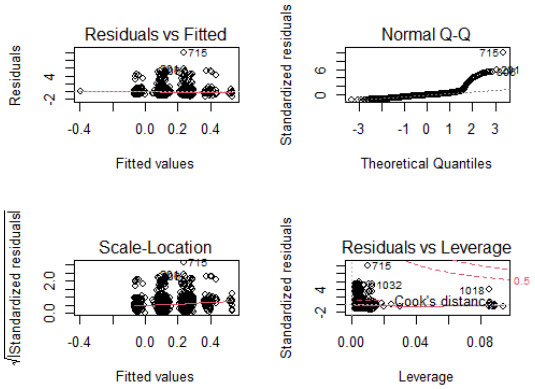
(c) NS - Underpricing



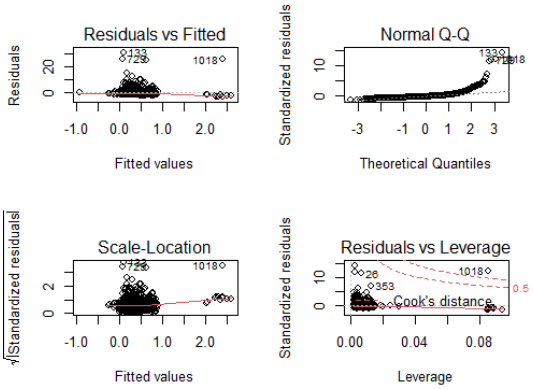
Note: *The residuals vs. fitted plots are not a random scatter plot and has a few plots around the center that are far from zero. These outliers may indicate points not well explained in the model. The QQ-plots are S-shaped starting from the bottom, which suggest over-dispersed distribution relative to normal meaning the tails are smaller (larger) than what we would expect the small (large) observations should be following a normal distribution. The scale-location plot indicates that there might be an issue with equal variances since the spread seems to increase with the fitted values, suggesting heteroscedasticity. The residual vs. leverage plot suggest biased model predictions as we have a high concentration of low-leverage, we also have some high-leverage points, but the residuals are not high indication influential points. Although it seems that all points are within cook's distance. The plots suggest inconsistent variance and mean, that we have some outliers, and generally do not meet the assumptions of linearity.*

Figure B.2: Robustness check of CAR regression - PE

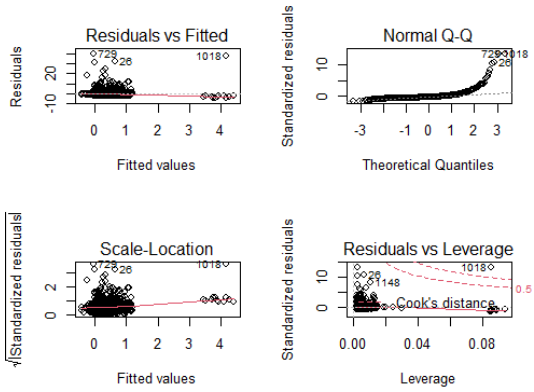
(a) PE - 6 months



(b) PE - 3 years



(c) PE - 5 years



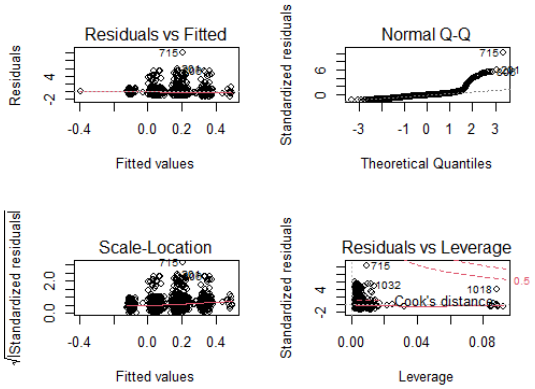
Note: *The residuals vs. fitted plots are in not a random scatter plots. (a) shows small, abnormal clusters around zero in residuals, including some inverted U-shapes. While (b) and (c) shows abnormal clustering. All this suggesting the variables are not linear. The QQ-plots looks right-skewed which may indicate a exponential distribution. Here, the smallest (largest) observations is larger (smaller) than what we would expect following a normal distribution meaning we have some outliers deviating from the expected line. The scale-location plot shows similar pattern as the residuals vs. fitted plot. The pattern in (a) may indicate non-constant variance, the other patterns show fan-shapes spreads in theirs clusters, suggesting heteroscedasticity. The residual vs. leverage plot shows similar patterns as of Figure B.1 suggesting biased model predictions. The plots suggest inconsistent variance and mean, that we have some outliers, and generally do not meet the assumptions of linearity*

B.1.2 Biases in abnormal return calculations

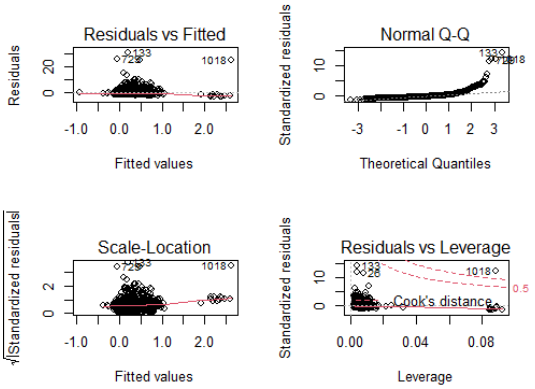
Barber and Lyon identify three biases in abnormal return calculations (Barber & Lyon, 1997). The first is the new listing bias, which arises because in event studies of long-run abnormal returns, sampled firms are tracked for a long post-event period, but firms that constitute the index typically include firms that begin trading subsequent to the event

Figure B.3: Robustness check of CAR regression - VC

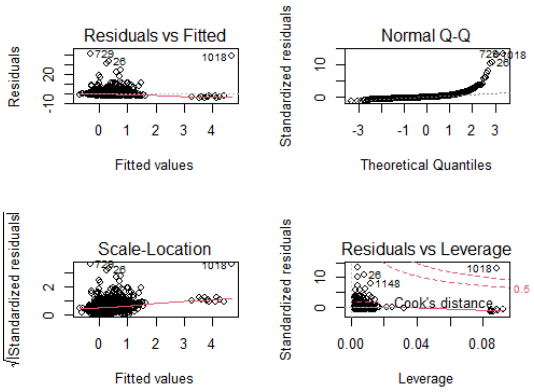
(a) VC - 6 months



(b) VC - 3 years



(c) VC - 5 years



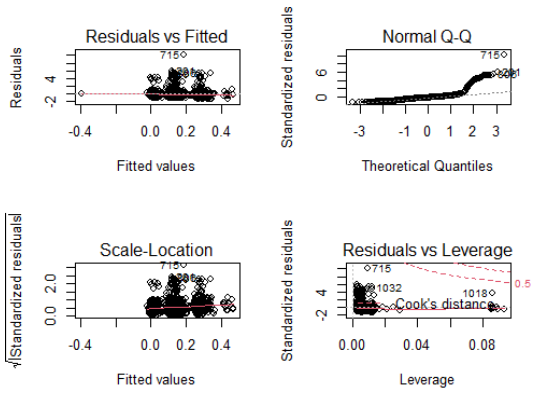
Note: *The plots shows generally the same patterns and indications as Figure B.2.*

month. This could underestimate expected returns and overestimate abnormal returns. However, our sample's mix of firms with varying trading histories should mitigate this bias. The second, skewness bias, stems from the asymmetrical risk in stock returns, with a limited downside but theoretically unlimited upside. This bias is more pronounced in individual stocks than in market indices. Using national benchmarks helps align IPOs with risks similar to those in their respective countries, though skewness bias remains a concern.

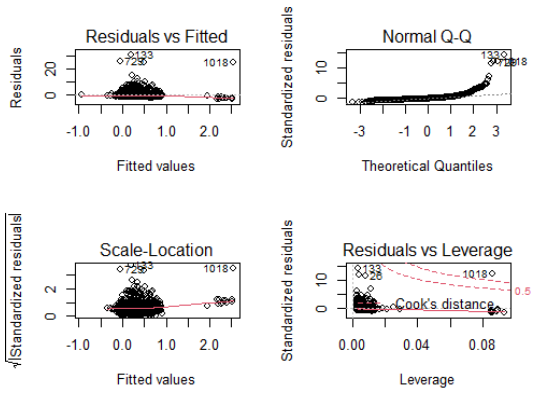
The third bias, rebalancing bias, occurs with equally-weighted indices used as benchmarks. It inflates benchmark returns due to the momentum effect in consecutive monthly returns of individual stocks. However, using value-weighted indices, as we do in this study, can reduce this bias, aligning more closely with the relative changes in individual stock sizes.

Figure B.4: Robustness check of CAR regression - Non-sponsored

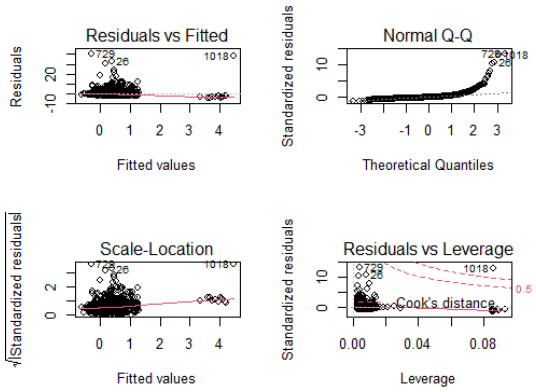
(a) NS - 6 months



(b) NS - 3 years



(c) NS - 5 years



Note: *The plots shows generally the same patterns and indications as Figure B.2.*