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# IPO Underpricing and Venture Capitalism: A Study of the Western European Market.

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# ABSTRACT

This paper examines underpricing, as the percentage change between the offering and closing price on the first day of a stock's trading, in relation to the presence of venture capital investors. Underpricing is a common phenomenon in initial public offerings (IPO) may be interpreted as a short-term market inefficiency. One may imagine that the market starts to establish an idea about the true value of the issuer's prospects. With a sample consisting of 1,419 IPO issuers between 2010 and 2023 from Western Europe, the study tests the certification hypothesis: does the degree of IPO underpricing reduce under the presence of venture capitalist investors? The analysis entails an ordinary-least squares (OLS) regression including a Heckman correction model to account for a significant sample selection bias. Additionally, a Wilcoxon rank sum test enhances our understanding of the true effect as it complements the regression's pitfalls. In conclusion, this study provides evidence in support of the certification hypothesis across multiple tests. However, none of the models could explain more than thirteen percent of the variance, which calls for careful interpretation and motivates further research. In practical terms, VCs seem to reduce underpricing, yet investors cannot solely rely on information about the presence and quality of certifying agents to generate first-day returns. Drawing from referenced literature's assessment, I propose behavioral concepts, including cascades and sentiment, as a possible explanation for the evidence. The intuition would confirm research, suggesting that the degree of informational access and reach has arguably transformed IPOs into highly anticipated events and may induce herd behavior.

**Keywords:** Underpricing, Venture Capitalism, Initial Public Offering

**JEL codes: G32, G24**

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# CHAPTER 1 Introduction

Underpricing, as the percentage change between the offering and closing price on the first day of a stock's trading, is a common phenomenon in initial public offerings (IPO). Issuing firms and underwriters try to determine the right price in the so-called book-building process to minimize the amount left on the table; another way we may think of underpricing. Scholars have observed underpricing over long periods and found averages in the world's largest capital market, the US, between 10 and 20 percent (Eckbo, 2007). In bust years such as 1999 and 2000, the average IPO was underpriced by a massive 71 percent and 57 percent, leaving a total of $62 billion on the table over two years (Eckbo, 2007).

Underpricing in the presence of venture capitalists (VC) prior to an IPO has been examined in various papers before. Scholars across the board acknowledge investors' adverse selection problem when deciding whether to invest or not to invest in an IPO company. The problem is rooted in the information asymmetry between insiders (shareholders) and outsiders (potential investors) and is sought to reduce as more information becomes available. However, evidence on the impact of VCs across academic papers is inconclusive and even contradictory at times. First formulated by Booth and Smith (1986), the certification hypothesis initially proposed that underwriters could certify the insiders' signals. Later, this framework was extended to any well-informed agent (Tirole, 2006) that may certify the information, including VC firms (Gompers & Lerner, 2004). Some papers support the certification hypothesis (Pennacchio, 2014; Megginson & Weiss, 1991), while others find no effect (Arikawa & Imad'eddine, 2010; Elston & Yang, 2010) and even diametrically opposing evidence (Francis & Hasan, 2001; Lee & Wahal, 2004).

The different samples used to explore the certification hypothesis are characterized by different geographical contexts, sample periods, and market environments. The most general studies regard the highly developed US market, mostly pre-financial crisis (2008). Meanwhile, the evidence of the Western European market in its current form is scarce. Today, the context and circumstances have radically changed concerning the reach, speed, and access of information relative to related studies. Moreover, all past papers try to control for the innate endogeneity of the treatment variable (VC-backing). Intuitively, VCs do not randomly select their portfolio companies; hence we are certain about predispositional differences between IPO companies. This study aims to address the remarks above and gathers renewed insights on the following relationship:

**How does the presence of a VC firm affect underpricing in European IPO companies?**

The quantitative analysis consists of both non- and parametric tests respectively. The latter entails a regression analysis paired with a Heckman correction, a separate estimator reflecting the probability of selection to account for a sample selection bias. Thereby, we can estimate the effect of our independent dummy variable (VC-backing) on IPO underpricing (measured as a percentage), including further controls and time fixed effects, while aiming to correct for the sample selection bias.

The non-parametric method, a Wilcoxon rank sum test, supports the discussion with insights less prone to a violation of the regression's normality assumption. As opposed to comparable methods, I decided to use this test method as it strikes a balance between appropriate sample size and familiarity. The dataset consists of 500 IPOs from up to 24 Western European countries between 2010 to 2020. The observations and further information are assembled from two separate subscription-based public sources. Information on VC-backing is collected from an established private markets database (Pitchbook). Else, IPO data and company financials are derived from Bloomberg. Both are independent and well-established market screeners with extensive information to support this research paper with quality data.

I expect to find evidence in support of the certification hypothesis. The theoretical mechanism outlined by those in favor of the certification hypothesis is more convincing to me than the 'transfer of wealth to new shareholder'-argument by their counterparts (Francis & Hasan, 2001; Lee & Wahal, 2004). Given the precautionary measures, we must observe the sign and significance of the main predictor (VC-backing) and the p-value of the Wilcoxon rank-sum test results to strike a verdict. Presumably, this paper will not be the end of the ongoing academic discussion, but it may reveal an additional layer of analysis, both in recentness on Western European markets and VC firm characteristics.

In the following chapters I will first outline the prevailing academic points of views on underpricing, venture capitalism and their relationships in a literature review. In the end of I will consolidate the learnings into an explanation of the theoretical mechanism to inform my research expectation. Then, I describe and contextualize my sample traits, explain variables, and present meaningful variable data characteristics. Moreover, I provide background on the appropriate research methodology that will uncover the models used to study the research relationship. Ultimately, I will discuss my results, provide a possible explanation for the paper's findings, and relate the results to other studies. To finish, I will comprise the key findings in a concluding paragraph.

# CHAPTER 2 Theoretical Framework

To unpack the effect of VCs on IPO underpricing I will first outline the theoretical mechanism behind IPO underpricing in detail. Each theory is explained and discussed according to syntax. Second, I explain and discuss the most relevant characteristics of VCs and their relations to capital providers and entrepreneurs as a specialized investor class. Last, the two lines of ideas converge to a coherent theoretical framework. In consideration of similar empirical studies, I will finally deliver an informed hypothesis over the expected effect.

## 2.1 IPO Underpricing

IPO underpricing is the "difference between the closing price on the first day of trading and the offering price" (Pennacchio, 2014, p.378). We may interpret it as a type of market anomaly as described by Akerlof (1970). Since information about newly issued companies is revealed sequentially after the IPO, the market learns about the true prospects of the firm over time. Then, according to the efficient market hypothesis (EMH), all relevant (available) information will then be reflected in the stock price.

### 2.1.1 Beginnings of Underpricing Theory

The first scholars to detect a 'new issue fever' were Reilly and Hatfield (1969). They asked whether the run on newly issued companies was justified. More than half of issuances exhibited a direct premium, but the authors were unable to identify a significant relationship. They compared investor returns between short-term (following Friday) and long-term (the Friday in 52 weeks). The authors acknowledged that there is an uncertainty of how the market would judge the issuing firm's past performance and future. Leading to the hypothesis, that underwriters have an incentive to price the issuer lower. Therefore, one can observe an average short-run (up to one year) outperformance. The authors argued that the hypothesis is adjacent to prevailing economic theory that investors should require a higher rate of return to be compensated for uncertainty of new issuances.

Following up, Ibbotson (1975) discovered the 'underpricing puzzle' without a clear solution. He concurred that further examination would be needed. A crucial part of his reasoning long prevailed. He hypothesized; issuers may want to leave a good taste. It refers to the possibility, that issues may be purposely underpriced to please and continue to attract investors. Alterations of this argument are still used in practice today.

### 2.1.2 Asymmetric Information

To grasp why new stock issues are underpriced we must understand one indispensable economic concept - information asymmetry. Information asymmetry refers to a situation where there is a knowledge imbalance between two parties. Originally discussed as an economic concept by Akerlof (1970), we know information superiority by one party causes an adverse selection effect. In response, the demand and willingness to pay shrinks in this given market. Contemporary review studies and meta-

analyses confirm information asymmetry as a primary determinant and the most established certainty in the ongoing IPO underpricing discussion (Ljungqvist, 2006; Daily et al. 2003).

The academic discovery is credited to Baron (1982) and Rock (1986), who discovered asymmetries across two separate levels. Baron (1982) introduced information asymmetry between underwriters and issuers as a formal explanation to the IPO underpricing phenomenon. He claims that investment banks are compensated for their information superiority about the market. The intuition is in line with Ibbotson (1975), that the higher the issuer's uncertainty about the market demand, the more valuable the bank's offer price decision. The author (Baron, 1982) shows that bankers' optimal effort will be below the first-best effort level. Consequently, the issue will be priced below the first-best price, which is what we understand as underpricing.

The second seminal study conceptualizes the role of asymmetric information between informed investors and uninformed investors and shareholders in new issuances (Rock, 1986). This assumption was later modified to a discrepancy between insiders (shareholders) and outsiders (IPO investors) (Welch, 1989; Grinblatt & Hwang, 1989; Allen & Faulhaber, 1988). The author establishes the presence of a winner's curse – informed investors participate only if the price is attractive relative to expected value and drive out uninformed investors. On the contrary informed investors decline bad issuances, leaving uninformed investors with an expected return below one. The concept helps us to understand, that underpricing is necessary to attract both (un)informed investors to purchase the issue (Rock, 1986). To engage uninformed investors, issuers must discount the price such that uninformed investors are compensated for their informational disadvantage.

We can conclude at this point that both Baron (1982) and Rock (1986) paved the way for an entire group of scholars. The core of their theories still prevails today and has shaped our thinking of IPO underpricing. In the subsequent subsections, I will outline two closely connected concepts that build and expand on their seminal contributions.

### 2.1.3 Ex-ante Uncertainty

Ex-ante uncertainty refers to the lack of knowledge about the true prospects of a firm before the issuance. Therefore, we may regard it as a more accurate reflection of the dynamic behind information asymmetry. The concept was brought forth by Ritter (1984), who studied the 'hot issue market' of 1980, where a natural resource boom fueled the IPO markets on an industry level. In this period, an unusually large number of companies went public within industries that rely on natural resources, and high-risk issues made up an uncommonly large share of IPOs.

Beatty and Ritter (1985) then started the analysis of 'ex-ante uncertainty' and point to an equilibrium relation between the uncertainty on a company's true value and the level of underpricing. Greater ex-ante uncertainty is hypothesized to lead to greater underpricing. This claim is overwhelmingly supported by the empirical evidence and still prevails today.

In that regard, Ritter (1984) offers an alternative interpretation, that is, underpricing is merely the compensation for investors for the costs of becoming informed. He suggests that large underpricing

is exhibited when information about the company is scarce and lower quality underwriters are at work. The study reveals that the effect is amplified in the issuances of startups at the time where uncertainty is assumed to be high. In the opposite case, Michaely and Shaw (1994) confirm information homogeneity across investors reduces underpricing close to zero. Consistent with this Beatty and Ritter's (1985) prediction, the authors show that average underpricing among 39 in-house IPOs completed between 1984 and 1988 is −.04 percent. Hence, we can support the statement that information disclosure is beneficial. The reduction in heterogeneity between uninformed and informed investors requires the issuer to underprice less to compensate for the winner's curse.

In summary, the introduction of 'ex-ante uncertainty' greatly contributed to the study of IPO underpricing, as it allows us to conceptually link the impact of information asymmetries to the evidence of underpricing. Various authors have hypothesized, and later confirmed, the positive relation between underpricing and asymmetrical information. Thereby, this body of work provided a starting point for the next wave of theoretical analysis - signaling theory. The next section will then round off the platform to understand the certification hypothesis (Booth & Smith, 1986).

### 2.1.4 Signaling Theory

As established, reducing the 'ex-ante uncertainty' is expected to decrease the degree of underpricing. In the following paragraphs I will highlight prominent papers that advanced our understanding of underpricing through signaling theory.

Three subsequent papers emphasized the role signals in overcoming uncertainty discounts and alluded to Ibbotson's (1975) theory of 'leaving a good taste investor's mouth' in different ways (Allen & Faulhaber, 1988; Grinblatt & Hwang, 1989; Welch, 1989). Notably, all three studies interpreted underpricing as a universally positive signal of quality, which we can partially devalidate. Today, we commonly assume that issuers evidently prefer certifiers to signal quality, which I will elaborate in the upcoming subsection. Nonetheless, the authors (Allen & Faulhaber, 1988; Grinblatt & Hwang, 1989; Welch, 1989) assumed an asymmetrical distribution of information between insider (issuer) and outsider (investor). Therein, it contrasts Rock (1986) and corrects for shortcomings of his winner's curse explanation. Today's scholars have largely adopted this assumption.

First, signaling was studied in the context of seasoned equity offerings (SEO). He hypothesized that quality firms could undertake a 'multiple-issue strategy' to distinguish themselves from poor-quality firms. The idea entails, that confident issuers accept the short-term losses as they expect to compensate them later by raising equity again, when more information about the true value becomes public. The underpricing of the IPO is regarded as costs to credibly signal quality, as this would be costly to imitate. Although theoretically the suggestion is sound, in practice, issuers use other signals and do not wait to realize their gain. Very similar in their conclusions and assumptions, Grinblatt and Hwang (1989) examined the degree of underpricing in relation to the entrepreneur's retained share. The authors find a positive relationship between the two variables. They developed a two-signal model from the entrepreneur to prospective shareholders, which formalized the ideas voiced by preceding scholars.

Allen and Faulhaber (1988) extended the range of signals a firm can use to signal value. They included many variables such as the choice of underwriter, and auditor, operating results, quality of the board to name a few. The authors followed up on Ritter (1984) to study hot market periods and in addition to testing various signals, they could confirm Ritter's observation that underpricing is subject to cyclical fluctuations.

In conclusion, signaling theory has further strengthened our understanding of underpricing because of information asymmetry. The leading scholars have corrected the pitfalls of Baron (1982) and Rock (1986) and complemented the seminal work by Ritter (1984) and Beatty and Ritter (1985). The upcoming section combines these academic advancements to outline the intuition behind certification - the essential hypothesis of this paper.

### *2.1.5 Certification Hypothesis*

Booth and Smith (1986) introduced the role of certifying agents, who can credibly reduce 'ex-ante uncertainty'. Consequently, certifiers may lessen the underlying adverse selection problem. The original certification hypothesis implies that investment banks act as financial intermediaries. When a company decides to go public, they are ought to verify information in the due diligence process and pitch the issuer to potential investors. Yet, investors cannot observe the bank's due diligence efforts and standards. Therefore, the key assumption of certification implies that investment banks serve the market repeatedly. It follows, that banks rely on their reputation and simply cannot risk transmitting false information. Over time, the investment bank's past performance becomes an approximation for the credibility of their signals. The information revealed is determined in a sequential equilibrium. In practical terms, investors and banks choose at each step such as to maximize their payoff. Any deviation is valued as a negative sign by investors.

To summarize the theoretical idea of certification, Chemmanur and Fulghieri (1994, p.59) state their empirical findings: "(...) the extent of IPO underpricing and the size of the negative stock price reaction around seasoned equity issues are decreasing functions of the reputation of the underwriters involved. (ii) More prestigious investment banks engage in underwriting contracts with less risky client firms. (iii) The greater the underwriter's reputation, the larger the amount of fees charged. (iv) The proceeds to a firm selling equity, net of underwriter fees, increase with underwriter reputation.".

However, certification is more valuable, when the potential wealth transfer increases due to information asymmetry. The greater the firm-specific risk, the more the firm would be willing to pay for certification. Later, Ljungqvist (2006) discusses that the choice of underwriter may be endogenous as firms that expect higher underpricing opt for more prestigious underwriters. Counterintuitively, the exhibited sign of the underwriter prestige variable has flipped to positive in a range of studies. This implies that more renowned investment banks exhibit greater underpricing. In line with Ljungqvist (2006), the best available explanation to rationalize this phenomenon is rooted in behavioral theories. An early paper by Bikhchandani et al. (1992) analyzed 'informational cascades. In essence, individuals choose based on the foregone decision of others, also known as 'herd behavior'. In relation to new

issues the authors (Daily et al., 2003) suggest that large groups of people feel invited to aggressively purchase stock certified by reputable underwriters, hence leading to larger degrees of underpricing.

These findings highlight the role of certifying agents as a producer of credible information. We learned that due to certifying agents' reputational capital at risk, they are incentivized to truthfully reveal information. As information is revealed in the IPO process, the 'ex-ante uncertainty' can be reduced, which is hypothesized to have a negative effect on the expected underpricing. Recent empirical studies have shown contradictory results and offered possible explanations. The most appealing argument proposes behavioral theories to explain more of the evidence. Further research is needed to assess these propositions. However, in the context of this paper, the focus is set on venture capitalists as certifiers of information. The following chapter will provide an overview of this specific investor type.

## 2.2 Venture Capitalism

Venture capital (VC) is a specific type of private equity investor, or a source of funding for privately held companies. Gompers and Lerner (2001) documents that the first true venture capital firm was American Research and Development (ARD), established in 1946. Their investments focused on high-risk investments in emerging companies developing technology for World War II. Then, the first limited partnership, Draper, Gaither, and Anderson, was formed in 1958. Before then the industry experienced a large influx in the 1990s in terms of fundraising, number of registered VCs and numbers of IPOs.

Three characteristic features of VC investors, as defined by Tyebjee and Bruno (1984), are: (i) invested in young firms with little performance history; (ii) investments focus on small firms and the investor and investee relationship involves a higher degree of direct involvement; (iii) venture capital investments are illiquid in the short-term because of the lack of efficient capital markets for equity shares of privately held companies.

Second, VC firms are organized in form of a limited partnership (LP), with the venture capitalists serving as general partners (GP) and the investors as limited partners (Sahlmann, 1990). The venture capitalists are agents to the limited partners, which utilize the intermediary to finance entrepreneurial firms. Therefore, the fund manager (GP) is obliged to report back to their capital providers. The LPs structure the compensation as to incentivize the fund manager to maximize returns. Venture Economics, a popular VC database, reports that half of the questioned funds include an annual management fee equal to 2.5 percent of committed capital until liquidation of the fund. 88 percent of the venture capitalists are entitled to 20 percent of the realized gains on the fund. This is also known as 'carried interest'.

### 2.2.1 Investment Process and Decision Criteria

First, I would like to manifest how venture capital investors pick their portfolio companies as this has considerable applications for this paper.

Briefly, as for the screening phase Tyebjee and Bruno (1984) determine five relevant considerations. At this stage VCs usually look at ticket size, the scale of the investment, investment focus of the fund, congruence with fund's agenda, the sector, location, and stage of the company. This part is most commonly preceded by either an online research or an industry peer's referral (Botazzi et al., 2004).

Authors structure their decision frameworks in different levels of detail, yet point to the same essential factors. I focus on Fried & Hisrich (1994) as the authors have built on and improved Tyebjee and Bruno's (1984) model.

The authoritative paper divides the decision criteria into three groups: concept, management, and returns. Let us break it down into its parts. 'Concept' pertains to the idea's future earnings potential. VCs are looking for concepts that can be brought to market in a reasonable timeframe with reasonable capital requirements. 'Management' intuitively regards the leaders' integrity and judgements skills as well as their understanding of the organization. Multiple papers stress the importance of those two factors, and report variance in their respective weighting across VC investors. A helpful metaphor to describe the relationship between those two concepts is 'jockey and horse'. The third and final factor is 'returns'. Here, investors stress the importance of exit opportunities and the potential for high absolute and rates of returns.

The authors have assessed and validated their framework through a combination of personal interviews and a criteria-based evaluation model across a broad sample of VC investors. We can assume, VCs would verify this to be indeed representative of their actual investment process. In summary, VC firms consider a firm's concept, management and returns potential when evaluating prospective investment opportunities.

### 2.2.2 Agency conflict – Contracting, Syndication and Staging

The investments of venture capital severely suffer from an agency problem, which arises from an asymmetrical distribution of information (Gompers, 1995). To deal with this issue, VCs investors have invested into designing effective control mechanisms. Scholars have identified three primary tools: (i) the use of convertible securities; (ii) syndication of investment; and (iii) the staging of capital infusions. The following paragraphs lists their characteristics and intended effects on all stakeholders. Then, the role of incentives in harnessing agents and mitigate conflicts will become clear.

Intuitively, fund managers' compensation is heavily linked to fund returns. Similarly, VC contracts with entrepreneurs are designed to mitigate the underlying agency conflicts. First, VCs often attain a special type of equity, namely convertible preferred stock. As the name would suggest, convertible preferred stock allows the VC investor to convert the option into common equity at a specified time. There are three common features of this instrument: (i) conversion price, which can vary according to the performance of the company; (ii) liquidation preference, a right of remuneration before other equity-holders like debt; (iii) dividend rate, payment terms, and voting rights, usually conditional on performance targets. These conditions shift risk to the entrepreneurs and incentivize them to meet the dedicated targets, while VC investors can inform their decisions (Da Rin et al., 2013). During the

holding period, the VC investor will monitor the company's prospects and require regular transmission of inside information. Gompers (1995) further mentioned that due to tighter regulations VCs are better suited to extensively monitor and produce valuable information. He argued further that VCs are especially skilled at evaluating projects with high ex-ante uncertainty. Periodically, the investor will then decide whether to exercise or abandon the option to convert. If the VC learns negative information about a company's prospects, they do not hesitate to withdraw from the venture. But despite the entrepreneur's tight corset, there are checks and balances for the VC investor as well. The author argues that VCs who abuse contracting at the cost of the entrepreneurs, will decrease the chance of attracting the best companies. In consequence, VCs who cannot attract the best entrepreneurs have a harder time raising new funds. This observation alludes to the VC's reputational capital at stake.

Next, syndication refers to multiple VCs joining forces to invest into a company. This is a very common occurrence and serves the purposes of sharing costs and efforts, maximizing the firm's profits through higher amounts invested and a broader knowledge base. VCs usually revert to partners from their network to invest along as they prefer to invest in homogenous syndicates (Gompers & Lerner, 2001). This observation is the line with 'second opinion hypothesis', which states that investors are looking to test their views through a peer firm within the same community.

Last, staging refers to a specialized type of investments in sequences over time commonly applied in VC. One may think of it as a call-option as they share similar characteristics, particularly the option to exercise upon success, and else abandon. It allows the investor (VC) to reevaluate a company several points in time, and often ties reinvestment to performance measures. Thereby, the investor can reduce the risk involved, and react to negative signals from the portfolio company. It is characteristic of VCs to invest multiple times with increasing amounts, as the project progresses. Further Sahlmann (1990) states that it serves another purpose, which is filtering out candidates that are not able, or willing to follow those risk-shifting conditions. Gompers and Lerner (2001) notes that one must consider that staging is an incomplete contract, and it is challenging to empirically test the effectiveness of staging. We can only compare outcomes in hindsight; hence, it would be tough to separate the firm's performance from staging effects.

All things considered, we understand that VCs have designed solutions to mitigate agency conflicts between themselves (principal) and the entrepreneur (agent). Meanwhile, they closely monitor the company's prospects and make investment decisions in stages. We can assume that VCs are excellent information producers and hold valuable information about their portfolio companies. To further decrease firm-specific risks, VCs syndicate with other like-minded investors that can confirm the VCs evaluation of a company's prospects.

## 2.3 IPO Underpricing in the Presence of Venture Capital Investors

The upcoming section consolidates the separate discussion on venture capitalism and underpricing to a cohesive narrative how the two topics may be related. I will first summarize the

hypothesized relation in a brief theoretical discussion. Then, I will discuss related papers and their findings to inform my expectation at the end of this chapter for the following analysis.

### 2.3.1 Theoretical Discussion

From the discussion on fund manager's (GP) compensation structure we know that their income is directly linked to the fund's return. To materialize returns, their investment needs to be liquidated. Oftentimes, the preferred option is an IPO, as it is believed to be the most preferable exit route. We can assume that as a rational consequence the VC would like to maximize the proceeds from an IPO. Second, VCs are specialized in producing information that is valuable to outsiders and can reduce the 'ex-ante uncertainty'. Third, VCs signal quality as they choose to reinvest due to the staging of capital infusions. Fourth, VCs syndicate to invest in companies. If multiple investors confirm the information and sequentially reinvest their funds' capital, the signal's credibility enhances. In short, VCs are financial intermediaries, like underwriters, and are trained to produce and certify insight information.

With regards to underpricing of IPOs the consensus is that information asymmetry is a primary factor in the expected degree of underpricing. In turn, it causes an adverse selection problem for potential investors (outsiders) that arises from the 'ex-ante uncertainty'. The certification hypothesis suggests that intermediaries that frequent the market, such as investment banks and VCs, can credibly reduce the ex-ante uncertainty, hence the expected underpricing. Scholars find variance in underpricing and hypothesize about cyclical fluctuations or behavioral phenomena as additional considerations. However, certification, by consensus, is regarded as one major force.

### 2.3.2 Empirical Discussion

Underpricing is most observed between individual firms. All studies considered in this paper, investigate IPO underpricing on the same unit of analysis - the firm level. Booth and Smith (1986) have initiated the research on certifying agents' impact on IPO underpricing. Rather than VC investors, the authors considered investment banks as certifiers of inside information to reduce the adverse selection effect. They outlined the rationale for the certification hypothesis based on previous research on IPO underpricing and found evidence in support of it. We may view this as the commencement of further research in this field. From today's perspective we must note that various factors, including the macro-environment or information reach, have changed since then. Megginson and Weiss (1991) introduced VCs as another certifying agent, as a partial substitute or complementary to underwriters. Despite similar concerns over today's representativeness of their findings, the authors examined a larger sample of US IPOs and found further evidence in support of previous studies (Akerlof, 1970; Booth & Smith, 1986). They concluded that "(...) the presence of venture capitalists in offering firms maximizes the fraction of the proceeds of the IPO, net of underpricing and direct costs, which accrues to the issuing firm." (Megginson & Weiss, 1991). The authors reason that outsiders ought to believe VCs signals

through the assumption of reputational capital. That implies that provision of false information will adversely and materially affect the certifier.

On the other hand, later studies by Lee and Wahal (2004) and Daily et al. (2003) found the opposite effect. As Daily et al. (2003) expressed their surprise in their conclusion over their findings, Lee and Wahal (2004) referred to cyclical fluctuations across a large global sample and the wealth transfer from pre-IPO shareholders to new shareholders as a potential cause. They suggested that the positive relationship between first day returns, and future fundraising (a form of grandstanding) may explain the reverse sign of the VC variable (Lee & Wahal, 2004; Gompers, 1996). Notably, the authors applied statistical correction methods but do acknowledge multiple sources of endogeneity that may harm the validity of their results (Lee & Wahal, 2004). The latest paper by Pennacchio (2014) considered the Italian market only. Related but more restricted as this paper's scope of Western Europe, the author found evidence in favor of the certification hypothesis. He advanced on the contrarians' (incl. Lee and Wahal, 2004) claims, and paid particular attention to endogeneity issues (Pennacchio, 2014). The author applied several non-parametric tests as well as a matching procedure to account for the sample characteristic's pitfalls. The recentness of the sample, statistical diligence, and geographical proximity to this paper suggest that Pennacchio (2014) may be the closest comparable study of those considered in the discussion.

### 2.3.3 Research Expectation

By and large, studies of the VC's effect on IPO underpricing have yielded different results. Given the relevant literature's practical implications, I would think that it is most feasible to assume that VCs will reduce the degree of underpricing due to their ability to certify information. However, it is likely one of many things to impact underpricing.

**H1: IPO underpricing will reduce under the presence of a venture capitalist.**

# CHAPTER 3 Data

The following section will describe the dataset and highlight unique traits. I will then lead you through the variables in the regression analysis. For each variable, I define and discuss them while providing some background and remarks we should keep in mind throughout the rest of this study.

## 3.1 Data description

To study the effects of VC on underpricing, this study examines a sample of 2,270 Western European companies, 192 of which canceled or postponed the planned issue. The sample reduced to 1,419 observations for all other issuers after eliminating observations with missing values for first-day underpricing or issue dates. One hundred twenty-nine issuers were flagged as VC-backed, accounting for 9.09 percent of observations. As opposed to selective approaches to data collection as in Pennacchio (2014), I aimed to capture a large sample while meeting the minimum information requirements. The sample period stretches from January 1st, 2010, until June 2023, also the data collection time. I decided to start in 2010 as it marked the first year of normalization after the acute financial crisis 2008, which has already been extensively studied. Over time the frequency of issues varies with high influx periods around 2014, 2018, and, foremost, 2022, as depicted in Figure 1. The extreme values for underpricing of IPOs range from -86.07 percent to a peak of 1005.56 percent (Figure 2). The mean underpricing across the entire sample is 12.29 percent, yet with significant deviations in the sample as suggested by 59.8 percentage points of standard deviation.

**Figure 1**

*Density of Issues per Issue Date*
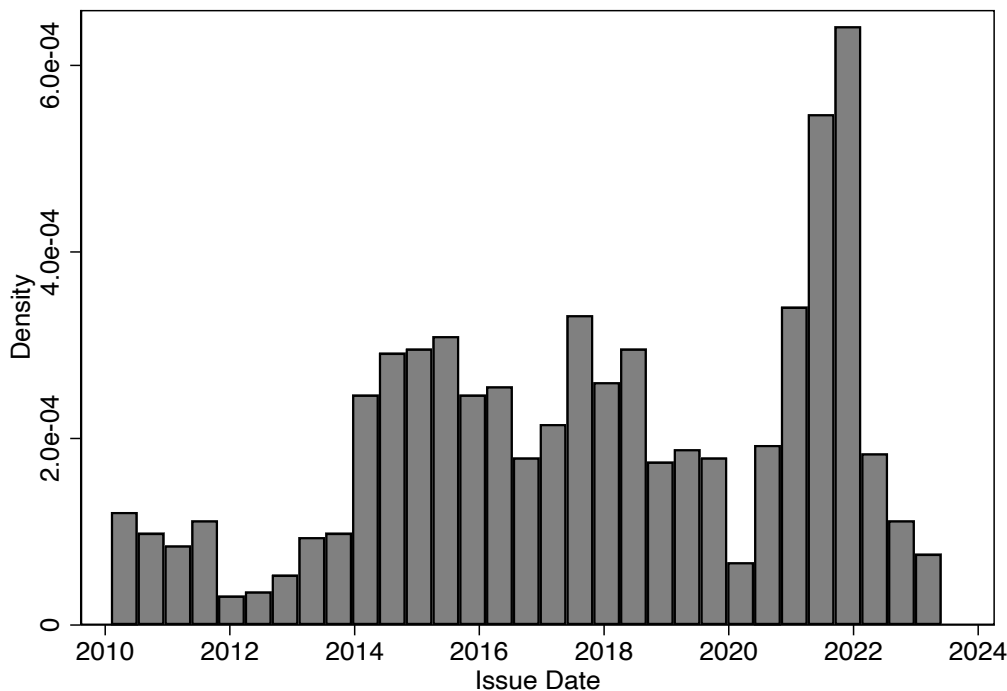
*Note.* The figure above is a histogram that visualizes the density of issues over the sample period. The y-axis reflects the density for the respective issue date on the x-axis. While the interpretation of the density may be cryptic, the figure nonetheless provides a helpful visual presentation of potential peaks in issue periods, alluding to the hot market cycle concept.

We can see that the influx into the issue market is most pronounced around 2014, 2018 and especially 2022.

The data was obtained mainly from Refinitiv Eikon Reuters' terminal (DSCREEN function). They offer various listing, financial, and other circumstantial information criteria for IPOs and more capital markets activity. One may add deal criteria in columns and export the data to Excel. Each variable may be added and operationalized, as explained in the respective section. I then reduced the dataset such that all observations are represented once, containing a value for first-day underpricing and a registered issue date. Despite its reliability and wide range of screened issues, Refintiv only fractionally covers relevant firms' financials and deal-specific data such as fees. There is a tradeoff to be addressed, which I considered in the different specifications of the analysis. The second dataset exclusively contains observations with their offering status market as 'canceled' or 'postponed' and a value for the planned issue date. Moreover, data pertaining to VC and PE firms' assets under management (AUM) was retrieved from Pitchbook to approximate investor's reputation. They offer a wide range of public and private market data with in-depth information about multiple investor types and target companies. However, due to substantial costs for queries, my access was limited.

## 3.2 Variable Description

In the following section, I will describe and provide context on the variables included in the statistical analysis. Starting with the main variables of interest, I proceed to the control variables sorted by their domain. Connecting to the description, I will highlight noteworthy aspects about the data and characteristic differences across variable groups. A full overview of the summary statistics and tabulates is provided and explained in Appendix A.

### 3.2.1 IPO Underpricing and Venture Capital

The distribution of **underpricing** (dependent variable) *Y*, IPO underpricing, is defined as the percentage change from offer price to closing price at the issue date for each observation *i*. It is computed as presented in the following Equation 1:

$$IPO\ Underpricing_i = \frac{P_{EndIssueDay} - P_{IPO}}{P_{IPO}}$$

*Note.* The equation above outlines the calculation of first-day underpricing. You take the difference between issue price and closing price at the end of the first trading day and divide it by the issue price.

Underpricing varies substantially across the sample groups, as seen in the significant difference between means for VC-backing (3.09 percent) and non-VC-backed companies (13.21 percent), as

exhibited in Table 1. I found evidence for the non-normally distribution of underpricing data due to significant skewness and kurtosis across the observations with heavy tails in line with related studies (Pennacchio, 2014). The standard deviation scale relative to the mean for non-VC issuers suggests that the sample is broad and heterogeneous in the issuers' offering profiles.

**VC-backing** (independent variable) is represented by a binary variable that takes the value one in case an issuer is backed by a VC and zero otherwise. Only 9.09 percent, 129 issues total, of all observed IPO companies were backed by venture capitalists. The lower fraction of VC-backed issues may likely be connected to differences in the sample selection process. Concerning underpricing, VC-backing exhibits a negative correlation coefficient (Table 2), and the sample means and medians are substantially lower than other issuers. The descriptive statistics provide evidence in support of certification.

**Table 1**

*Underpricing Descriptive Statistics*

|  | Mean | Median | SD | Skewness | Kurtosis | Obs. |
|---|---|---|---|---|---|---|
| Total IPOs | 12.28 | 3.46 | 59.80 | 12.87 | 197.68 | 1,419 |
| Non-VC-backed IPOs | 13.21 | 3.88 | 62.50 | 12.36 | 181.50 | 129 |
| VC-backed IPOS | 3.09 | 0.38 | 13.48 | 2.39 | 16.30 | 129 |

*Note.* The table lists detailed summary statistics on the dependent underpricing variable across the entire sample, VC- and non-VC-backed firms. From left to right you may see the mean and median for each group and the standard deviation all in percentage points. Followed by distributional traits skewness and kurtosis with higher scores indicating a right-bound distribution. Lastly, I listed the numbers of observations for each of the three groups. We can see that VC-backed IPOs are on average significantly less underpriced. The standard deviation although, is also much larger for non-VC-backed issues.

Yet, in connection to that 11.13 percent, 158 total issues, were backed by other types of **private equity** companies such as most commonly, leveraged buyout (LBO) firms (Table 3). The variable is characteristically similar and adjacent to the conceptual role of VCs, private equity investors are a common funding source for later-stage companies. Like VC-backing, the PE variable too, is negatively correlated to underpricing. Crucially, both variables may be reversely causal by construction as the choice of being selected by VC is assumed to be non-random across related studies.

### 3.2.2 Control Variable Description – Firm Characteristics

To isolate the effect of VCs on underpricing, I add three sets of control variables to the regression equation - firm, offering, and macroeconomic characteristics. Factors that may influence the ex-ante uncertainty or risks involved in an issue are included. X is the vector for the set of control

variables for each observation I and is the corresponding vector for all controls' coefficients. I will elaborate on the included controls in the upcoming section.

Starting with **age**, defined as the difference between founding and issuing date, the variable shall proxy the degree of establishment and certainty about a firm's prospects. Conforming with this explanation, age is negatively correlated with underpricing. Although VCs are known to invest at early stages, the median age at issue is only approximately 1.5 years below that of all other issuers. Unfortunately, not all founding dates were available; consequently, only 911 companies contain values for age (Table 4). Next, the **country** of the issuer is a simple string variable that reflects the location of an issuer's incorporation and is sought to compare underpricing across different nations. Geographical distribution may impact a company's access to capital or a valuable network. The sample is exceptionally concentrated in the United Kingdom (407), with close to half of all observations coming from the UK and related states such as Guernsey (36) or Jersey (22) (Table 5). All 58 listings on the British Islands are secondary, implying that the issuer's primary exchange is somewhere abroad. Other well-represented countries are Sweden (215), Italy (162), France (75), and Germany (74). Moving on, the business sector or **industry** control captures a cross-industry variation as categorized by Reuters. From 30 sectors, the largest share consists of service industries such as 'financial & investment' or 'software & IT' service providers. Together these two industries make up a cumulative share of 32.54 percent, only 6 percent of which are VC-backed (Table 6). With 53 percent, the highest concentration of VC-backed issuers is exhibited in Pharmaceuticals and Medical firms. This study expands the analysis of **reputational capital** to an ownership-specific proxy variable. This idea pertains to the argument that private investors can credibly certify information because VC and PE investors repeatedly visit the market. If one abuses the certifying role, this investor must expect a reputational punishment for transmitting false information. In support of this theoretical explanation, the correlation matrix (2) shows a negative relation to underpricing. VC and PE firms' prestige is assumed to be well-indicated by their assets under management (AUM). Lenders and capital providers carefully consider who to entrust their funds with. VC and PE firms AUM is divided into five categories: less than $100M (1), less than $1B (2), less than $10B (3), less (4), and more than $30B (5). I have manually retrieved the data from Pitchbook across all firm names uncovered by Eikon Reuters. The mean underpricing consistently decreases and exhibits lower standard deviation with a higher firm reputation, except the second highest category due to a lack of observations. However, this observation may also reveal something about the top-heavy distribution of funds since category five funds back close to 40 percent of VC- or PE-backed issues with mean proceeds approximately double of category three and seven times that of category one investors.

Firm characteristics are rounded off by four indicators of financial size and ability. The variables approximate an issuer's financial size, past performance, and ability to generate cash going into the first trading day. **Total proceeds** count the amount of capital raised (in millions of Euros) from the issue, including additional proceeds from the overallotment option. Notably, VC-backed firms

generated 40 million Euros less compared to other issuers. **Book value (BV) per share**, **total assets**, and **net income after tax before offering** (in $USD) reflect the auditors' view of the company's state. The accounting statements commonly serve as a start-off point for financial valuation assumptions and are adequate proxies. As I mentioned earlier, I could only obtain information on 1,113 companies for total assets and net income after taxes, and 729 observations also covered the book value per share ratio. Overall, non-VC-backed companies exhibit more than four times higher book value per share, seven times higher total asset values, and, most interestingly, positive as opposed to negative income after taxes.

### 3.2.2 Control Variable Description – Offering Characteristics

The first set of offering-specific controls shall characterize the macroeconomic environment at the offering time. Proponents of certification (i.e., Megginson & Weiss, 1991; Pennacchio, 2014) have disregarded the macro climate to a large extent. To critically challenge the VCs' true effect on underpricing, I follow the challengers' approach of Lee and Wahal (2003). In their time series, the authors showcase inter-periodical differences regarding fundraising activity and capital flows. To adequately approximate these considerations, monthly the analysis contains year-over-year **inflation** as it impacts companies' real value and investment strategies. Second, one-year **LIBOR** rates represent the long-term risk-free rate for institutional borrowers, which would followingly impact fundraising activity and capital flows. Both inflation and LIBOR rates exhibit a sharp incline approaching the end of the sample period. While inflation is slightly positively related, LIBOR rates are negatively correlated with underpricing. This may suggest a potential push-and-pull dynamic between the two components. The data is provided by inflationtool.com and macrotrends.net, respectively; both collect data from public institutions and offer accessible exporting options. Then, **percentage of failed and postponed IPOs,** relative to successful IPOs per year, shall reflect market sentiment in each period. The peak occurred in the COVID-19 year of 2021 with 33 failed IPOs, accounting for 10,12 percent.

The following group of control variables consists of general offering characteristics. Starting with **underwriter reputation**, which signals whether an underwriter has led more than ten (2), less than five (0), or between five and ten issues (1). This is a categorical augmentation to the market-share approach (Megginson & Weiss, 1991). Underwriters are an integral player in the IPO process as advisors and distributors to the issuers and certifiers to outsiders. Most reputable VCs work relatively more with the most reputable underwriters (Table 7). Although the sample statistics do not reflect the claim that the choice of underwriter may be endogenous. The proposition implies that lower-quality issuers seek high-quality underwriters. Furthermore, underwriter reputation is negatively correlated with underpricing in line with the proposed role of reputational capital in certification. Moving on, **secondary listing** is a variable that indicates whether the company's main stock exchange alters from the specific listing observation. The summary statistics show that 11.84 percent of observations were secondary listings, as exhibited in Table 3. This measure may cause a variation in ex-ante

uncertainty as information is already publicly available through another exchange at the time of issue; consequently, it would reduce underpricing. More than 90 percent of secondary listings are non-VC issuers, and the correlation coefficient is negative. Next, **offering technique** may be many combinations, but most commonly, a version of 'offer for subscription' is used. The subscription-only variant makes up a share of 54.76 percent of all issues excluding hybrid types. The difference between mechanisms implies different risk allocation between insiders and outsiders. Underwriters with lower reputations engage relatively more often in firm commitments that carry the risk of the issue than more reputable underwriters who usually engage in subscription offerings. Then, a **filing-to-issue** variable count the days from IPO filing to its issue date. It shall approximate the complexity of an IPO process and can reflect the degree of ex-ante uncertainty. The distribution over backing types suggest that VCs and PEs may reduce the time of the IPO process (Figure 3). Proceeding onwards, **syndicate type** is a categorical variable that distinguishes between underwriter organizations. Either a new issue is led by multiple (syndicated, 2), a single (sole managed,1), or no (0) underwriter(s). This proxy shows the impact of variation in the amount of potential underwriting certifiers. Most deals are either sole-managed (530 observations) or syndicated (682 observations), indicating that firms prefer the underwriter's distribution services. Only four VC-backed issuers did not use an underwriting firm in the IPO process, unlike 203 other companies.

A novel consideration in underpricing studies is the binary **sustainable finance** variable. Sustainability concerns and their relation to firm-specific risk are increasingly important to consider through the lens of institutional investors today, as suggested by the negative correlation to underpricing. Only 28, 1.97 percent, and five VC-backed, meet Refinitv's ESG requirements to be awarded such a flag.

The last offering-related variables regard special rights, clauses, and provisions that may serve as signals of value from insiders to outsiders. Starting with **lockup provision** as a binary variable, which prevents pre-IPO shareholders from selling their shares for a specified time. Just 60.54 percent of issuers utilized this option, and even less than half of VC-backed issues. This fact is surprising. Theoretically, lockups can effectively align incentives between insiders and outsiders to signal value. However, the main source of VC returns is the liquidation of active investments, which may explain the counterintuitive observation. Subsequently, **lockup type** specifies the combination of lockup clauses. Lockups most commonly involve management and other current shareholder lockups. Furthermore, the **overallotment** or greenshoe option allows underwriters to sell up to 15 percent additional shares after the issue. The objective is to stabilize the price once the issue is public In line with related studies, a binary variable indicates the presence of an overalltoment option. Issues with more fluctuations or purposely discounted issue prices signal a greater degree of uncertainty. While most VC-backed issues include such an option, all other companies predominantly did not. Lastly, the binary **rule 144A** variable refers to the right to privately place shares with institutional investors without the need to comply with registration requirements. This option allows selling shareholders to groom ties with

strategic investors including banks or mutual funds at privately negotiated terms. Second, it may serve to increasing liquidity for the newly issued shares. Both are desirable objectives for the issuer and are negatively correlated with underpricing.

**Table 8**

*Hypotheses for independent control variables*

| Variable | Variable Type | Expected sign |
|---|---|---|
| PE | Firm-specific | - |
| VC Syndication | Firm-specific | - |
| Proceeds | Firm-specific | - |
| Age | Firm-specific | - |
| Total Assets | Firm-specific | - |
| Percentage of failed IPOs | Macro-specific | - |
| LIBOR | Macro-specific | + |
| Inflation | Macro-specific | - |
| Sustainable Finance | Offering-specific | - |
| Filing to Issue | Offering-specific | + |
| Lockup Provision | Offering-specific | - |
| Rule 144A | Offering-specific | + |
| Syndicate Type | Offering-specific | - |
| Underwriter Reputation | Offering-specific | - |
| Secondary Listing | Offering-specific | - |
| Overallotment | Offering-specific | + |

*Note:* The table above visualizes the expected signs for all included control variables. As the main independent variable, VC, has an already defined expectation, I now provide an overview of all other variables from the model. The column from left to right present the variable names, their domain and lastly, their expected sign regarding the impact on underpricing. The expectations are founded on the understanding developed in the theoretical discussion.

# CHAPTER 4 Method

To adequately examine the effect of VC-backing on the expected degree of underpricing in IPOs, I conduct two separate (non-)parametric statistical analysis methods. Each of the tests is processed using a STATA package, comparable to R or SPSS. In the upcoming two sub-chapters I will describe and explain the statistical tests applied in this study. For one, I predict the expected degree of underpricing using an ordinary least-squares (OLS) regression model including an additional Heckman correction model. Second, I will apply the Wilcoxon-rank-sum test as this non-parametric test, which is more robust to non-normally distributed data as exhibited here.

## 4.1 Parametric Method

In the parametric statistical analysis, I regress the degree of underpricing on the presence of a venture capitalist. The standard regression model contains further control variables and a time fixed effect coefficient. The Equation 2 reads as follows:

$$IPO\ Underpricing_i = \alpha + \beta_1 VC_i + \delta \boldsymbol{Controls_i} + \tau_t + \varepsilon_i$$

*Note.* The equation above depicts the regression model. On the left IPO underpricing is the dependent variable, regressed on VC with its coefficient $\beta_i$ for each observation *i*. The constant and error term are represented by $\alpha$ and $\varepsilon$, respectively.

OLS regressions shall find a predictor for the VC's effect on IPO underpricing that minimizes the sum of squared residuals between the predicted and the actual value. The hypothesized effect is tested with a two-sample t-test. Since previous studies have showcased evidence opposite of the certification hypothesis, a one-sided test is inadequate. The variable's corresponding beta-coefficients indicate the sign and the magnitude of the predicted effect, while the p-value measures the significance of each predictor. The closer the p-value is to zero, the more significant the effect. Moreover, the 'goodness-of-fit' between the predicted and actual data is reflected by the r-squared value, which assess the independent variables' explanatory power of the model's variance. The closer the r-squared value converges to one, the better the model fits the actual data.

Meanwhile, I include a vector of control variables, which may impact underpricing next to VCs. These factors shall isolate the effect of VCs on underpricing. Congruent with related studies these controls reflect firm-, offering- and macroeconomic-specific circumstances. Then, I add a coefficient of the time fixed effects in the model. This is included as various relevant academic articles showcased a cyclical component to IPOs and the connected underpricing. It shall absorb any time-related components that may deter the variables' effect on underpricing. STATA offers a function to include such a variable into the regression model.

Evidently, VCs do not randomly select their portfolio companies as I have outlined the selection criteria. This fact is discussed in the theoretical framework and dealt with similarly in related papers.

Consequently, there are unobserved predispositional differences the standard model (Equation 1) does not account for. To address the issue, I include a Heckman (1979) correction. The procedure entails a two-step procedure. The selection equation entails a range of factors that may impact the VCs investment decision. The selection equation is a probit-regression that determines the likelihood of being targeted by a VC investor based on firm and macroeconomic variables. The Heckman selection Equation 3 reads as follows:

$$\varphi_i = \rho \textbf{\textit{FirmCharacteristics}}_i + \delta \textbf{\textit{MacroCharacteristics}}_i + u_i$$

*Note.* $\varphi$ denotes the probability of each issuer *i* to be selected based on the regressors of firm- and macro-characteristics.

The variables considered start with age since VCs are known to invest in companies at earlier stages. Continuing with firm financials including BV per share, total assets, and net income after taxes. These factors reflect a firm's ability to generate and retain value. They allude to the aspect of returns from the theoretical discussion. Country and industry reflect a company's access to capital and network. Furthermore, the variables may approximate differences regarding the 'concept' criterium. These are assumed to vary across industries and countries. Lastly, LIBOR and inflation shall approximate the VCs predicted costs of refinancing and ability to liquidate the investment at the time of entry. In essence, this selection equation measures the issuer's probability of being selected as a target company by a VC firm and addresses the sample selection bias in the data. The second step involves including the inverse of the Mills-ratio (IMR, Equations 4 and 5) into the main equation to account for the selection process. Given a sample selection bias, the Heckman correction allows for a consistent estimation in the main regression model.

$$E[X \mid X > \alpha] = \mu + \sigma \frac{\phi(\frac{\alpha - \mu}{\sigma})}{1 - \Phi(\frac{\alpha - \mu}{\sigma})}$$

$$E[X \mid X < \alpha] = \mu - \sigma \frac{\phi(\frac{\alpha - \mu}{\sigma})}{\Phi(\frac{\alpha - \mu}{\sigma})}$$

*Note.* Here, with X as a random variable $\alpha$ marks the constant, $\mu$ the sample mean, and $\sigma$ the standard error. $\phi$ Is the standard normal density function, and $\Phi$ the standard normal cumulative function.

Finally, regarding the Gauss-Markov OLS regression assumptions, the specifications are tested for each assumption. This shall ensure the best possible prediction and inform the interpretation for any possible pitfalls. The tests were conducted through the corresponding commands in STATA and displayed attached to regression Table 9.

First, to avoid issues with linearity and improve additivity, continuous variables are logarithmically transformed. Homoskedasticity is rejected by the Breusch-Pagan test, and consequently robust standard errors were added to the model specifications. Then, the normal distribution of the

residuals is rejected for all specifications by the Shapiro-Wilk test at the one-percent level (Table 9). Therefore, a non-parametric analysis will complement the regression. Exogeneity is tested with the Ramsey test and rejected for all models. This meets the expectation as pointed out in the literature review, there are likely omitted undiscovered impact next to those discussed. Finally, multicollinearity issues are preemptively avoided by examining the correlation matrix (Table 2). Except the deliberately large model specification the regression analysis follows the principle of parsimony. This is further reflected in the mean VIF value in Table 9. However, the mean is primarily affected by a slightly higher scores of single industry and country variables, while the other variables are reasonably low.

In conclusion, all relevant assumptions were tested, and precautions were taken. Proceeding, the regression analysis should deliver the best possible results after addressing present concerns. Merging all listed considerations, the extended regression Equation 6 reads as follows:

$$IPO\ Underpricing_i = \alpha + \beta_1 VC_i + \delta \boldsymbol{Controls_i} + \tau_t + IMR + \varepsilon_i$$

## 4.2 Non-parametric method

In addition to adaptations to the regression-based approach I perform a non-parametric test. The Wilcoxon rank sum test, also known as the Mann-Whitney U test is advantageous over regression models' t-tests in dealing with non-normal data distributions. The observations are grouped by one variable, VC, and then assigned a rank in order from lowest to highest with regards to underpricing. It then tests the null hypothesis of no difference across the split samples and reports a p-value corresponding to a z-score.

The test method is designed to deal with differences among two test groups within the sample, VC-backed against all other observed companies. In the context of this research this test method may provide additional information on the true effect of VC-backing on underpricing as the limitations of regression analysis are known. For one, the observability of impacting factors that may lead to different levels of underpricing is limited. Maybe more importantly, the characteristics of the relationship between the variables of interest are subject to less strict assumptions. We know ex-ante that the choice of being selected by a VC as an investment target is non-randomly distributed, while close to all variables exhibited non-normal distributions as shown in the Shapiro-Wilk test. Henceforth, after preliminary and regression testing, the Wilcoxon rank sum test is an adequate third layer of analysis to explore the complex true relationship between underpricing and venture capitalists.

# CHAPTER 5 Results & Discussion

The following chapter bridges the formal analysis and expectations formulated in the theoretical discussion. I will highlight my key findings in consideration of the model's explanatory power. This entails an outline of the coefficient's interpretation to navigate the analysis' output. I will proceed to present the non-parametric test results as a complementary layer of analysis. Subsequently, the results will be. Imbedded in a discussion and provide a possible interpretation of the evidence.

## 5.1 Results

The analysis contains five model specifications (Table 9). The first model exclusively entails the effect of VC-backing on IPO underpricing. The second is designed to maximize the number of observations while including as many of the relevant control variables discussed in the theoretical chapter. In connection, the third model entails the same variables including the Heckman correction. Similarly, the fourth and fifth model includes all relevant control variables and interaction effects. The difference again is the inclusion of the Heckman correction in the fifth specification. Furthermore, both models entail logarithmic transformations, which attempt to improve additivity and enhance the models' accuracy in light of the variables' non-normal distribution.

**Table 9**

*OLS Regression Output*

| Underpricing | | Specification | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| VC | | -10.12*** | -8.39** | -16.17** | -33.38** | -45.04** |
| | | (2.10) | (3.64) | (7.21) | (16.89) | (22,77) |
| PE | | | -4.88* | -5.54 | -4.71 | -4.59 |
| | | | (2.66) | (4.89) | (5.87) | (7.72) |
| VC Syndication | | | | | | |
| | Not Syndicated | | 8.08 | 12.23 | 6.80 | 9.67 |
| | | | (6.10) | (11.12) | (9.04) | (12.36) |
| | Syndicated | | 2.42 | .74 | -2.65 | -6.91 |
| | | | (3.55) | (6.41) | (6.76) | (10.11) |
| Proceeds (ln) | | | .01 | -.01 | 1.86 | 2.32 |
| | | | (.01) | (.01) | (3.34) | (3.52) |
| Filing to Issue (ln) | | | .01** | -.01 | -.69 | .96 |
| | | | (.01) | (.01) | (1.03) | (1.42) |
| Age | | | | | -.09 | -.12 |
| | | | | | (.07) | (.16) |
| Age*VC | | | | | -.14 | -.26 |
| | | | | | (.36) | (.59) |
| ln Total Assets | | | | | -2.17 | -3.59 |
| | | | | | (2.13) | (3.18) |
| Sustainable Finance | | | -11.59* | -11.81 | | |

| Underpricing | Specification | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | | (6.22) | (17.33) | | |
| Percentage of failed IPOs (ln) | | 178.66* | 305.25* | 21.38* | 36.42* |
| | | (97.16) | (176.78) | (12.67) | (20.60) |
| LIBOR | | -.45 | -3.22 | -.92 | -5.36 |
| | | (2.10) | (4.88) | (3.48) | (5.89) |
| Inflation | | 1.91 | -1.59 | -2.42 | -1.47 |
| | | (1.01) | (1.85) | (1.94) | (3.68) |
| Lockup Provision | | 3.91 | -7.19 | -10.05 | 14.40 |
| | | (3.12) | (8.03) | (8.03) | (13.77) |
| Lockup Provision*VC | | | | 6.69 | 14.96 |
| | | | | (9.07) | (14.26) |
| Rule 144A | | 1.90 | -5.85* | .78 | -.43 |
| | | (2.00) | (3.55) | (5.17) | (5.44) |
| Rule 144A*VC | | | | 8.77 | 13.56 |
| | | | | (8.90) | (13.45) |
| Syndicate Type | | | | | |
| Sole Managed | | 11.07 | 15.73 | 22.04 | 18.59 |
| | | (7.36) | (13.11) | (14.43) | (13.13) |
| Syndicated | | 2.65 | 7.10 | 13.01 | 9.78 |
| | | (5.11) | (9.94) | (12.75) | (14.38) |
| Underwriter Reputation | | | | | |
| between 5 and 10 IPOs | | -9.83* | -4.09 | -8.05 | -.51 |
| | | (5.28) | (9.01) | (7.39) | (9.86) |
| >10 IPOs | | -5.73 | -4.46 | -11.78 | -4.04 |
| | | (6.11) | (9.51) | (9.01) | (9.64) |
| Secondary Listing | | -8.27** | -12.76 | -11.78 | -22.25* |
| | | (3.49) | (8.89) | (9.01) | (13.05) |
| Overallotment | | 3.11 | 2.48 | -1.36 | 1.57 |
| | | (3.97) | (9.90) | (8.48) | (10.14) |
| Overallotment*VC | | | | 23.94** | 21.81 |
| | | | | (11.88) | (14.04) |
| Industry Dummy | No | Yes | Yes | Yes | Yes |
| Country Dummy | No | Yes | Yes | Yes | Yes |
| Time FE | No | Yes | Yes | Yes | Yes |
| Heckman Correction | No | No | Yes | No | Yes |
| VC/PE Reputation Dummy | No | Yes | Yes | Yes | Yes |
| Lockup Type Dummy | No | No | No | Yes | Yes |
| Offering Technique Dummy | No | Yes | Yes | Yes | Yes |
| Constant | 13.21 | -92.55 | -160.92 | 33.03 | 63.27 |
| | (1.74) | (46.55) | (97.55) | (96.71) | (169.47) |
| Root MSE | 59.75 | 60.10 | 67.95 | 64.24 | 71.10 |

| Underpricing | Specification | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| R-squared | .01 | .04 | .08 | .11 | .13 |
| Breusch-Pagan | Rej.*** | Rej.*** | Rej.*** | Rej.*** | Rej.*** |
| Shapiro-Wilk | Rej.*** | Rej.*** | Rej.*** | Rej.*** | Rej.*** |
| Ramsey | Rej.*** | Rej.*** | Rej.*** | Rej.*** | Rej.*** |
| Mean VIF | 1.00 | 11.22 | 4.10 | 14.39 | 8.94 |
| Observations | 1,419 | 1,404 | 491 | 694 | 461 |

*Note.* The regression output table above depicts three model specifications to capture the effect of VCs on the degree of underpricing. On the left-hand column, the names of the variables are listed. Notably, two names combined with a star reflect interaction effects. Those variables containing a suffix with '(ln)' in brackets have been logarithmically transformed in the third specification. Consequently, we interpret them as a one percent change in the independent variable causes a percentage point change in underpricing corresponding the coefficient's value. The coefficients are listed for each of three specifications from left to right. Significance levels are reflected through ***(one percent), **(five percent) and *(ten percent). Below each coefficient, you may find its standard deviation. Due to measurement characteristics and formatting guidelines, coefficients with values <.005 are rounded to the nearest decimal place (.01). The sub-section below the coefficients indicates the inclusion of dummies with 'Yes' and 'No' conversely. Followed by the subsections containing the root of the mean squared error, the r squared. Further model diagnostics test outcomes are showcased including tests for OLS assumptions for heteroskedasticity test (Breusch-Pagan) outcome, normality of the residuals (Shapiro-Wilk) and the mean multicollinearity score (VIF). Lastly, the table shows the count of observations. We take certification through VC investors seems to reduce underpricing consistently across all three regression specifications. However, the regressions may be limited in their explanatory power as a considerable part of the variance seems to be impacted by other factors.

Explanatory power inclines throughout the specifications and peaks at an r-squared of thirteen percent. The first model exhibited an r-squared value of less than one percent, while the second rises only marginally to just over the three percent. However, the third model doubles in explanatory power to eight percent of the variance, when adding the Heckman correction. This finding is remarkable as the selection regression confirms a sample selection bias at the one percent significance level with an r-squared of seventeen percent (Table 10). In application, the correction yielded a jump in model performance, while the VC coefficient remains significant. We can interpret the VC's impact with improved confidence as the sample selection bias is addressed. From the succeeding two models, we can concur that adding interaction terms notably increased the model's goodness-of-fit. In parallel, the same incline in model performance occurred when adding the Heckman correction from the fourth to the fifth specification. This finding underlines the statement above.

However, we must consider the relatively low model performance carefully when interpreting the results. The r-squared value suggests the model can only explain a smaller part of the variance.

Moreover, the root of the mean squared error is rather stable. More importantly, the magnitude of the model's error is quite large relative to the mean and median level of underpricing. Therefore, I included robust standard errors. These worries occur throughout other papers including, for example, Pennacchio (2014), Lee and Wahal (2003). These findings match the expectations from the literature review. We need to consider that the explanatory power of information-theoretical models has been shrinking over time. Megginson and Weiss (1991) documented an r-squared value of .59, where Pennacchio (2014) have only attained a value of .16 for a comparable specification. With a much more complex specification he achieved a maximum r-squared of .42, much below Megginson and Weiss (1991). I will offer a possible explanation in the discussion of the results.

Despite the reservations on the model's explanatory power the VC variable's coefficient has been significantly negative across all five specifications. Concerning the magnitude and interpretation of a VC's presence in issuers, the larger models suggest a slightly larger reduction in underpricing depending on other characteristics of VC-backed issues. The fourth and fifth model introduce interaction terms, which causes a jump in the VC's coefficient. The VC coefficients' range from -8.39 in the second model up to -45.04 in the fifth. In practical terms, the models predict a reduction in underpricing between 8.39 and 45.04 percentage points. However, considering that all VC interaction effects exhibit a positive sign, the large change in the VCs magnitude is moderated to levels like those of the previous specifications. Much rather the interactions suggest that there are distinctive differences within the VC-backed group. The coefficient's magnitude of the interaction between VCs and an overallotment option exemplifies this with a predicted increase above twenty percentage points.

The levels of significance stay persistently high across all three models. The isolated VC model indicates a one-percent significance level, the following four expanded models exhibit an effect significant at the five percent level. Meanwhile the coefficients' standard deviation increases with the number of variables included from first to last. This is likely related to inclusion of interaction terms and less observations. However, across all four models the coefficient's standard deviation relative to the coefficient is strictly smaller than .51.

Considering the non-normal distribution of the sample, the non-parametric Wilcoxon rank sum test yielded further insights in examining the role of VC with regards to underpricing (Table 11). Underpricing observations were grouped by VC presence and ranked accordingly. With a z-score of 4.18 the null hypothesis of no effect can be rejected at the one percent significance level. Looking at the differences of expected to actual rank sum, we see that VC-backed issuers are below the expected value and vice versa. That would imply that these issues exhibit significantly lower underpricing in terms of ranks assigned compared to non-VC-backed issuers.

**Table 11**

*Wilcoxon rank sum test output table*

| Issue Type | Observations | Rank Sum | Expected Count |
|---|---|---|---|
| Non-VC-backed IPOs | 1,290 | 934,419.5 | 915,900 |
| VC-backed IPOs | 129 | 73,070.5 | 915,900 |
| z | 4,18 | | |
| Prob.>z | .00 | | |

*Note.* The output table depicts the results from the Wilcoxon rank sum test. It dichotomously groups the IPOs between VC- and non-VC-backed issues, which can be seen in the middle-left cells. It further states the counted observations per group, the counted rank sums and the very right the expected count. The lower two rows present the tests z-score and the p-value.

The non-parametric test supports the findings from the regression model. Regardless of the data's distribution the test finds the presence of VC investors to be highly significant regarding underpricing.

The statistical tests have provided evidence in support of the certification hypothesis (H1), implying that the presence of a VC investor will have a negative effect on underpricing is not rejected.

The overwhelming majority of control variables exhibit coefficients with the expected sign and magnitude, suggesting the theoretical propositions have held up. We can concur that factors sought to reduce ex-ante uncertainty about a company's prospects do so in practice according to the model. Examples would be variables including age, secondary listing, or VC syndication.

Although, there are a few notable exceptions and turnarounds in sign. First, higher inflation switches the sign from the second to the third model. Either this is an irritation due to the correlation with time fixes effects, or inflation entails a multi-facetted impact on underpricing. Next, a lockup provision shows a positive relation to underpricing. It was discussed as a signal of confidence from insiders to outsiders it shall reduce underpricing. The finding could suggest an endogenous choice, meaning that issuers with higher risk could be forced to enter a lockup agreement. Interestingly, introducing an interaction between rule 144A and VCs has switched the sign of the clause's variable from positive to negative. The magnitude of the negative interaction term suggests that VCs seem to utilize the option to privately allocate shares to qualified institutional investors at a lower price. Overallotment is another offering-specific option whose interaction term with VCs is positive related to underpricing. We can take from it that any 'safety nets' increase underpricing and the effect amplifies with the presence of VCs.

## 5.2 Discussion

This research corroborates the findings of similar studies such as Pennacchio (2014), Megginson and Weiss (1991) and provides evidence in favor of the certification hypothesis, stating that agents can reduce ex-ante uncertainty through certifying information to outside investors in IPOs. In contrast to scholars including Lee and Wahal (2001), this study aligns with the predominant consensus that VCs can significantly decrease first-day underpricing through certification. This result has proven

consistent across both parametric and nonparametric testing. Nonetheless, the regression model exhibited limited power in explaining the variance, while using similar specifications and methodological approaches. This finding matches a development across related studies over time. Informational theories' explanatory power has decreased continuously over time, opening the discussion for further academic research.

To critically assess distinct differences in context and understand to which extent the results are comparable to related papers, I highlight noteworthy aspects and provide a possible answer below. By design the research was aimed at examining a large sample group of IPOs in all of Western Europe in the time after the 2008 financial crisis. Just as VCs may reduce uncertainty, other characteristic factors pertaining to geography, regulation and economic sentiment may further impact uncertainty, and thereby underpricing. Obviously national studies such as those focused on the US or Italy are geographically and regulatorily more homogeneous and allow for more precise regional controls compared to international studies. One may even extend the argument that geographical differences translate to cultural differences, which are challenging to quantify. Then, there is the evolution of economic sentiment. In 2010, Western Europe started as a rebounding economy with low interest rates and economic growth. Looking at the period after December 2019, we experienced a truly global shock with the COVID-19 pandemic, a land war on European soil and global banking turmoil, which resulted in sudden rate hikes, higher inflation, and low economic growth. In a Keynesian sense, one may argue that the 'collective expectations' pendulum overturned quite severely from optimism to pessimism.

All things considered, it should be obvious that there is something to be discovered beyond VCs, PEs and underwriters, beyond backstop, overallotment and lockup options, beyond rates of interest or inflation. This paper's goal is clearly stated as to examine the role of VCs in underpricing. Nevertheless, it is feasible and part of academic discourse to encounter a follow-up question. A possible answer we may find in behavioral finance. Early on, Bikhchandani et al. (1992) has introduced behavioral concepts to underpricing theories through his paper on informational cascades. Cascades describe a situation where an individual adopts the decision of another without verifying the information used to reason the action. Later, Ljungqvist (2006) concluded that next to informational theories including certification, there is substantial variation unexplained. In a careful consideration of multiple propositions, he deemed behavioral theories, including cascades and investor sentiment, to be most credible. The informational radius, the pace at which information travels, and the access we have to information-gathering tools are substantially higher in this paper's sample period compared to related studies. These dynamics should hypothetically all amplify the behavior-theoretical considerations' impact on underpricing.

In conclusion, the consideration of behavior, distinctly next to information theories, is an attractive explanation. First, the propositions are very much possible. The argumentative reasoning is intuitive, and the conceptual proposition sounds plausible. Moreover, the idea that behavior could be another unobserved influence is arguably probable.

# CHAPTER 6 Conclusion

This paper has studied the venture capitalist investor's ability to reduce the degree of underpricing in IPOs as certifiers of information. After formal explanations were discussed in the 1980s and tested in the 1990s, the debate resurfaced again in recent times as prevailing approaches grounded in informational theory could only partially explain the empirical evidence. A group of scholars provided inconclusive, or even counterevidence to the certification hypothesis. Implicitly, this paper belongs to a body of follow-up research that aims to reexamine the validity of the certification hypothesis.

I attempted to capture the studied relationship across a sample of 1,419 IPOs, 129 of which were venture capital-backed, between January 2010 and June 2023. Considering the sample's characteristics, I applied a combination of testing methods. For one, a parametric regression analysis entailing a Heckman correction selection model and a non-parametric Wilcoxon rank sum test. The regression model consisted of first-day returns as the dependent and venture capitalism as a binary independent variable. In addition, time-fixed effects, and a vector of control variables in firm-, macroeconomic- and offering-related domains facilitated the isolation of venture capitalists' impact. To control for the endogenous choice of venture capital-backing, I regressed firm- and macroeconomic variables in a probit selection equation.

The relationship between underpricing and venture capitalism has remained consistently negative. Depending on the specification, the effect has exhibited significance at the five and one percent levels across regression and rank sum testing models. However, none of the regressions could explain more than thirteen percent of the variance. This finding follows the development of more recent related studies that constituted decreasing explanatory power of information-theoretical models compared to earlier papers. We should interpret the findings cautiously and conduct further research. In practical terms, it is not advisable to choose IPO stocks solely based on information about the presence and quality of certifying agents to generate first-day returns. The field of research that may further enhance our understanding of underpricing is behavioral finance. We understand that certifying agents can effectively decrease the amount of money 'left on the table'. However, the degree of informational access and reach has arguably transformed IPOs into highly anticipated events and may induce herd behavior. Drawing from referenced literature's assessment, I propose behavioral concepts, including cascades and sentiment, as a credible explanation for the evidence. Hence why, I motivate a deeper examination regarding the influence of behavioral explanations. The sound argumentative structure by leading scholars, in combination with the development of informational access and reach, would amplify such influences and, therefore, strongly motivate further research.

The limitations of this paper are rooted in the availability and completeness of detailed data. Eikon Reuters can provide a good range of variables concerning firm- and offering-related data. Nevertheless, several aspects considered in other research, such as pricing revision, gross spread, or

specific balance sheet data, must be completed. This would limit the sample chance to test larger samples and control for factors I outlined in the theoretical discussion. This primarily pertains to the regression model. In consequence, the Heckman selection equation cannot fully reflect the theoretical discussion. The discussed domains of concept, management, and market could then be better represented regarding management and concept. However, this would require considerable resources and time to compile. Then, endogeneity through self-selection bias is an ongoing concern we cannot monitor. This bias occurs where firms may deliberately underprice their offers less or more. Future research could include anonymous interviews at this intersection. Furthermore, a shift in macroeconomic conditions may simultaneously impact underpricing and firm- and offering-specific control variables. In connection, I addressed the sample selection bias, which I have explained in more detail, and it shall not be dismissed in future research. I have discussed possible additions from behavioral theories such that future models could explain a higher portion of the empirical evidence

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# APPENDIX A Tables

**Table 2**

*Correlation matrix*

| Variable | Inflation | Sec. Listing | Lockup Provisi-on | Lockup Type | Syndicate Type | Rule 144A | Overall. | BV/Share | Quart. FE | Offering Technique | VC/PE Reputat-ion | Underwriter Reputation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflation | 1.00 | | | | | | | | | | | |
| Secondary Listing | .01 | 1.00 | | | | | | | | | | |
| Lockup Provision | .02 | -.14 | 1.00 | | | | | | | | | |
| Lockup Type | .01 | .05 | -.44 | 1.00 | | | | | | | | |
| Syndicate Type | -.16 | -.03 | .20 | -.12 | 1.00 | | | | | | | |
| Rule144A | -.12 | -.01 | .30 | -.11 | .45 | 1.00 | | | | | | |
| Overallotment | -.02 | -.13 | .27 | -.13 | .54 | .38 | 1.00 | | | | | |
| BV/Share | -.01 | .13 | .04 | .00 | .07 | .00 | .07 | 1.00 | | | | |
| QuarterlyFE | .46 | -.14 | .13 | .00 | -.15 | -.04 | -.05 | .01 | 1.00 | | | |
| Offering Technique | -.04 | .00 | -.05 | -.01 | -.24 | -.11 | -.10 | -.07 | -.06 | 1.00 | | |
| VC/PE Reputation | -.12 | -.05 | .14 | -.04 | .23 | .22 | .24 | .00 | -.20 | -.03 | 1.00 | |
| Underwriter Reputation | .01 | -.08 | .08 | -.01 | -.19 | .01 | .03 | -.08 | .08 | .01 | .04 | 1.00 |

*Note.* The tables above depict the pairwise correlation between each variable on the horizontal and the vertical axis. The scores range from zero to one with one increasing in correlation with the score closer to one. Each combination of two of the same variables is hence always equal to one. Across the four tables each relationship is presented. We see that almost all variables are only moderately correlated. Only exceptions may be the status of syndication for VCs and PEs and cyclical components.

| Variable | Underpricing | VC | PE | VC Syndication | Country | Industry | Percentage of failed IPOs | Filing to Issue | Total Assets | Proceeds | Age | LIBOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Underpricing | 1.00 | | | | | | | | | | | |
| VC | -.05 | 1.00 | | | | | | | | | | |
| PE | -.04 | -.11 | 1.00 | | | | | | | | | |
| VC Syndication | -.06 | .53 | .47 | 1.00 | | | | | | | | |
| Country | .06 | -.19 | .5 | -.13 | 1.00 | | | | | | | |
| Industry | .05 | .11 | -.2 | .08 | -.04 | 1.00 | | | | | | |
| Percentage of failed IPOs | .06 | .04 | -.02 | .06 | -.01 | -.04 | 1.00 | | | | | |
| Filing to Issue | -.01 | -0,01 | -.01 | .00 | .01 | -.05 | .00 | 1.00 | | | | |
| Total Assets | -.01 | -.03 | .00 | -.02 | -.01 | -.08 | .00 | .02 | 1.00 | | | |
| Proceeds | -.03 | -.02 | .18 | .13 | -.03 | -.02 | .02 | .02 | .40 | 1.00 | | |
| Age | -.05 | -.08 | .14 | .02 | -.06 | -.06 | -.02 | -.04 | .05 | .14 | 1.00 | |
| LIBOR | .00 | -.07 | -.12 | -.12 | .02 | -.04 | .09 | -.01 | 1 | -.02 | .04 | 1.00 |
| Inflation | -.01 | -.03 | -.14 | -.13 | .02 | .00 | .16 | .00 | -.02 | -.04 | -.04 | .42 |
| Secondary Listing | -.03 | -.02 | -.07 | -.04 | -.18 | -.06 | .14 | .04 | -.03 | -.03 | -.08 | -.05 |
| Lockup Provision | -.06 | .05 | .12 | .12 | -.03 | .05 | -.17 | -.03 | .06 | .18 | .03 | .01 |
| Lockup Type | .03 | -.09 | .00 | -.09 | .10 | -.03 | .03 | .01 | -.03 | -.03 | .06 | .01 |
| Syndicate Type | -.07 | .13 | .24 | .26 | -.10 | -.02 | .02 | .00 | .08 | .31 | .20 | -.01 |
| Rule144A | -.06 | -.01 | .26 | .20 | .06 | -.02 | -.06 | -.01 | .12 | .39 | .08 | -.07 |
| Overallotment | -.05 | .16 | .21 | .26 | -.22 | .07 | -.02 | -.02 | .09 | .28 | .20 | -.04 |
| BV/Share | .01 | -.03 | -.01 | -.02 | -.06 | .00 | .01 | .06 | .04 | .06 | .07 | .03 |
| QuarterlyFE | .01 | -.11 | -.12 | -.23 | .00 | .07 | -.49 | -.04 | -.02 | -.07 | -.04 | .20 |
| Offering Technique | .04 | .08 | -.13 | -.01 | -.02 | .02 | -.01 | .04 | -.01 | -.05 | -.05 | -.04 |
| VC/PE Reputation | -.05 | .26 | .53 | .73 | -.07 | .04 | .03 | .00 | -.01 | .15 | .07 | -.09 |
| Underwriter Reputation | -.02 | -.05 | .06 | .00 | .15 | .07 | -.06 | .03 | -.04 | .03 | .02 | -.03 |

**Table 3**

*Dummy variables summary statistics*

| Variable | Total IPOs | VC-backed IPOs | Percentage of VC-backed IPOs |
|---|---|---|---|
| Secondary Listing | 156 | 12 | 7.69% |
| Sustainable Finance | 23 | 5 | 21.74% |
| Underwriter Reputation | | | |
| <5 IPOs | 292 | 36 | 12.33% |
| 5 to 10 IPOs | 222 | 27 | 12.16% |
| >10 IPOs | 776 | 66 | 8.51% |
| Syndicate Type | | | |
| Not Syndicated | 203 | 4 | 1.97% |
| Sole Managed | 490 | 40 | 8.16% |
| Syndicated | 597 | 85 | 14.24% |
| Overallotment | 590 | 95 | 16.10% |
| Rule 144 A | 370 | 35 | 9.46% |
| Lockup Provision | 771 | 88 | 11.41% |
| VC Syndication | | | |
| Unrecognized | | 34 | 26.36% |
| Not Syndicated | | 11 | 8.53% |
| Syndicated | | 84 | 65.12% |
| VC/PE Reputation | | | |
| Unrecognized | | 65 | 50.39% |
| <100M Euros | | 13 | 10.08% |
| <1Bn Euros | | 17 | 13.18% |
| <10B Euros | | 22 | 17.05% |
| <30B Euros | | 1 | 0.78% |
| >30B Euros | | 11 | 8.53% |
| Accelerated Bookbuilt | 4 | 0 | .00% |
| Best Efforts | 3 | 0 | .00% |
| Firm Commitment | 379 | 24 | .33% |
| Offer for Sale | 215 | 19 | .84% |
| Offer for Subscription | 777 | 76 | .78% |
| Placement | 39 | 10 | 25.64% |
| Rights | 2 | 0 | .00% |

*Note.* The table above lists summary statistics for dummy variables. The left-hand side lists the categorical and binary variables aligned to the left. Then aligned to the right below you see the respective categorical distinctions. Next to it on the right you may find the total number of IPOs for each distinction. Then further to the right each row counts the number of VC-backed issues and the ratio of VC-backed issues for each categorical and binary variable. This overview offers provides an intuitive insight into the preferences of VCs in the IPO process.

**Table 4**

*Continuous variables summary statistics*

| Variable | Obs | | Mean | | SD | | Min | | Max | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VC | Non-VC | VC | Non-VC | VC | Non-VC | VC | Non-VC | VC | Non-VC |
| LIBOR | 129 | 1.289 | 1,02 | 1,29 | .94 | 1,10 | .23 | .23 | 5,55 | 5,55 |
| Inflation | 127 | 1.277 | 1,58 | 1,80 | 1,86 | 2,10 | -0,60 | -0,60 | 9,20 | 10,60 |
| PercFailed | 129 | 1.290 | .12 | .11 | .04 | .04 | .00 | .00 | .25 | .25 |
| Age | 98 | 813 | 12,11 | 16,85 | 10,75 | 19,55 | .00 | .00 | 56,00 | 117,00 |
| Filing to Issue Date | 129 | 1.290 | 91,26 | 129,01 | 364,38 | 1.642,62 | .00 | .00 | 2.627,00 | 41.453,00 |
| Proceeds | 129 | 1.290 | 152,93 | 191,92 | 335,94 | 468,69 | .97 | .00 | 2.113,54 | 9.081,67 |
| BVShare | 93 | 636 | .67 | 2,98 | 2,39 | 30,63 | -11,80 | -12,44 | 10,63 | 747,60 |
| TotalAssets | 122 | 991 | 225,40 | 1.541,45 | 844,69 | 14.107,13 | .41 | 0,00 | 6.646,85 | 414.863,10 |
| Net Income After Tax | 122 | 991 | -3,86 | 19,21 | 45,38 | 108,82 | -253,46 | -585,96 | 245,23 | 2.051,89 |

*Note.* The table above lists the relevant summary statistics for continuous variables. Starting on the left hand-side with the variable names, followed by observations, mean and standard deviation. Hereby, each of the three statistics is distinguished by VC- and non-VC-backed companies. This table showcases differences between the groups of interest regarding key firm and macroeconomic variables.

**Table 5**

*Country overview*

| Country | Total IPOs | VC-backed IPOs | Percentage of IPOs |
|---|---|---|---|
| Austria | 4 | 0 | .00% |
| Belgium | 21 | 3 | 14.29% |
| Cyprus | 4 | 0 | .00% |
| Denmark | 61 | 3 | 4.92% |
| Faroe Islands | 1 | 0 | .00% |
| Finland | 44 | 2 | 4.55% |
| France | 135 | 60 | 44.44% |
| Germany | 85 | 11 | 12.94% |
| Gibraltar | 1 | 1 | 100.00% |
| Guernsey | 36 | 0 | .00% |
| Iceland | 1 | 0 | .00% |
| Ireland | 10 | 2 | 20.00% |
| Isle of Man | 8 | 0 | .00% |
| Italy | 163 | 1 | .61% |
| Jersey | 22 | 0 | .00% |
| Luxembourg | 24 | 1 | 4.17% |
| Malta | 4 | 0 | .00% |
| Netherlands | 38 | 8 | 21.05% |
| Norway | 63 | 2 | 3.17% |
| Portugal | 2 | 0 | .00% |
| Spain | 27 | 1 | 3.70% |
| Sweden | 220 | 5 | 2.27% |
| Switzerland | 12 | 3 | 25.00% |
| United Kingdom | 433 | 26 | 6.00% |
| Total | 1,419 | 129 | 9.09% |

*Note.* The table above distinguishes issues by country. It further splits between total observations and the number of VC-backed issues per country. The outer right column takes the ratio of VC-backed issuers relative to the total number of issuers per country. The last column summarizes the total number of issues, those backed by VCs and the respective ratio. The overview may provide meaningful background information to understand the geographical distribution of issuers grouped by backing type.

**Table 6**

*Industry overview*

| Industry | Total IPOs | VC-backed IPOs | Percentage of IPOs |
|---|---|---|---|
| Academic & Education | 5 | 0 | .00% |
| Applied Resources | 10 | 1 | 10.00% |
| Automobiles | 16 | 3 | 18.75% |
| Banking & Investment Services | 152 | 2 | 1.32% |
| Chemicals | 22 | 3 | 13.64% |
| Collective Investme.. | 45 | 0 | .00% |
| Cyclical Consumer Products | 76 | 4 | 5.26% |
| Cyclical Consumer Services | 82 | 7 | 8.54% |
| Energy - Fossil Fuels | 34 | 0 | .00% |
| Financial Technologies | 3 | 0 | .00% |
| Food & Beverages | 39 | 4 | 10.26% |
| Food & Drug Retailing | 8 | 1 | 12,50% |
| Government Activity | 4 | 0 | .00% |
| Healthcare Services | 61 | 12 | 19.67% |
| Industrial & Commercial Goods | 110 | 3 | 2.73% |
| Industrial Goods | 82 | 7 | 8.54% |
| Institutions | 1 | 0 | .00% |
| Insurance | 9 | 0 | .00% |
| Investment Holding | 75 | 1 | 1.33% |
| Mineral Resources | 29 | 0 | .00% |
| Personal & Househol | 10 | 0 | .00% |
| Pharmaceuticals | 101 | 35 | 34.65% |
| Real Estate | 54 | 0 | .00% |
| Renewable Energy | 9 | 2 | 22.22% |
| Retailers | 73 | 10 | 13.70% |
| Software & IT Services | 182 | 17 | 9.34% |
| Technology Equipment | 33 | 6 | 18.18% |
| Telecommunications | 38 | 5 | 13.16% |
| Transportation | 26 | 4 | 15.38% |
| Uranium | 2 | 0 | .00% |
| Utilities | 28 | 2 | 7.14% |
| Total | 1,419 | 129 | 9.09% |

*Note.* The table above distinguishes issues by industry. The table further splits between total observations and the number of VC-backed issues per industry. The outer right column takes the ratio of VC-backed issuers relative to the total number of issuers per industry. The last column summarizes the total number of issues, those backed by VCs and the respective ratio. The overview may provide meaningful background information to understand the sectoral distribution of issuers grouped by backing type.

**Table 7**

*Underwriter and VC/PE reputation matrix*

| Underwriter Reputation | VC/PE Reputation | | | | | |
|---|---|---|---|---|---|---|
| | <100M | <1B | <10B | <30B | >30B | Total |
| <5 IPOs | 7 | 10 | 9 | 1 | 8 | 328 |
| 5 to 10 IPOs | 3 | 4 | 10 | 1 | 10 | 249 |
| >10 IPOs | 9 | 22 | 35 | 3 | 36 | 842 |
| Total | 19 | 36 | 54 | 5 | 54 | 1,419 |

*Note.* The matrix above highlights the counts of issues as a combination of underwriter and VC/PE reputation variables. On the left-hand column the three categories for underwriter reputation in order from top (lowest) to bottom (highest). The second row from the top categorizes VC/PE reputation by AUM ascending from left to right. The outer right column summarizes the total counts per underwriter reputation. Conversely, the bottom row does so for VC/PE reputation. The matrix allows us to understand the relationships across the levels of recognition regarding underwriters and VC/PE investors.

**Table 10**

*Heckman selection model output*

| VC | Coefficient | SD |
|---|---|---|
| LIBOR | -.19 | .11 |
| Inflation | -.01 | .05 |
| Age | -.01* | .01 |
| BVShare | -.01 | .02 |
| TotalAssets | .00 | .00 |
| NetIncomeAT | .00 | .00 |
| Country | -.06*** | .01 |
| Industry | .02** | .01 |
| Constant | -.07 | .28 |
| Obs. | 491 | |
| LR chi2(8) | 66.84 | |
| Prob.>chi2 | .00 | |
| Pseudo r-squared | .17 | |
| Log likelihood | -165.89 | |

*Note.* The output table above showcases the Heckman selection probit regression. with their respective coefficients, including standard deviation next to it on the right. The coefficients' significance is signaled by the asterisks *** at the one percent level, ** at the five percent level, * at the ten percent level. Followed by the number of observations included, the chi-squared test-statistic with its degrees of freedom. Afterwards, you may see the p-value, goodness-of-fit and log-likelihood. The p-value indicates the significance of the selection bias. The r-squared is interpreted as the explanatory power of the model to address the selection bias. The output table

suggests the presence of a sample selection bias. Nevertheless, more factors seem to influence VCs decision to invest in target firms.

# APPENDIX B Graphs and Figures

**Figure 1**

*Density of issues per issue date*
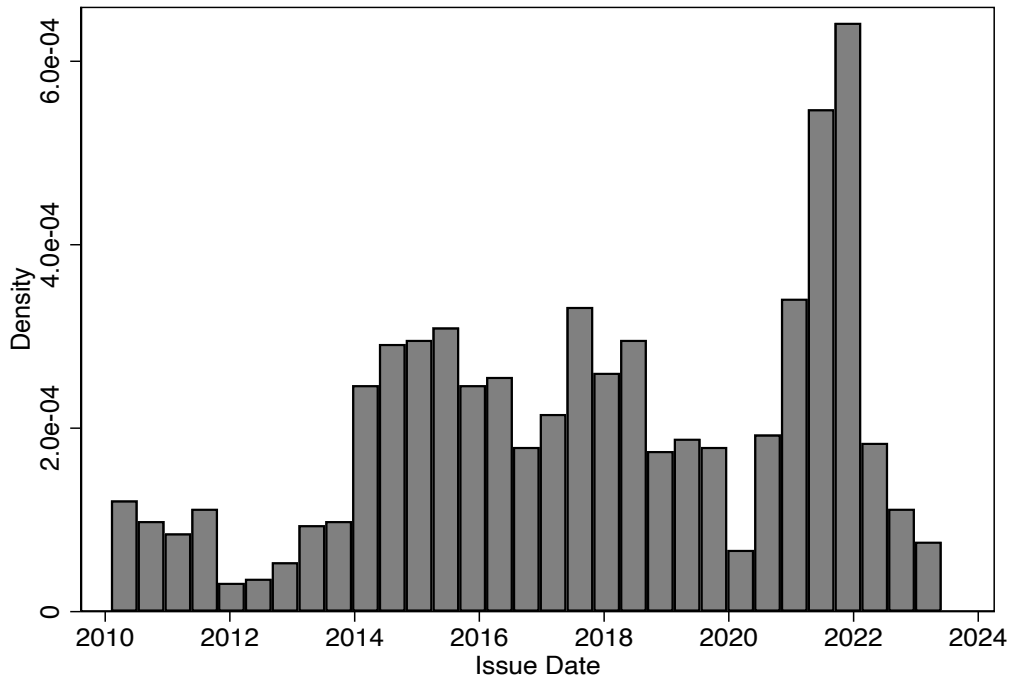


*Note.* The figure above is a histogram that visualizes the density of issues over the sample period. The y-axis reflects the density for the respective issue date on the x-axis. While the interpretation of the density may be cryptic, the figure nonetheless provides a helpful visual presentation of potential peaks in issue periods, alluding to the hot market cycle concept.

We can see that the influx into the issue market is most pronounced around 2014, 2018 and especially 2022.

**Figure 2**

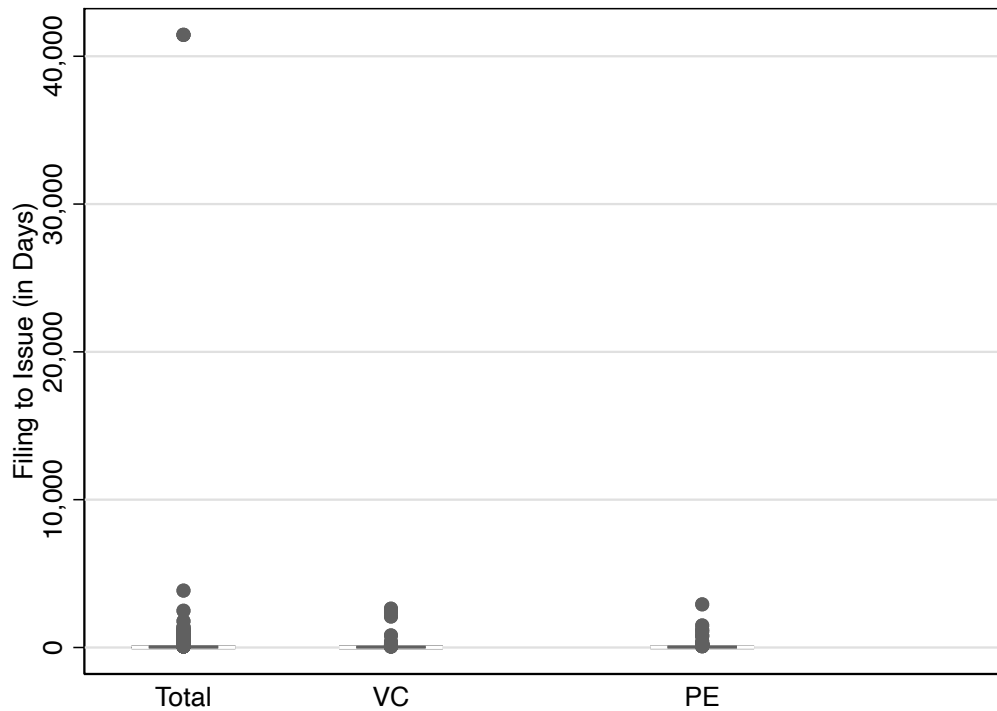*Boxplot distribution of underpricing over backing type*
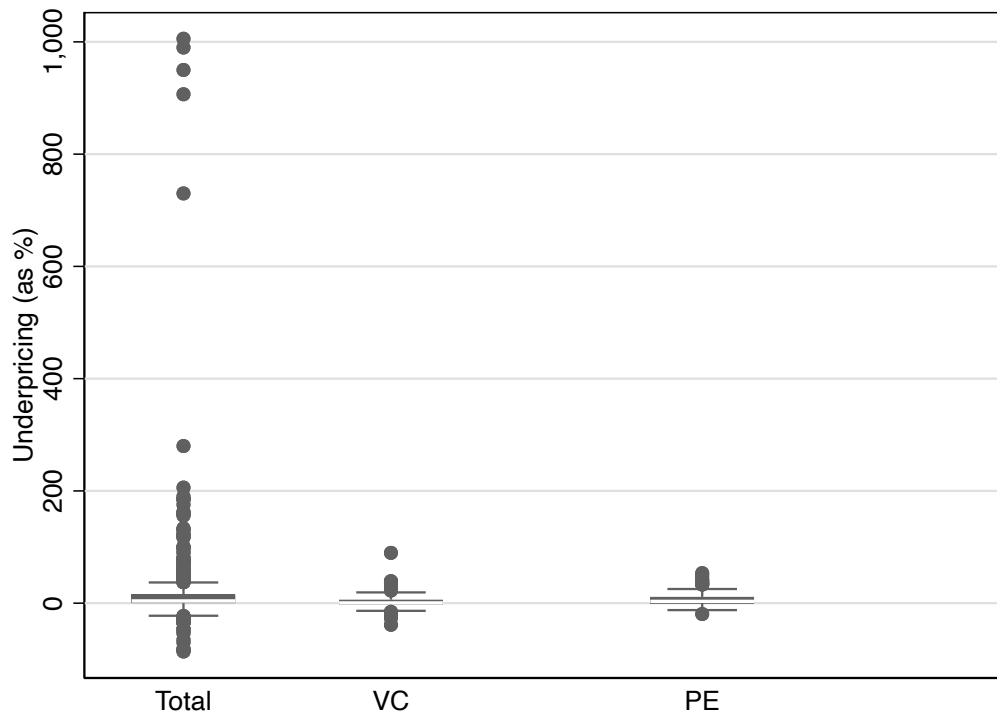


*Note.* The figure above depicts the distribution of underpricing grouped by backing type. On the left-hand side is the entire sample's distribution, followed by VC- and PE-backed issues. The y-axis measures the degree of underpricing in percentage points. Each box plot revolves around the mean, which is marked as a thick dash and two outer finer lines marking the 95 percent confidence interval.

The plot intuitively visualizes the distributional properties across groups. We can see that VCs and PEs have much less variation in both directions compared the whole sample.

**Figure 3**

*Boxplot distribution of filing to issue days over backing type*



*Note.* The figure above depicts the distribution of filing-to-issue days grouped by backing type. On the left-hand side is the entire sample's distribution, followed by VC- and PE-backed issues. The y-axis measures the number of days from the first filing to the issue. Each box plot revolves around the mean, which is marked as a thick dash and two outer finer lines marking the 95 percent confidence interval.

The plot intuitively visualizes the distributional properties across groups. We can see that VCs and the total population take slightly less time to market on average. However, the distribution of VC issues looks rather split between lower than average and on average with the total observations. PEs take more consistently less time, suggesting the IPO process bears less complications to overcome.