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THE IMPACT OF VENTURE CAPITAL ON IPO UNDERPRICING AND LONG RUN PERFORMANCE: AN INVESTIGATION INTO EUROPEAN MARKET

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ABSTRACT

The research aims to investigate the impact of venture capital on IPO performance in Europe from 2010 to 2024. VC-backed IPOs were found to experience significantly less underpricing than non-VC-backed, supporting the certification role of VC in minimizing information asymmetry. Moreover, the negative effect of VC on underpricing is significant when employing OLS regression for robustness check. The average initial market-adjusted returns of the VC-backed sample equals 1.59%, while that of their counterpart is approximately 8.93%. However, this short-run phenomenon is inconsistent when inspecting them in different economic cycles, indicating its sensitivity to market conditions. The calendar-time analysis showed that firms backed by VC outperformed the market portfolio, while the non-VC-backed group exhibited underperformance in the long run. The difference in the means between the two samples is statistically significant, suggesting evidence for the superior long-term returns of VC-backed IPOs compared to their counterpart. In contrast to short-run underpricing, the significant impact of VC on aftermarket performance remains consistent in all subperiods. However, the finding can be subjected to methodology as the positive effect of VC is insignificant when estimating long-run returns by buy-and-hold strategy.

Keywords: IPO Underpricing, Long run performance, Venture Capital

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CHAPTER 1 Introduction

Venture capital (VC), a subset of private equity, is an investment fund that provides financial and strategic support to its portfolio firms. Although there have been debates on their controversial role, VC has proven their positions in the industry with successful cases of VC-backed firms. They generally target startups with high growth potential and assist them from the very first stages: from developing ideas, bringing products to the markets to running the business. Investing in entrepreneurial instead of established firms is risky but indicates their objective to fuel internal growth and maximize their chances of exiting with high returns. Among several exit routes, exiting through IPO is considered the most profitable (Gompers and Lerner, 2001). With their added value, VCs can help portfolio firms succeed in their first time going public and enhance performance in the long run. Several prominent examples of successful VC-backed firms that went public are Facebook, LinkedIn, Airbnb, etc.

There has been plentiful research on the impact of VCs on IPOs, especially IPO underpricing and aftermarket performance. IPO underpricing occurs at the time of issuance, reflecting the positive initial returns at the closing of the first trading date compared to its offer price. Loughran and Ritter (2004) observed in the US market that the scale of underpricing fluctuated over time: doubling from 7% to 15% from 1990 to 1998 before surging to approximately 65% during bubble years 1999-2000, and finally falling back to only 12% one year after that. This phenomenon was primarily caused by information asymmetry between investors and issuers (Baron, 1982), which can be resolved through the certification role of underwriters (Booth and Smith, 1986). The presence of VC was proven to minimize the degree of uncertainty and information gap between involved parties as it acts as a guarantee for IPO quality (Megginson and Weiss, 1991). Barry et al. (1990) also showed that the active participation of VCs in daily operations contributed to reducing underpricing. However, the insignificant impact of VCs on underpricing was also discovered in many studies, such as Elston and Yang (2010) in the German market or Kirkulak (2008) for Japanese IPOs.

Moreover, there have been contrasting findings on the firm's ability to generate positive returns, considering the period of three to five years after public listing. Evidence of underperformance was found by Ritter (1991) for the US market or Levis (1993) for UK IPOs, while this pattern was indicated to disappear when using calendar-time instead of buy-and-hold analysis (Gompers and Lerner, 2003). It is undeniable that financial support and monitoring services from VCs have a significant impact on firm performance, as they help alleviate financial distress and operational difficulties (Liao et al., 2014). Campbell and Frye (2006) presented that IPOs with a higher proportion of VC ownership and involvement in daily business experienced lower underperformance in the long run. However, papers in different geographical contexts suggested that VC-backed IPOs did not significantly outperform, or even underperformed their counterparts (Belghitar and Dixon, 2012; Kirkulak, 2008).

Studies on the impact of VCs on IPO underpricing and long-run performance have mainly focused on the US market. Similar research was conducted in other countries but concluded mixed results, due to

discrepancies in market conditions and VC characteristics. Although there are resourceful investigations on individual countries, studies on aggregated levels are relatively limited to this date, especially in Europe from 2010 to 2024. This period witnessed major events that had never happened before, such as the interest rate crisis, Brexit, or the global pandemic. 2010 is chosen as the starting point because the economy at that time began to recover from the financial crisis in 2008, thus making the results less affected by that volatility. Moreover, focusing on a specific region will test the generalizability of the study by Belghitar and Dixon (2012) on the UK market, which is the top IPO venue in Europe. Therefore, two main research questions are proposed for this thesis:

1. What is the impact of VC on IPO underpricing in Europe?
2. What is the impact of VC on IPO long run performance in Europe?

The sample include IPOs issued in Europe from 2010 to 2014 obtained through Refinitiv, which were classified into VC and non-VC-backed sets. Data on returns in the long run was collected on Datastream using identifiers, while daily and monthly market index MSCI Europe was retrieved on Investing.com and MSCI. Replicating the original study of Belghitar and Dixon (2012), I will calculate initial market-adjusted returns to test the significance of VC on underpricing. Moreover, the calendar-time analysis will be utilized to analyze long-run performance, where average monthly returns are computed from a portfolio containing IPOs issued in the previous 6 to 36 months. However, instead of comparing with a size-matched portfolio, the market index will be used as benchmark. Finally, the multivariate analysis will be employed to test the validity of our results, in which the initial market-adjusted returns and buy-and-hold returns for 36 months will be the dependent variable for underpricing and long-run underperformance respectively. The independent variable for both equations is the presence of VC, which is inputted as a dummy variable. Several control variables will be included, such as firm age, size, reputation of the accounting firm, and offering technique to account for possible endogeneity issues.

Similar to Belghitar and Dixon (2012), I hypothesize that the differences in means of initial market-adjusted returns between VC and non-VC-backed IPOs are statistically significant, such that VC-backed IPOs exhibit less underpricing compared to their counterparts. Consequently, the presence of VC will negatively influence the underpricing in regression analysis. This effect is expected as VC can reduce information asymmetry among investors, thus mitigating pricing inefficiency. Regarding the long-run performance, it is predicted that VC-backed firms will significantly outperform their counterparts. The degree to which VC-backed firms generate better returns is determined by numerous factors, including the potential of their products/services in the long run, people-related components, or percentage of ownership of VC after the IPO period. However, the value created by VC plays a key role in improving the operational model and expanding their business. Overall, I expect that the results from the original study in the UK will be generalizable to this study in a larger context, except that long-run performance findings can be altered when clustering regulatory and operational differences across countries.

After the brief introduction, theoretical frameworks with related theories and findings from past papers will be discussed in Chapter 2 to give a background of the studied subjects. Chapter 3 will elaborate selection of data as well as the methodology utilized to investigate two hypotheses, which the findings will be described in Chapter 4. Finally, a discussion on limitations and recommendations for future research will be concluded in Chapter 5.

CHAPTER 2 Theoretical Framework

This section is dedicated to elaborating relevant theories related to IPO underpricing and long run performance as well as venture capital industry. Past research on their relationship will then be summarized, which helps develop the hypothesis on this study.

2.1. Initial Public Offerings

2.1.1. Overview

Initial Public Offerings (IPO) indicate the first-time private companies start selling their stocks on the public market (Ibbotson and Ritter, 1995). This higher liquidity suggests a more favorable risk-return tradeoff, so firms could have access to additional capital at better terms and reduce financial dependency on limited internal funds, especially when it becomes too expensive. The process of IPO is of high complexity and includes various stages, ranging from hiring underwriters, value estimation, official launching to other post-IPO periods.

The decision to go public does not only consider the possibility of reaping the benefits of market conditions, but also the current stage of that firm, such that IPO only occurs when firm reaches a certain phase of its life cycle (Ritter and Welch, 2002). They investigated that apart from attracting public attention, the crucial reason for going public is to allow early investors to cash out their investments and diversify their portfolios. This event creates a market for them to sell their shares, thus earning some proceeds after a long period of locking in their capital. Zingales (1995) argued that entrepreneurs could maximize their returns by using IPO to optimally alter the share of cash flow and control rights after the sale. On the other hand, going public comes with substantial costs due to its complicated procedure. Ibbotson and Ritter (1995) pointed out that in addition to continual costs associated with sharing information with related parties, there are one-time direct and indirect costs that influence the firm's cost of capital. While direct costs include underwriter (on average 7% of total proceeds), printing, legal, or audit fees, indirect ones consider underpricing as well as time and effort dedicated to this transformation process. Other drawbacks consist of potential conflicts of interest between pre- and post-IPO shareholders as well as loss of competitive advantage due to disclosure of private information (Draho, 2004).

2.1.2. IPO Underpricing

IPO underpricing refers to the increase in price after listing, such that IPO offer price is lower than its closing price at the first trading date. Therefore, issuers suffer from great loss by "leaving money on the table", whereas new investors benefit from earning additional profits.

2.1.2.1. Evidence

Reilly and Hatfield (1969) were one of the first papers to discover evidence for IPO underpricing. Examining 53 US stocks from 1963 to 1966, they investigated that since relative losses were offset by

their considerable gain, these newly issued stocks experienced superior average gain, compared to both market indexes and the sample of randomly selected over-the-counter stocks. This finding on the magnitude of gain and loss supported the hypothesis of superior short-run returns, despite the insignificant number of stocks with greater price change. Moreover, the authors documented that average price change was higher when considering the first one-to-five trading days than after one month, suggesting that price adjustment is absorbed immediately after listing. Logue (1973) and Ibbotson (1975) also proved positive initial returns, but neither of them managed to find a definitive answer for this phenomenon.

2.1.2.2. Asymmetric information

The theory of asymmetric information was first introduced by Akerlof (1970), which describes a situation where one party possesses more information compared to others. Due to differences in perceiving values for the trading goods, buyers are not willing to pay higher than average prices, leaving the market with only low-quality products. This concept was quoted by Baron (1982) as one of the most prominent driving factors for IPO underpricing, which was later mentioned in subsequent studies (Ritter and Welch, 2002; Ljungqvist, 2007). Looking into the case between investment banks and an issuer with inquiries for investment funding, the author observed that bankers – the more informative party – tend to deliver less than their best effort. To improve the situation, issuers are willing to pay the premium for the superior knowledge of the banker, causing the offer price to be lower than its optimal level. It was also reported that the greater uncertainty of issuers on market demand increases the degree of underpricing (Beatty and Ritter, 1986).

Developing the concept of information asymmetry, Rock (1986) demonstrated the winner's curse model which justifies the existence of IPO underpricing. The model consists of informed and uninformed investors such that the former only purchases in case of favourable price, while the latter purchases unconditionally. Consequently, uninformed investors refuse to participate due to negative expected returns, leading to a lack of demand to facilitate the issuance. Therefore, the offer price must be lowered until the uninformed party is indifferent between going for the bid or not, which means their expected return to be at least zero. Michaely and Shaw (1994) also agreed with the winner's curse model which they found no evidence of underpricing in the presence of information homogeneity between investors.

2.1.2.3. Certification hypothesis

The certification hypothesis highlights the role of underwriters in certifying the quality of the issuance and ensuring accurate reflection of issue price on future earnings (Booth and Smith, 1986). The presence of a third party makes investors perceive less risk, so firms do not need to discount their offer price to compensate for the information gap between parties, which consequently minimizes underpricing. Booth and Smith (1986) pointed out one potential issue with their credibility in transmitting information, which is affected by several determinants, such as self-interest, compensation, etc. However, the

difference in returns managed by prestigious and non-prestigious underwriters was proved by Logue (1973), who also discovered the significant impact of some factors influencing the underwriter's behaviours on stock performance. Chemmanur and Fulghieri (1994) resolved this concern by emphasizing that underwriters also consider their reputation in this trade-off such that lying can damage their benefits in the long run. Investors evaluate their reputation based on past performance, so underwriters are committed to delivering accurate estimations of issuing firms. They also indicated that underpricing decreased when IPO was handled by prestigious underwriters, which this negative association was later found by Carter et al. (1998) through their analysis of 3-level reputational ranking.

2.1.2.4. Other factors

In addition to asymmetric information, Ljungqvist (2007) also explained underpricing patterns based on institutional, control, and behavioural theories. Institutional theory constitutes three main parts: preventing legal disputes from shareholders because of long-run underperformance, stabilizing price by minimizing gap of reduction, and tax benefits due to higher tax on personal income than capital gains. The first two points apply mostly to US markets, while the last one is a more general case. The author mentioned that the cost of confronting lawsuits, including direct legal fees and reputational capital, was significantly higher than proceeds lost from underpricing. Control theory specifies that underpricing makes shares more attractive, so its greater demand allows smaller portions of shares to be allocated, thus mitigating excessive control from major investors. Finally, behavioural theory considers the overbidding of "irrational" investors on IPO shares. However, Ljungqvist (2007) stated that it was unclear to give a concrete conclusion on the two last theories, where more evidence was needed.

Consideration for change in wealth rather than level of wealth was also proposed as an explanation for a firm's willingness to underprice IPO (Loughran and Ritter, 2002). Although companies leave enormous proceeds on the table, on average 9.1 million dollars, this loss can be offset by the increase in those share prices where they remain as investors. This is more prominent for those IPOs with large underpricing since the offer and market price are too undervalued.

2.1.3.Long run performance

In addition to short-run performance, IPO performance in the long run is also widely studied to examine its ability in generating positive returns. There is no general guideline on a specific time frame, but most papers consider a period of three to five years after listing.

2.1.3.1. Evidence from the US market

Analyzing cumulative adjusted returns (CARs) and buy-and-hold abnormal returns (BHAR) strategy on US IPOs from 1975 to 1984, Ritter (1991) presented that the 3-year aftermarket performance of these firms was significantly lower than a selected set of size and industry-matched firms, which later aligns with the study by Ritter and Welch (2002) for the similar period length. The long-run returns of these IPOs were proved to equal approximately 0.83 dollars for every dollar earned through investing in stocks

of the comparison sample. This underperformance was worsened if IPOs were issued during peak periods. Ritter (1991) considered fads, over-optimistic expectations, market conditions, and risk adjustment to be accountable for these changes in market prices. Similarly, Heaton (2002) illustrated that overconfidence would lead to inefficient allocation of available resources, thus damaging financing situations and long-run returns. Sharing the same findings in the US context, Loughran and Ritter (1995) demonstrated the evidence for economically significant underperformance after 3 and 5 years of listing, such that returns earned through IPOs only equal one-fourth of those earned through non-issuing firms. They interpreted this pattern through "window of opportunity" where firms wait until favourable periods to issue their equity. However, Gompers and Lerner (2003) proved that underperformance for IPOs disappeared when utilizing the calendar-time analysis instead of the BHAR strategy, which the use of this methodology was also supported by Schultz (2003) to tackle biases. The degree of deterioration in returns over a long horizon was also enhanced if IPOs were accompanied by prestigious investment banks, thus suggesting the positive impact of the underwriter's reputation (Michaely and Shaw, 1994). This association can be explained similarly to underpricing, where their reputation serves as a guarantee for quality as well as resolves conflicts of interest between related parties.

2.1.3.2. Evidence from other markets

This phenomenon was also documented in papers on other geographical contexts. Studying IPOs in the United Kingdom - the third-largest market at the examined period, Levis (1993) showed that IPO long-run underperformance was not only subjected to US market characteristics. Compared to selected market benchmarks, their IPO sample underperformed when considering 3-year periods, and potentially longer. Using a similar time length, Bessler and Thies (2007) witnessed the deterioration of long-run returns in the German market, with BHAR between -26.3% to – 48.9%, but this phenomenon tended to reduce if firms came back to the equity market. Therefore, they concluded that the aftermarket performance relies on the possibility of raising additional funds in subsequent financing rounds. In contrast, research on the Asian market is inconsistent, which could be due to different market characteristics. Long-run overperformance was observed in the study of Chi and Padgett (2005) on Chinese IPOs where they witnessed firms with lower government ownership were likely to perform better in the long run thanks to less impact from political issues. This difference is more prominent if companies have lower initial returns and offer yet more advanced technology. Regarding the ownership structure, Field and Lowry (2009) illustrated that institutional holdings can significantly enhance the aftermarket performance, at least until 2 years after being listed. Those at the highest percentile generated 1% more returns compared to their counterparts. Findings on underperformance were reported by Cai and Wei (1997) on the Japanese market where they related this pattern to "window of opportunity". Several other findings reported statistically insignificant differences compared to benchmarks.

2.2. Venture Capital

2.2.1. Characteristics

Venture capital (VC) refers to a subset of private equity that plays the role of financial intermediaries and invests in private companies, especially start-ups with growth potential. VC is considered illiquid and risky due to the substantial uncertainty of new enterprises and the long capital commitment period, on average 10 years according to Sahlman (1990). The author stated that most VCs are structured as limited partnerships. Investors as the limited partners invest in their capital, and VC managers as general partners will use that funding and their skills to finance targeted companies. As suggested by the name, the maximum loss that investors suffer equals their invested capital, while managers are responsible for unlimited liability. In return for their effort, managers will receive management and incentive fees, which the common scheme is 2-2.5% of total capital and 20% of profit respectively.

It is undeniable that funding from VC not only initiates the realization of innovation but also relaxes financial constraints, enabling firms to execute investment projects. Besides invested capital and the reputation of VC, Sapienza et al. (1996) pointed out that strategic involvement in portfolio companies is viewed as their most critical role, followed by interpersonal and networking skills. With valuable experiences and managerial skills, VC could help make profitable investment decisions and closely monitor business operations, thus minimizing the risk of loss. Indication for better performance returns was also observed to be more prominent when VC have industry-specific experience, compared to those of different backgrounds (Sapienza et al., 1996). Moreover, it was reported that not only is the possibility of launching a new product on the market enhanced but also the time length for that process is reduced significantly if the innovative firm receives support from VC (Hellmann and Puri, 2000). Their later study in 2002 addressed that VC is far more than traditional financial intermediaries, such that they could influence the internal organization. Evidence has shown that they are involved in the hiring process of chief employees, human resources policies, etc. to assist with the professionalization of start-ups (Hellmann and Puri, 2002).

Global VC funding with its focus on IT, healthcare, and financial services in recent years has been falling behind compared to its popularity in the past (Ernst and Young, 2024). 2023 continued to undergo a drop in deal volume, where total capital merely reached 100 billion dollars excluding mega deals for artificial intelligence innovations (Ernst and Young, 2024). Following the 35% decrease in 2023, the investment level in the first quarter of 2024 reached the lowest record for the past 5 years (KPMG, 2024). Similarly, the number of deals was described to shrink to the lowest record since 2016. KPMG (2024) reported that the US maintained to be the largest VC market with half of total global funding despite experiencing a drop compared to 2023. Asia witnessed the same declining trend as the US, while an increase in VC investment was observed in Europe.

2.2.2. Life cycle

There are three stages in the fundamental life cycle of VC: capital calls, investing, and exiting (Gompers and Lerner, 2001). The first phase involves raising funds from investors, where authors demonstrated that VC is attractive due to their lower tax on capital gain. After collecting sufficient funding, VC proceeds to screen their portfolio candidates. Due to the high volume of start-ups but a low percentage of success, it is required to carefully sort out exceptionally high-performance firms to compensate for the failure cases. Baum and Silverman (2004) also noted that VC placed great emphasis on selecting firms for their portfolios rather than solely investment strategy, so it can generate a substantial risk-return tradeoff. Their strategy also varies across countries, such that the majority of VC in the US invest in the seed and early stages, while they choose to start their funding from later stages in the UK, or generally European market (Murray, 1999). The subsequent periods of active participation, monitoring, and adding value to invested firms take up the longest time. Finally, VC will exit their investments through different channels – IPO, acquisition, entrepreneur's buyout, or liquidation – and distribute proceeds to involved parties. In some cases, VC remains on board after their exits to continue providing support to firms.

2.2.3.Agency problem

The agency problem arises from asymmetric information and misaligning in interest between parties, for which many solutions were studied by many researchers and summarized by Gompers and Lerner (2001): staged capital commitment, compensation, syndication, and obtaining board seats.

Staged capital commitment enables VC to divide their funding into several rounds, depending on the evaluation of investment progress. Sahlman (1990) described this tool as the most powerful control mechanism that VC can closely monitor to decide on their next action, whether to continue or abandon, thus preventing inefficient allocation of resources on infeasible projects. Moreover, previously negative NPV investment can become positive since the option to abandon allows investors to opt out in case of failure, thus reducing costs. The author also discussed the role of signaling and screening of this solution which enables VC to keep only confident and prospective candidates.

Providing compensation under equity, options, or fixed percentage was claimed to incentivize employees to deliver their best effort (Gompers and Lerner, 2001). The paper also mentioned the implementation of a vesting period on entrepreneurs' stocks to prevent their sudden leave. Moreover, the authors suggested syndication which refers to the involvement of other VC in a deal to minimize firm-specific risk and learn from other opinions on investment decisions. The latter benefit was earlier confirmed by Lerner (1994) which those sharing similar knowledge are preferred by VC to syndicate.

2.3. Relationship

Gompers and Lerner (2001) reported that IPO is regarded as the most profitable exit route for VC. The impact of VC on IPOs short and long-run performance have been studied by several researchers, which will be summarized below.

2.3.1. Venture Capital and IPO Underpricing

Investigating the most active IPO market in Europe – the United Kingdom, Belghitar and Dixon (2012) found that differences in means of initial market-adjusted returns between the two groups are statistically significant, suggesting that VC-backed IPOs experienced lower underpricing compared to their counterparts. This is consistent with the belief that VC-backed firms are perceived as less risky, which requires a lower degree of underpricing to attract investors. Megginson and Weiss (1991) also shared similar results of lower underpricing in VC-backed firms when looking into the US market where VC mainly invests in early-stage and seed companies (Murray, 1999). Their research was conducted by comparing two samples of firms in the same industries while controlling for firm age, offering value, and underwriter-related quality. While most studies focus on countries with active IPO markets US and the UK, there is similar research conducted in other countries, but concluded relatively different results. Both studies on the German market by Elston and Yang (2010), and the Japanese market by Kirkulak (2008) argued that VC does not have a significant impact on IPO underpricing. Regarding the German setting, as VC is not the first option of funding, there is little role for this agent in minimizing the information asymmetry.

Information asymmetry is mainly responsible for underpricing patterns in the short run. The reputation and active support of VC in monitoring and management can give a positive signal to investors and alleviate the uncertainty in newly issued IPOs. Megginson and Weiss (1991) presented that underpricing and the cost of going public are significantly lower in the presence of VC as their certification role acts as a proof for the quality of issuance, thus bridging the gap of information between involved parties. These VC-backed firms were analyzed to have a greater median book value of assets and proportion of equity compared to non-VC-backed ones. Similarly, Barry et al. (1990) proved that underpricing is significantly reduced with the help of monitoring services from VC. In their sample of VC-backed IPOs from 1978 to 1987, VC was seen to actively participate in the business operation from pre- to post-IPO periods, where they maintained their positions on the boards.

As summarized, there have been different results regarding the impact of VC on IPO underpricing. However, it is undeniable that the certification role of VC can contribute to reducing information asymmetry and mitigating price inefficiency. Therefore, my first hypothesis on the influence of VC on IPO short-run performance is as follows:

H1: VC-backed IPOs experience lower underpricing compared to non-VC backed IPOs.

2.3.2. Venture Capital and Long run performance

Inspecting on Japanese IPO market, Kirkulak (2008) presented evidence for poorer 3-year post IPO performance of VC-backed firms compared to non-VC-backed, which resulted from fads. When utilizing the calendar-time and event-time analysis, Belghitar and Dixon (2012) also observed that UK VC-backed IPOs do not outperform those that are non-VC-backed in the long run. However, this is contrasted to the previous study of Brav and Gompers (1997) who discovered the superior performance of VC-backed firms when using equal-weighted returns. They also carried out robustness checks by comparing the performance of two groups to several benchmarks, in which they investigated that the difference is smaller when returns are value-weighted.

Many researchers have proposed factors accountable for the impact of VC on IPO long-run performance. As summarized, financial support from VC is one of the most fundamental yet critical determinants that enables firms to maintain and improve their business model. Moreover, VC adds value by contributing exceptional managerial advice to avoid unwanted mistakes, especially if portfolio firms are within their industry-specific expertise. Liao et al. (2014) showed that VC-backed IPOs significantly experienced better financial health and corporate governance than their counterparts, as VC could resolve budget distress and equally disperse the proportion of ownership. Their degree of involvement in daily management and monitoring has a positive influence on IPO long-run returns (Campbell and Frye, 2006). Therefore, those with VC that remain on board post-IPO were proved to outperform the sample of non-VC-backed firms. The authors also presented that networking of VC can help target a group of familiar investors with the same interest, making it easier to cooperate towards a common goal. The study of Otchere and Vong (2016) for the IPO market in China also found that VC-backed firms experienced higher IPO underpricing but appeared to outperform their counterparts in the long run, which resulted from skills and monitoring value added by prestigious VC. Similarly, Krishnan et al. (2011) explored the positive correlation between VC reputation and long-run performance, such that reputational VC is more dedicated to involving in company operations, thus delivering higher returns.

Findings on IPO long-run performance have been inconsistent across literature, given different contexts, market characteristics, or methodology. However, it is reasonable to assume that the value generated by VC on management and organizational structure will continue to take effect for a period of time after IPOs. Therefore, the second hypothesis on IPO long-run performance and the presence of VC:

H2: VC-backed IPOs outperform non-VC-backed IPOs in the long run.

CHAPTER 3 Data & Methodology

This section presents data collection and models used to conduct this study. Sample description will first be discussed to generate an overview and portrait current European IPOs and VCs landscape. The module will then be clustered by hypothesis, rather than dividing into two separate parts of data and methodology, to give a more focused structure.

3.1. Sample description

The initial sample consists of 911 IPOs issued on the European market from January 2010 to May 2024, which was retrieved from the Refinitiv database. The filtering was done by only retaining IPOs with the status of announced, live, and in progress, as well as information of (non) VC-backed. Therefore, the binary variable VC classification, taking values 0 for non-VC and 1 for VC-backed, divides the sample into 2 subsets. Primary data cleaning was conducted by removing duplicates and inserting identifiers for merging purposes. IPOs with missing issue dates were supplemented with information from published news or reports.

To analyze the underpricing pattern, those IPOs with missing values for the offer price and the closing price at the first trading date were excluded. There are a few extreme values, including IPOs with underpricing larger than 150% and smaller than -200%, as they can cause skewness and make statistical results imprecise. The data were adjusted for outliers, which yields a sample of 629 deals.

Regarding the second hypothesis, data on monthly returns were extracted under the variable name Total Return Index (RI) on DataStream through identifiers DataStream and ISIN. This variable, displayed in USD, assumes that dividends are reinvested to buy additional equities at the closing price on the ex-dividend date. If no data were found for that IPO after utilizing both identifiers, it would be marked as missing values and dropped out of the sample. Since the 36-month period is chosen to analyze the long-run performance, any IPOs issued after May 2021 will not be included, which the total number of IPOs further reduces to 455 offers.

As for robustness check, data for control variables, including market capitalization, firm establishment year, accounting firm, and offer technique, were retrieved through Datastream. After excluding missing values, the sample was reduced to 184 and 319 IPOs for analysis of underpricing and long-run returns respectively.

The European market has evolved considerably over time, which the total proceeds of IPOs in this sample are estimated to be approximately 135000 million USD from 2010 to 2024. Figure 1 demonstrates that the United Kingdom has dominated the European market, accounting for approximately 32%. Together with Sweden and Italy, these three countries explained half of the total number of IPOs issued during this specified period. Some developed markets in Western and Northern Europe, including the Netherlands, France, Germany, Norway, and Denmark also make up a substantial proportion. The other one-fourth is issued by the remaining countries.

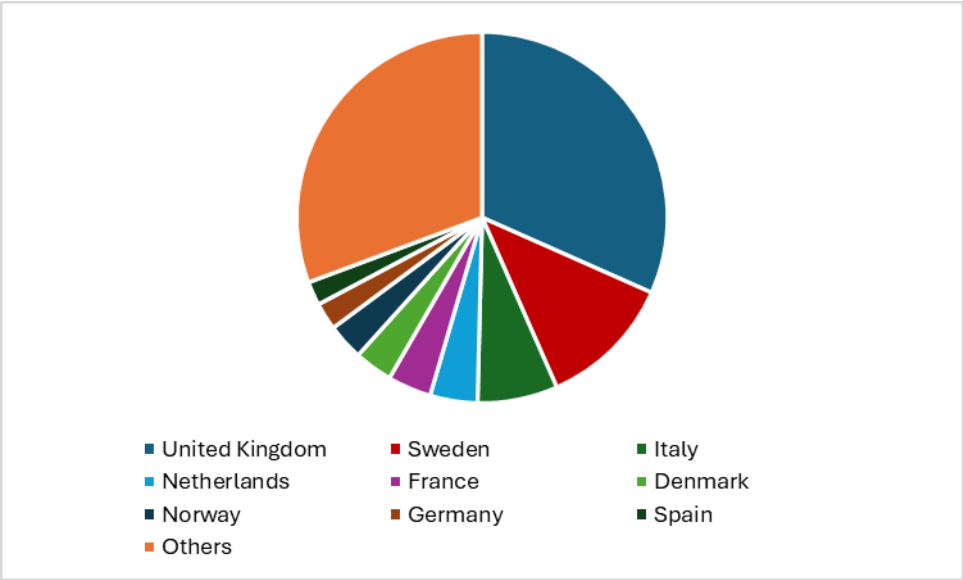

Figure 1. Proportion of IPOs per country in Europe from 2010 to 2024

Note. The figure displays the proportion of IPOs issued per country in Europe from 2010 to 2024. The values are calculated by dividing the number of IPOs issued within that country by the total IPOs issued in Europe. Major markets are computed individually while small countries are grouped as Others.

Figure 2 illustrates that the number of IPOs fluctuated greatly during 2010-2024 due to the impact of several economic and political events. The Brexit event in 2016, the COVID-19 pandemic from 2019, and the Russia-Ukraine conflict in 2022 had considerable influence on the low level of IPO activity as they created major market volatility and hesitation from investors. The total number of IPOs varied between 20 and 60 deals per year from 2010 to 2019, before witnessing an eight-fold increase to 162 deals in 2021. The global IPO market hit a record in 2021, both in volume and value, thanks to the recovery stage of the economy as well as supporting programs by governments (Ernst and Young, 2021). The report stated that all regions showed optimism in IPO activity, such that US and EMEIA markets experienced significant growth while a moderate boom was seen in Asia-Pacific. However, it soon got over the boom period, in which total volume subsequently dropped by more than half in the next two years. This reduction can be attributed to the high interest rate, which is adjusted to combat inflation. The high borrowing rates make it more illiquid and affect the share price, causing a loss in confidence for companies to go public as well as investors to make investments. Moreover, the number of VC-backed IPOs has remained to equal a small fraction of the total volume with a peak of 22 in 2021.

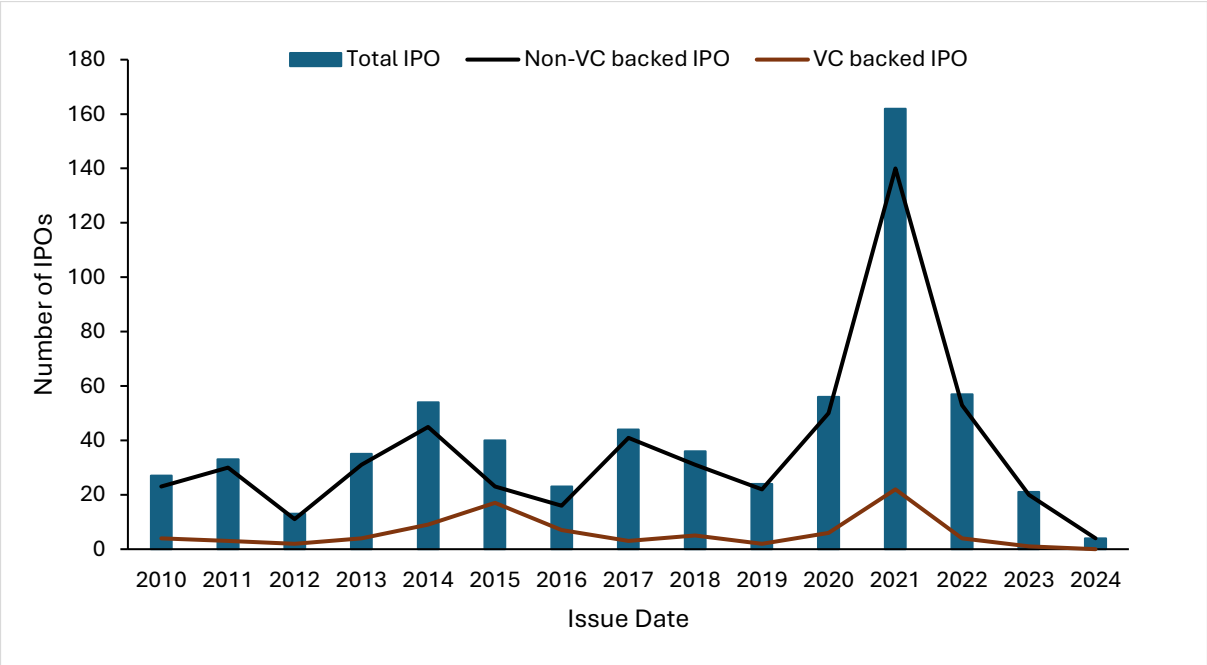

Figure 2. Total number of IPOs in Europe from 2010 to 2024

Note. The figure displays the yearly number of IPOs in Europe from 2010 to 2024. The column presents the total sample while the black and brown line graph illustrates number of issues by non-VC and VC-backed respectively. It is noted that 2024 only contains data up until February.

3.2. Venture Capital and IPO Underpricing

3.2.1. Variable description

First, IPO underpricing for each IPO is interpreted as the percentage change between offer price and closing price at the first trading date, which is calculated as Equation (1):

$$IPO\ Underpricing = \frac{P_{offer} - P_{closing}}{P_{offer}} \quad (1)$$

Table 1 displays that out of 629 IPOs issued in Europe from 2010 to 2024 in the sample, there are in total 89 VC-backed cases, accounting for approximately 14%. Overall, the mean of underpricing for European IPOs equal -8.68%, along with a standard deviation of 13.95%. VC-backed IPOs exhibited an underpricing of -6.04%, while that of non-VC-backed was relatively one-third higher. After excluding extreme values as explained above, the maximum and minimum statistics of the sample were 50% and -66.72% respectively.

Table 1. Descriptive statistics of IPO Underpricing in Europe from 2010 to 2024

	Number of observations	Mean	Median	Standard deviation	Maximum	Minimum
VC-backed IPOs	89	-6.04%	-1.44%	15.53%	50.00%	-44.00%
Non-VC-backed IPOs	540	-9.12%	-7.90%	13.64%	34.61%	-66.72%
Total IPOs	629	-8.68%	-6.99%	13.95%	50.00%	-66.72%

Note. This table demonstrates the descriptive statistics of IPO underpricing in Europe 2010 – 2024 for VC and non-VC samples. Number of observations, mean, median, standard deviation, maximum and minimum values are reported from left to right.

Second, **market returns** r_m are identified as the difference between the market index value at the opening and closing at the first trading date (Equation 2). As Europe is the main context of the study, MSCI Europe is selected as a market index, which represents a risk-free portfolio containing mid to large-cap of developed markets. Data on its daily returns from January 2010 to May 2024 are retrieved from two sources, namely Investing.com and MSCI. The former stores both the opening and closing prices every day, while the latter shows only one daily value. However, Investing.com stores the performance history from 2012 onwards, so the remaining period will be supplemented by MSCI. Due to data availability, the index value of the following date will be used as a proxy for the closing price at the first trading date for IPOs issued from 2010 - 2012.

$$r_m = \frac{I_{closing} - I_{opening}}{I_{opening}} \quad (2)$$

3.2.2. Methodology

Replicating the study by Belghitar and Dixon (2012), **initial market-adjusted returns** ar_i will be used to examine IPO underpricing, which is defined as difference between initial return and market return index (Equation 3). This variable also captures the market timing compared to underpricing, thus reflecting its ability to adjust for the market movements. It is noted that **initial return** r_i will be used in this calculation, which equals to negative of IPO underpricing.

$$ar_i = r_i - r_m \quad (3)$$

, where $r_i = -IPO\ Underpricing = \frac{P_{closing} - P_{offer}}{P_{offer}}$

Before conducting statistical tests, the normal distribution is examined using the Shapiro-Wilk test. If the samples are normally distributed, the t-test will be calculated as shown in Equation 4, otherwise, the result from one-sample Wilcoxon signed rank with requirement for symmetry will be more reliable. The null hypothesis for the t and z-test states that the mean and median of initial market-adjusted returns are equal to zero respectively. Finally, to find evidence for the impact of VC on underpricing, a two-sample t-test with the null hypothesis of no difference in the average of initial market-adjusted returns between

non-VC and VC-backed IPOs will be employed. Similarly, if normal distribution is not fulfilled, the Mann-Whitney U test will be preferred.

$$t_{ar} = \frac{\overline{ar_{it}} \text{ x } \sqrt{n}}{\sigma_{ar_{it}}} \tag{4}$$

, with $\overline{ar_{it}}$ being the sample average, n being the respective sample size, and $\sigma_{ar_{it}}$ being the cross-sectional standard deviation.

3.3. Venture Capital and Long run performance

Following Belghitar and Dixon (2012), calendar-time analysis will be utilized to investigate aftermarket performance, where a portfolio consisting of n number of firms going public within specified periods is evaluated every month. The analysis is done every six months with a maximum length T of three years. Their returns in the long run will be assessed using **abnormal returns** $CTAR_{it}$, which refer to the difference between monthly returns of IPOs and benchmark returns (Equation 5). However, the market returns will be used as benchmark instead of constructing a size-matched portfolio as Belghitar and Dixon (2012). MSCI Europe will be chosen as the market index, which its monthly data for the same interval will be obtained from Investing.com.

$$CTAR_{it} = r_{it} - r_{mt} \tag{5}$$

, with r_{it} being return of IPO_i at month t and r_{mt} being market return at month t.

To compute t-statistics, the monthly average abnormal returns of IPOs within investigated periods T is calculated as follows:

$$Mean\ CTAR = \frac{1}{T}\sum_{t=1}^{T}(\overline{CTAR_t}) \tag{6}$$

, where $\overline{CTAR_t} = \frac{1}{n}\sum_{i=1}^{n}(CTAR_{it})$ is the mean of n firms within the portfolio in month t.

The null hypothesis for the t-test displayed in Equation 7 implies that the monthly average abnormal returns are equal to zero. To analyze the role of VC in improving aftermarket performance, a two-sample t-test will be performed with the null hypothesis that there is no difference in the means of abnormal returns between non-VC and VC-backed IPOs. Similarly, the non-parametric MW-test will be performed alongside.

$$t_{Mean\ CTAR} = \frac{Mean\ CTAR \text{ x } \sqrt{T}}{\sigma_{Mean\ CTAR}} \tag{7}$$

3.4. Robustness check

Replicating study by Belghitar and Dixon (2012), Ordinary Least Squares (OLS) regression with selection of control variables will be employed for robustness check for findings of IPO underpricing and performance in the long run.

3.4.1. Venture Capital and IPO Underpricing

The regression expressed in Equation 8 examines underpricing as the function of the existence of VC, market capitalization at time of issuance, firm age reputation of auditing firms and offering technique. With the inclusion of additional variables retrieved from Datastream, the sample further reduces to 184 IPOs due to missing values.

$$ar_i = \beta_0 + \beta_1 VC_i + \beta_2 \ln(marketcap_i) + \beta_3 age_i + \beta_4 reputational\ accounting_i + \beta_5 offer\ technique_i + \varepsilon \quad (8)$$

The dependent variable is the **initial market-adjusted returns** ar_i calculated in Equation 8, while the independent variable is the dummy variable VC, which equals 1 if IPOs are VC-backed and 0 otherwise. As supported in previous theories, VC can help bridge the information gap between involved parties, which is the root cause of underpricing. Therefore, the coefficient of VC is expected to be significantly negative, such that VC-backed IPOs experience lower initial market-adjusted returns.

To account for omitted variables bias (OVB), several control variables are added in the multivariate analysis. Firstly, **firm size**, measured in million USD, is characterized as market capitalization at the time of issuance. Since this continuous is skewed to the right (Figure 3, Appendix), a natural logarithm transformation will be made. Companies with larger scales are likely to endure less volatility compared to smaller ones as they have access to various funding sources and earn profit from multiple business lines. Due to this lower risk, these businesses can easily attract investors, especially risk-averse types, without having to considerably lower their offer price. Moreover, firm size is a good control variable as it impacts the funding decision of VC, but not the other way around. Secondly, **firm age** is defined as the number of years from establishment until going public, which younger firms were proven to experience a higher scale of underpricing (Hensler et al., 1997). Since the operational duration before listing is negatively correlated with independent and treatment variables, excluding it from the model can cause positive bias. Thirdly, the **reputation of accounting firms** is computed as a dummy variable that takes a value of 1 if firms are audited by the Big Four (Deloitte, KPMG, PwC, and E&Y), and 0 otherwise. Similar to the effect of hiring prestigious underwriters as discussed above, reputational accounting agents can signal the quality of the IPOs and minimize information asymmetry for investors. Therefore, a negative association is expected between this control variable and underpricing. Finally, the **offering technique** is added as a dummy variable that equals 1 if the firms is listed through placement, and 0 otherwise. Goergen et al. (2006) indicated that the riskier the firms are, the more likely they go public through placement to attract more demand, implying a negative relationship with underpricing. Due to data availability, this regression analysis lacks market momentum as suggested in the original model of Belghitar and Dixon (2012).

3.4.2. Venture Capital and Long run performance

Validity of finding on aftermarket performance will be analyzed by employing multivariate regression below:

$$BHAR_i = \beta_0 + \beta_1 VC_i + \beta_2 \ln(marketcap_i) + \beta_3 age_i + \beta_4 ar_i + \varepsilon \quad (9)$$

The independent considers the **dummy variable VC**, which significantly positive effect on long-run returns is expected to be found. The dependent variable is **abnormal returns** in the long run that are calculated using the buy-and-hold approach. This strategy is defined as the difference between investing in IPOs and portfolio benchmark, which is computed monthly for 36 months (Equation 10). However, instead of using a size-matched portfolio similar to the original equation of Belghitar and Dixon (2012), the market index will be used as benchmark, which was also employed by several papers (Brav and Gompers, 1997; Bessler and Seim, 2012).

$$BHR = \left[\sum_{t=1}^{T}(1 + R_{i,t}) - 1\right] - \left[\sum_{t=1}^{T}(1 + R_{m,t}) - 1\right] \quad (10)$$

, where $R_{i,t}$is return of IPO i at time t and $R_{m,t}$ is market return at time t

Table 2 summarizes the means of long-run returns under the BHR strategy, in which both samples reported negative abnormal returns, except that non-VC-backed IPOs yielded positive value for the first 6 months after issuance. VC-backed IPOs recorded higher averages compared to their counterparts if considering the 30 to 36-month period, while the degree of underperformance of non-VC increases as time intervals expand. If investors buy and hold their shares over three years, they can earn -9.21% and -19.19% for firms backed by VC and non-VC respectively.

Table 2. Buy-and-Hold long run performance of IPOs in Europe from 2010 to 2021

	VC-backed IPOs	Non VC-backed IPOs	Total IPOs
T = 6	-6.33%	2.25%	0.83%
T = 12	-12.65%	-4.38%	-5.74%
T= 18	-17.60%	-9.67%	-10.98%
T= 24	-17.64%	-15.10%	-15.52%
T= 30	-14.70%	-14.93%	-14.89%
T= 36	-9.21%	-19.19%	-17.55%
Number of observations	75	380	455

Note. This table displays the average abnormal returns of IPOs in Europe from 2010 to 2021 for non-VC and VC-backed samples. The abnormal returns are calculated using Equation 10, of which their averages are presented for the interval of 6, 12, 18, 24, 30 and 36 months after listing. It is noted that no effect can be drawn as no statistical tests are reported.

Regarding control variables, **firm age**, and **size** are expected to have a positive relationship with returns in the long run, which evidence for their significant impact was found by Ritter (1991). Moreover, underpricing was used as a signal to their quality, which high-potential firms are more financially strong

and able to underprice at a larger degree compared to the low-potential ones (Belghitar and Dixon, 2012). Therefore, the authors inspected that the greater the underpricing, which is measured by **initial market-adjusted returns**, the higher returns they can generate in the long run.

CHAPTER 4 Results & Discussion

This section is designated to present empirical results to two hypotheses and elaborate potential discussion. Robustness check utilizing OLS regression will also be employed to check for findings validity.

4.1. Venture Capital and IPO Underpricing

The first hypothesis on the role of VC in reducing underpricing will be analyzed on the sample of 629 deals issued in Europe from 2010 to 2024, of which 14% are VC-backed. According to Equation 3, the lower the initial (market-adjusted) returns, the lower the degree of underpricing. Table 3 shows that the initial returns of VC-backed IPOs equal two-thirds of non-VC-backed ones. However, if looking at the initial market-adjusted returns, the degree of underpricing that VC-backed exhibited only equal 1.59%, compared to 8.93% of their counterparts. This could be partly explained by the wide market benchmark on their issue dates, thus reflecting their ability in market timing. To inspect further, the breakdown of this short-run performance will be demonstrated in Tables 4 and 5 for VC and non-VC-backed groups respectively.

Table 3. Summary of initial market-adjusted returns of IPOs in Europe from 2010 to 2021

	VC-backed IPOs	Non-VC backed IPOs
Initial returns	6.04%	9.12%
Corresponding returns	4.45%	0.19%
Initial market-adjusted returns	1.59%	8.93%

Note. This table displays the average of initial return, corresponding market benchmarks and initial market-adjusted returns of IPOs in Europe from 2010 to 2021 for non-VC and VC-backed samples. The initial returns are negative of IPO underpricing as calculated in Equation 1. Corresponding returns and initial market-adjusted returns are calculated using Equation 2 and 3 respectively.

The initial market-adjusted returns investors can earn fluctuated significantly, such that they can either benefit or lose from trading at the issue date (Table 4). The lowest level of underpricing was recorded in 2023, whereas the highest value was witnessed in 2012. It is noticeable that 2015 and 2021 both have the highest number of IPOs but experienced opposite degrees of underpricing. While on average companies benefited from an overestimation of 12.45% in offer price in 2015, they underpriced by approximately 18.38% in 2021.

Table 4. Summary of initial market-adjusted returns per year of VC-backed IPOs in Europe from 2010 to 2021

Issue Date	Number of IPOs	Initial return	Corresponding return	Initial market-adjusted returns
2010	4	7.21%	-1.23%	8.45%
2011	3	3.67%	-2.02%	5.69%
2012	2	26.28%	4.82%	21.46%
2013	4	23.30%	15.89%	7.41%
2014	9	-0.66%	-2.61%	1.94%
2015	17	4.25%	16.70%	-12.45%
2016	7	2.49%	31.58%	-29.09%
2017	3	16.69%	4.12%	12.56%
2018	5	3.37%	2.43%	0.94%
2019	2	-12.15%	25.47%	-37.62%
2020	6	15.97%	4.42%	11.55%
2021	22	6.96%	-11.42%	18.38%
2022	4	6.61%	2.35%	4.26%
2023	1	-50.00%	-8.03%	-41.97%
2024	0	-	-	-

Note. This table displays the number of observations as well as average of initial return, corresponding market benchmarks and initial market-adjusted returns per year of IPOs in Europe from 2010 to 2021 for VC-backed sample. The initial returns are negative of IPO underpricing as calculated in Equation 1. Corresponding returns and initial market-adjusted returns are calculated using Equation 2 and 3 respectively.

Looking at the initial market-adjusted returns in Table 5, the degree of underpricing for non-VC-backed samples also varied but not as remarkably as their counterparts, with the maximum and minimum being 20.58% and -15.34% respectively. Compared to the huge discrepancy from -41.97% to 21.46% in the VC-backed group, the non-VC backed only has a gap of 35.91%. Therefore, while the average market-adjusted underpricing of non-VC-backed IPOs is 5.61 times larger than that of VC-backed (Table 3), these values are more stable and slightly smaller for some years. This insight could be attributed to the small size of VC-backed IPOs scattered every year, such that a slightly different value compared to the average could cause the statistics to be skewed. The boom period for the IPO market in 2021 also exhibited a high underpricing such that investors can earn relatively 18.83% during the first day of trading.

Table 5. Summary of initial market-adjusted returns per year of non-VC-backed IPOs in Europe from 2010 to 2021

Issue Date	Number of IPOs	Initial return	Corresponding return	Initial market-adjusted returns
2010	23	9.05%	0.31%	8.74%
2011	30	7.28%	-0.01%	7.29%
2012	11	15.42%	20.23%	-4.81%
2013	31	11.79%	11.22%	0.58%
2014	45	10.85%	-1.76%	12.61%
2015	23	8.19%	10.83%	-2.65%
2016	16	9.86%	25.19%	-15.34%
2017	41	11.27%	1.69%	9.58%
2018	31	6.16%	3.09%	3.07%
2019	22	9.25%	5.07%	4.18%
2020	50	10.08%	7.18%	2.90%
2021	140	8.87%	-9.95%	18.83%
2022	53	6.02%	-3.12%	9.14%
2023	20	7.35%	-4.98%	12.34%
2024	4	14.56%	-6.01%	20.58%

Note. This table displays the number of observations as well as average of initial return, corresponding market benchmarks and initial market-adjusted returns per year of IPOs in Europe from 2010 to 2021 for non-VC-backed sample. The initial returns are negative of IPO underpricing as calculated in Equation 1. Corresponding returns and initial market-adjusted returns are calculated using Equation 2 and 3 respectively.

Table 6 demonstrates that both non-VC and VC-backed samples have insignificant statistics for the Shapiro-Wilk test, so the null hypothesis of the normal distribution cannot be rejected. Moreover, skewness and kurtosis tests are also insignificant, indicating a good fit of data. Histograms for better visualization can be found in the Appendix (Figures 4, 5, 6). The result of the t-test on the significance of initial market-adjusted returns is thus appropriate. The mean of VC-backed IPOs is not significantly different from zero, while that of non-VC-backed IPOs is significant at the 1% level. To analyze the first hypothesis, the two-sample t-tests are employed, in which the differences in the means between the two samples are statistically significant at the 1% level. The null hypothesis of no difference in their means can be rejected, suggesting evidence that VC-backed IPOs underpriced less compared to their counterparts. This supports the previous theory that VC helps minimize informational asymmetry, allowing firms to improve short-run performance.

This finding is consistent with Belghitar and Dixon (2012) who presented evidence for significant differences in initial market-adjusted returns between the two samples, such that VC-backed IPOs do not need to underprice as much as their counterparts to attract investors. However, their degree of market-adjusted underpricing was much larger, being 12.07% and 15.02% for VC and non-VC respectively. Megginson and Weiss (1991) also reported the effect of VC in reducing underpricing in the US. In contrast, if looking at individual countries, there are findings of insignificant differences in

underpricing between non-VC and VC-backed IPOs, such as Elston and Yang (2010) in Germany or Kirkulak (2008) in Japan.

Table 6. Statistical tests on initial market-adjusted returns of IPOs in Europe from 2010 to 2024

	VC-backed IPOs	Non-VC backed IPOs
Shapiro-Wilk test	0.977	0.996
Skewness	-0.097	-0.035
Kurtosis	2.167	3.224
t-test	0.618	10.865***
Wilcoxon signed rank test	0.575	10.139***
T-diff	3.223***	
MW-test	2.641***	

Note. This table displays statistical tests on initial market-adjusted returns conducted to examine the first hypothesis of the impact of VC on underpricing of IPOs in Europe from 2010 to 2024. Shapiro-Wilk test, skewness and kurtosis are performed to check if normal distribution assumption is fulfilled. The t-statistic for the initial market-adjusted returns is computed as described in Equation 4. T-diff is the two samples t-test on the differences in their means between non-VC and VC-backed IPOs. Wilcoxon signed rank and MW-test is the nonparametric test for significance of the median and the difference in median between two samples respectively.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

The underpricing pattern is further analyzed by dividing 2010 - 2024 into subperiods based on important economic events. The t-statistics have been calculated using Equation 4, in which normal distribution has been fulfilled after running the Shapiro-Wilk test. 2010 – 2014 can be considered as the recovery period after the financial crisis in 2008, where GDP growth increased steadily and remained stable. Table 7 shows that VC and non-VC experienced significantly similar means of initial market-adjusted returns of 6% in this cycle. In the next five years, Europe witnessed the debt crisis in Greece and Brexit, leading to volatility in interest rates. VC-backed IPOs exhibited significantly negative initial market-adjusted returns compared to their counterparts, making it the only period witnessing significant differences in the means between the two samples. From 2020 onwards, the global pandemic and escalation of the Russia – Ukraine war caused detrimental impacts on financial markets. This could explain the significantly high degree of underpricing of approximately 13%, which was double compared to the first five years. Underpricing patterns alter when inspecting specific economic cycles, as short-run returns are more vulnerable to small changes in market movement, thus raising controlling concerns for future study.

Table 7. Statistical tests on initial market-adjusted returns of IPOs in Europe for different subperiods during 2010 - 2024

	2010 - 2014	2015 - 2019	2020 - 2024
VC-backed IPOs	6.41%*	-13.18%***	13.60%***
	(1.679)	(-3.324)	(3.636)
Non-VC backed IPOs	6.80%***	2.06%	13.46%***
	(4.657)	(1.291)	(11.465)
T-diff	0.099	4.082***	-0.038
Number of observations	162	167	300

Note. This table displays the average and statistical tests on initial market-adjusted returns of IPOs in Europe during 2010 – 2014, 2015 – 2019 and 2020 - 2024. Initial market-adjusted returns are calculated using Equation 3. The t-statistic for the initial market-adjusted returns is presented in brackets, which is computed using Equation 4. T-diff is the two samples t-test on the differences in their means between non-VC and VC-backed IPOs.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

4.2. Venture Capital and Long run performance

The second hypothesis on the impact of VC on enhancing aftermarket performance will be analyzed on the sample of 455 deals with 380 non-VC and 75 VC-backed IPOs. Utilizing calendar-time analysis by Belghitar and Dixon (2012), it was found that VC-backed IPOs outperformed the market, while non-VC-backed ones underperformed in all specified periods (Table 7). Regarding the VC-backed group, their positive monthly abnormal returns are statistically significant in all intervals, except for the first 6 and 12 months. Considering T = 18 to T = 36, the magnitude of their outperformance increases as the interval expands, from 0.21% per month in the first 18 months to 0.37% per month over three years. On the other hand, the abnormal returns of non-VC-backed IPOs are negatively significant at the 5% level for T = 6, and at 1% level for the remaining periods. The magnitude of their underperformance compared to the market benchmark varies from -0.23% to -0.31%, which the returns are also higher if considering wider time spread. Over 3 years after listing, investors can earn an average monthly return of 0.37% if opting for VC-backed IPOs, whereas they could risk losing -0.27% per month if investing in non-VC-backed ones. Compared to BHR returns reported in Table 2, the scale of underperformance calculated by calendar-time analysis is relatively smaller, which was supported by the study of Gompers and Lerner (2003).

Conducting a two-sample t-test, the differences in average monthly abnormal returns between the two samples are statistically significant for every examined period, suggesting evidence for superior performance of VC-backed IPOs compared to their counterparts. This result is also consistent when employing the non-parametric MW-test as shown in Table 8. Therefore, the value added by VC can be

concluded to play a role in enhancing the aftermarket performance of its portfolio firms, such that their investors can earn higher returns compared to opting for non-VC-backed ones.

These findings are in line with Bessler and Seim (2012) who analyzed long-run returns of European IPOs during two sub-periods of 1996 to 2003 and 2003 to 2010 due to "new economy" differences. They found that VC-backed IPOs could provide similar positive returns in two cycles, proving their consistency against fluctuations in market conditions. Moreover, VC-backed samples were discovered to significantly outperform their counterparts by 21.11% and 17.08% after two to three years of listing (Bessler and Seim, 2012). Similarly, Brav and Gompers (1997) realized the ability to generate higher returns in VC-backed IPOs compared to non-VC ones. However, these results do not align with Belghitar and Dixon (2012) who reported underperformance in both groups and no significant differences in the means of abnormal returns between non-VC and VC-backed IPOs. This could be attributed to discrepancies in authorities, shareholders' preferences, or VC characteristics in each country that their finding on long-run returns in the UK cannot be generalizable in a larger context.

Table 8. Calendar analysis for long run performance of IPOs in Europe from 2010 to 2021

	VC-backed IPOs	Non VC-backed IPOs	T-diff	MW test
T = 6	0.22%	-0.31%**	-2.29**	-2.74***
	(1.179)	(-2.282)		
T = 12	0.23%	-0.32%***	-3.12***	-3.54***
	(1.620)	(-3.007)		
T = 18	0.21%*	-0.32%***	-3.42***	-3.81***
	(1.766)	(-3.244)		
T = 24	0.24%**	-0.30%***	-4.04***	-4.08***
	(2.377)	(-3.435)		
T = 30	0.28%***	-0.27%***	-4.70***	-4.58***
	(3.235)	(-3.421)		
T = 36	0.37%***	-0.23%***	-5.93***	-5.46***
	(5.343)	(-3.112)		

Note. This table displays the average and statistical tests of monthly abnormal returns of IPOs in Europe from 2010 to 2021. The monthly abnormal returns are calculated using Equation 6, of which their averages are presented for the interval of 6, 12, 18, 24, 30 and 36 months after listing. The t-statistic for the abnormal returns is presented in brackets, which is computed using Equation 7. T-diff is the two samples t-test on the differences in their means between non-VC and VC-backed IPOs. MW test is the non-parametric test on the difference in their median between non-VC and VC-backed IPOs.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

Since aftermarket performance only contains IPOs issued until 2021, the total period is separated into two intervals of six years, which only 36-month interval is examined. For both periods, the differences in the average monthly abnormal returns over three years between non-VC and VC are statistically

significant at the 1% level. In contrast to the short-run underpricing, indicating that the superior performance of the VC-backed group is not subjected to change with market conditions. Moreover, while firms backed by VC consistently outperformed the market, the non-VC-backed group significantly underperformed in the first half but outperformed in the second half.

Table 9. Calendar analysis for long run performance of IPOs in Europe for different subperiods during 2010 - 2021

	2010 - 2015	**2016 - 2021**
VC-backed IPOs	0.04%	0.72%***
	(0.513)	(6.966)
Non-VC backed IPOs	-0.67%***	0.24%***
	(-7.545)	(2.653)
T-diff	-6.122***	-3.558***
Number of observations	276	134

Note. This table displays the average and statistical tests of monthly abnormal returns for 36-month interval of IPOs in Europe during 2010 – 2015 and 2016 - 2021. The t-statistic for the abnormal returns is presented in brackets, which is computed using Equation 7. T-diff is the two samples t-test on the differences in their means between non-VC and VC-backed IPOs.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

4.3. Robustness check

4.3.1. Venture Capital and IPO Underpricing

Employing the OLS regression in Equation 8 on a sample of 184 deals, the null hypothesis states that the coefficient of VC on initial market-adjusted returns equals zero. Table 10 displays that the coefficient is statistically significant at the 1% level. However, the conditional mean independence assumption may not be met as there could be confounding variables that are not yet controlled. We cannot reject the null hypothesis, but this does not necessarily mean that we accept it. Therefore, no causal effect but only association can be inferred. It is estimated that having VC to back their IPOs correlates with a decrease of 0.122, or 12.2% in initial market-adjusted returns, thus aligning with our finding of lower underpricing in the VC-backed group. All other variables are insignificant, but their relationship with underpricing is as expected.

Table 10. Regression on initial market-adjusted returns

	Initial market-adjusted returns
VC	-0.122***
	(-2.620)
Ln(marketcap)	-0.000
	(-0.060)
Age	-0.001
	(-1.250)
Reputational accounting	0.008
	(0.210)
Offer technique	0.015
	(0.230)
Constant	0.141***
	(4.030)
Number of observations	184

Note. The table presents estimated coefficients and constants obtained from regressing initial market-adjusted returns on sets of variables using OLS. The t-statistics are reported in brackets.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

4.3.2. Venture Capital and Long run performance

Regressing long-run returns over three years using the BHR approach on multivariate analysis expressed in Equation 9, all explanatory variables are statistically insignificant. With an estimated coefficient of 0.241, a positive correlation between VC and aftermarket performance under BHR can be detected, although no causal effect can be drawn. The discrepancy in our findings could be attributed to the methodology employed to compute long-run returns, such that BHR is more likely to underestimate compared to calendar-time analysis (Gompers and Lerner, 2003). Moreover, there could be omitted variables that have not been included in the regression, which can cause spurious relationships.

Table 11. Regression on BHR long run returns

	BHR 36-month
VC	0.241
	(1.160)
Ln(marketcap)	0.010
	(0.300)
Age	0.0001
	(0.050)
Initial market-adjusted returns	0.140
	(0.440)
Constant	-0.128
	(-0.700)
Number of observations	319

Note. The table presents estimated coefficients and constants obtained from regressing BHR long run returns on sets of variables using OLS. The t-statistics are reported in brackets.

***Significant at the 1 percent level

**Significant at the 5 percent level

*Significant at the 10 percent level

CHAPTER 5 Conclusion

This paper aims to study the impact of venture capital on IPO underpricing and aftermarket performance. The first hypothesis related to abnormal initial return is developed based on the efficiency of VC in alleviating informational asymmetry, while the long-run returns hypothesis is proposed according to the added value of VC. Several investigations into this role of VC have been conducted in different contexts but given inconsistent findings. Moreover, there have been resourceful studies in the US and individual countries, but limited insights into the larger context. Therefore, this study replicates the research on the UK market by Belghitar and Dixon (2012) to the European IPOs from 2010 to 2024, in which we share similar findings on underpricing patterns, but contrasting results regarding performance in the long run.

Regarding the first hypothesis, the initial market-adjusted returns are computed to analyze underpricing, which is defined as the difference between IPO initial returns and market returns on the first trading date. If not accounting for the market benchmark, the average degree of underpricing of VC-backed IPOs equals 6.04%, which is approximately two-thirds of that of non-VC-backed ones. The mean of initial market-adjusted returns of the VC-backed sample equals 1.59% and is not significantly different from zero, while non-VC-backed IPOs exhibited a significant degree of 8.93%. Comparing two samples, it was found that the difference in means of initial market-adjusted returns is statistically significant at the 1% level, suggesting evidence for less underpricing in the VC-backed group compared to their counterpart. This pattern can be attributed to the certification role of VC in minimizing information asymmetry and uncertainty of investors, allowing them to attract demand without leaving too much money on the table. However, this effect can be subjected to change according to fluctuations in market conditions.

Utilizing calendar-time analysis, it was discovered that VC-backed IPOs significantly outperformed market benchmarks during the first 18 months onwards, while the non-VC group experienced significantly negative abnormal returns every 6 months for over three years after listing. Moreover, the differences in means of monthly abnormal returns between the two samples are statistically significant in all examined periods, thus providing evidence for the outperformance of VC-backed IPOs in the long run compared to their counterparts. This relationship was found to remain significant across economic cycles, so investors are suggested to consider their long-term investment in firms backed by VC for better returns. Their superior returns in the long run could be explained by funding and managerial support from VC, which can help relax financial constraints and form a strategic vision. Although aftermarket performance is affected by several factors that are out of the control of VC, these added values play a crucial role in aligning the interests of involved parties and achieving long-term goals.

OLS regression was employed to conduct a robustness check for our findings. A significantly negative coefficient of VC on initial market-adjusted returns was found, implying the help of VC in alleviating underpricing. The coefficient of VC on BHR long-run returns is not significant, despite being positive as hypothesized.

Regarding future studies, some points of improvement can be implemented for better outcomes. Firstly, despite merging several databases, there are missing values in the selected variables, which observations need to be dropped. This led to a restricted sample size, subsequently reducing the statistical power. Therefore, it is suggested to construct a more complete dataset to improve the accuracy and reliability of findings. Secondly, constraint in data availability makes it difficult to form a size-matched portfolio for calendar-time analysis as suggested by the original methodology. More variables are needed to form this benchmark means that the sample size can be further reduced. Market portfolio is opted as an alternative, but it can cause certain degrees of imprecision in the results. The use of size-matched portfolios for comparison purposes can resolve new listing and rebalancing biases (Belghitar and Dixon, 2012). On the other hand, if the market index is selected as benchmark due to data availability, it is suggested to use MSCI per country, instead of MSCI Europe to account for country-level bias. Regarding the regression model, including additional control variables to incorporate confounding effects associated with independent variables can improve internal validity. Some variables to be considered are market volatility and market performance before IPOs (Belghitar and Dixon), or the reputation of VC and underwriters. Finally, future research could employ different methodologies in evaluating underpricing and returns in the long run, as well as replicating into other contexts to test for the generalizability of these findings.

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APPENDIX

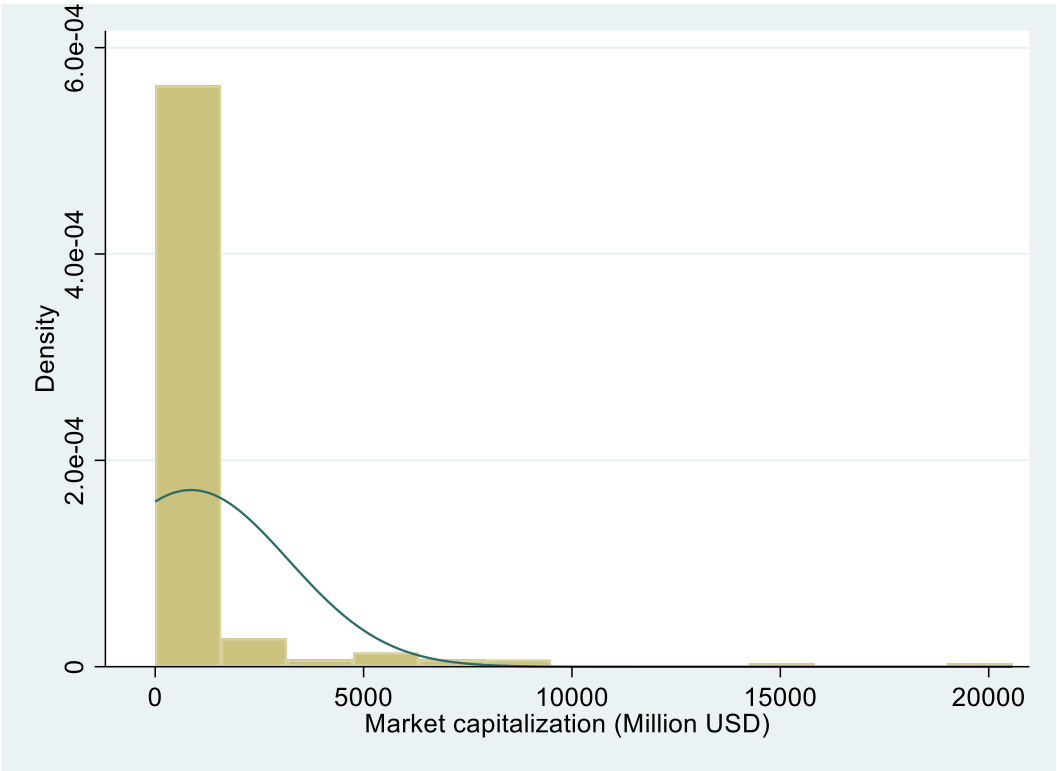

Figure 3. Histogram of market capitalization of IPOs in Europe from 2010 to 2021

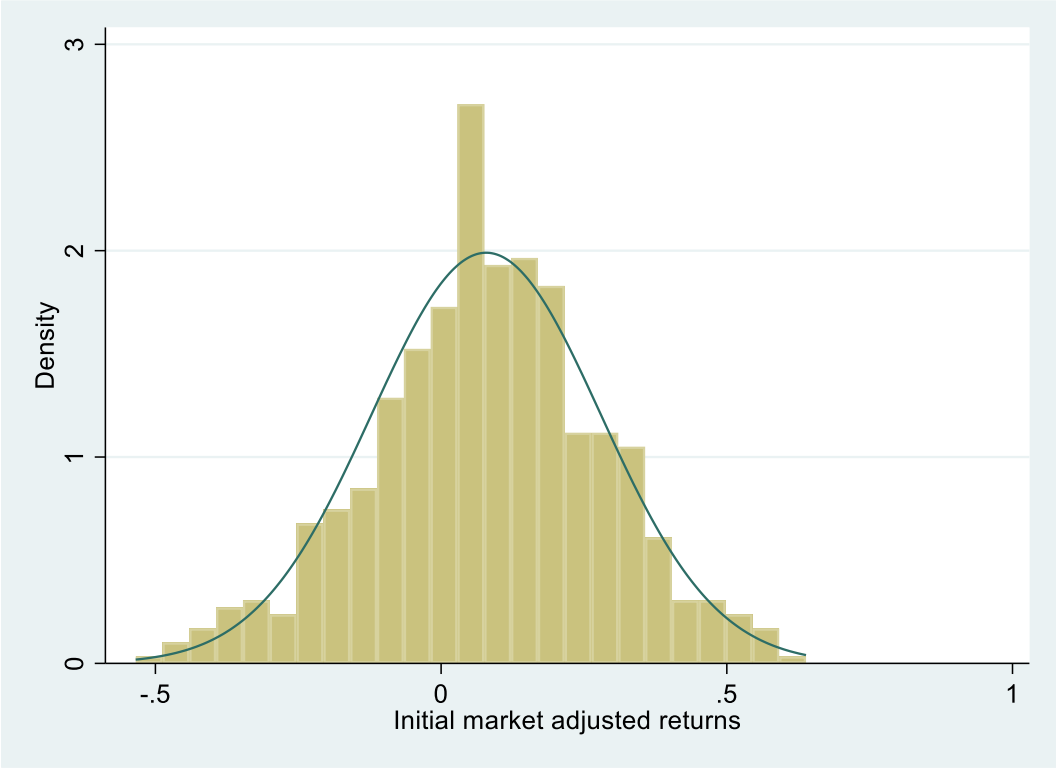

Figure 4. Histogram of initial market-adjusted returns of IPOs in Europe from 2010 to 2024

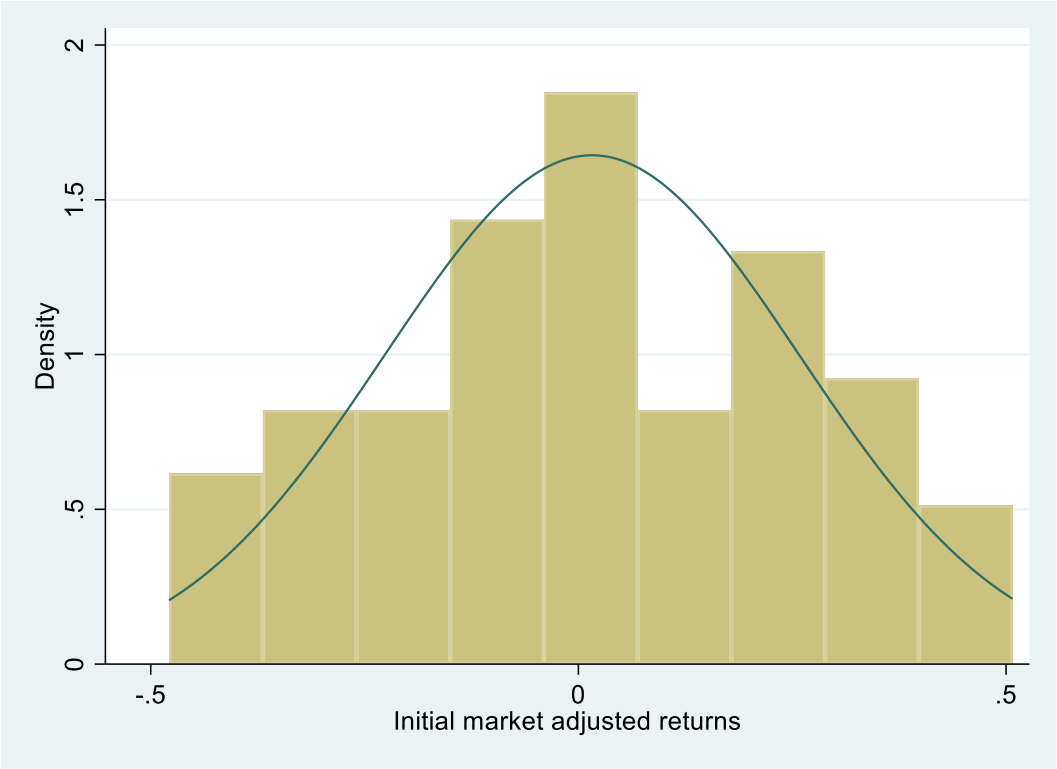

Figure 5. Histogram of initial market-adjusted returns of VC-backed IPOs in Europe from 2010 to 2024

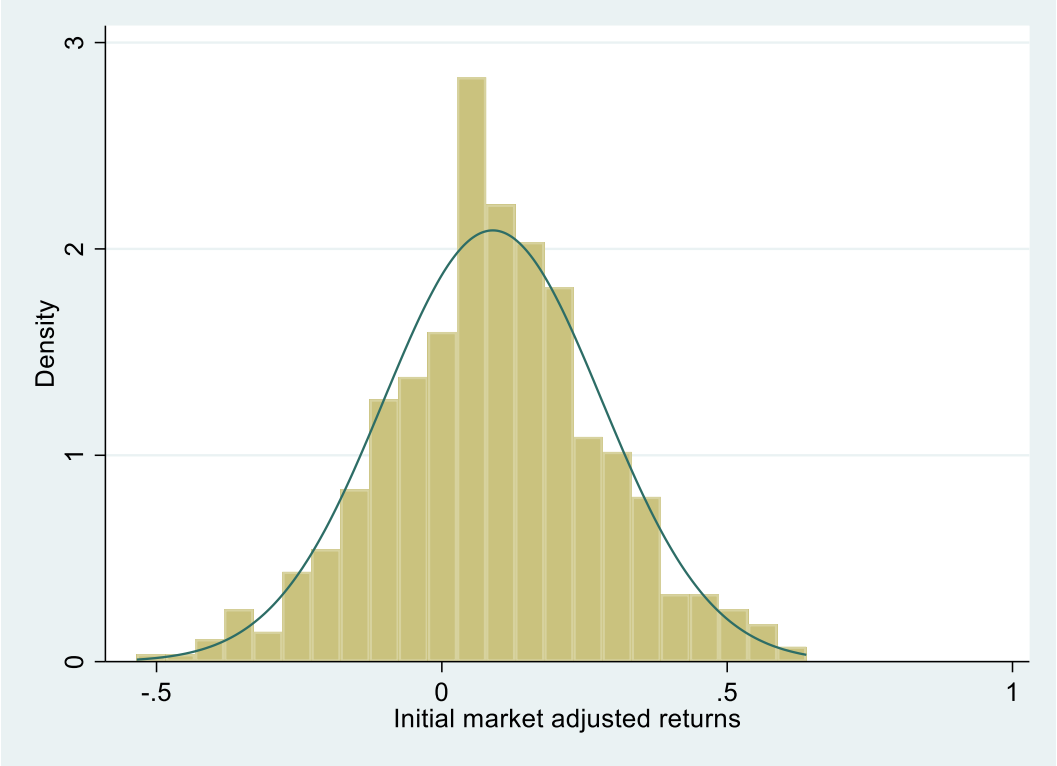

Figure 6. Histogram of initial market-adjusted returns of non-VC-backed IPOs in Europe from 2010 to 2024