Handelshøyskolen BI

GRA 19703 Master Thesis

Thesis Master of Science 100% - W

Predefinert informasjon

Startdato:	09-01-2023 09:00 CET	**Termin:**	202310
Sluttdato:	03-07-2023 12:00 CEST	**Vurderingsform:**	Norsk 6-trinns skala (A-F)
Eksamensform:	T		
Flowkode:	202310||11184||IN00||W||T		
Intern sensor:	(Anonymisert)		

Deltaker

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Informasjon fra deltaker

Tittel *:	IPO Underpricing in Europe
Navn på veileder *:	Janis Berzins

Inneholder besvarelsen konfidensielt materiale?:	Nei	**Kan besvarelsen offentliggjøres?:**	Ja

Gruppe

Gruppenavn:	(Anonymisert)
Gruppenummer:	124
Andre medlemmer i gruppen:	

BI Norwegian Business School – Thesis

IPO Underpricing in Europe

A study of European IPO Underpricing and Short-run performance Across Market Cycles and Crises

Empirical Evidence from 2006-2021

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Hand-in Date:

June 9, 2023

Campus:

BI Oslo

Examination Code and Name:

GRA 1970 – Master Thesis

Programme:

Master of Science in Business – Major in Finance

Abstract

This thesis presents a comprehensive analysis of 1207 initial public offerings (IPOs) listed on various exchanges across Europe from January 2006 to December 2021. We find that on average the IPOs were underpriced at 12,7% when adjusted for market return. Furthermore, we find that IPOs that were backed by either private equity or venture capital were exposed to significantly less underpricing than those that were not. The results also revealed that during the pandemic one observed significantly higher levels of underpricing, and that larger proceeds on average results in higher levels of underpricing.

We would like to acknowledge our thesis supervisor and professor, Janis Berzins, and thank him for his valuable input and guidance throughout working with our thesis.

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Glossary

ECMH	Efficient Capital Markets Hypothesis
PE	Private Equity
IPO	Initial Public Offering
VC	Venture Capital
NPE	Non-Private Equity-Backed/ Non-Venture Capital-Backed
NS	No Specification
HMA	High Market Activity
LMA	Low Market Activity
OLS	Ordinary Least Squares
CLRM	Classical Linear Regression Model
VIF	Variance Inflating Factor
BLUE	Best Linear Unbiased Estimator
CFI	Corporate Finance Institute
BAHR	Buy-and-Hold Return

PART I. INTRODUCTION

1.1 Background and Motivation

The Initial Public Offering (IPO) is a significant milestone for a company, symbolizing years of hard work and entrepreneurial dedication. It carries immense importance beyond just finances, serving as a powerful signal to the public and investors. Recent years have seen a surge in IPO activity due to favorable market conditions, although in times of heightened volatility. Private equity firms have also utilized IPOs to maximize their returns. However, their involvement raises questions about reputation implications. Underpricing is a common issue in IPOs, where the shares' market value exceeds the offer price, resulting in lost proceeds for the company. This inconsistency prompts an exploration of the conflict of interest between the issuing company, the underwriter and the investor.

In this thesis, we explore a range of factors that have the potential to influence the extent of underpricing of IPOs, with the aim of acquiring a more comprehensive understanding of this phenomenon. Additionally, the relationship between underpricing and market cycles becomes more evident when underpricing is absent, as highlighted by seminal research such as Ibbotson's (1975) paper. Notably, Loughran and Ritter (2004) conducted a comprehensive study in the U.S. stock market, revealing significant variations in the average level of underpricing across different periods, ranging from 7% to 65%. This prompts us to examine the impact of the emergence of COVID-19 on IPO performance. The opportunity to analyze the characteristics of IPOs during this period and compare them to the dynamics observed during the financial crisis and normal times adds further intrigue to our exploration.

We investigate the potential influence of market cyclicality and volatility on the level of underpricing observed in European initial public offerings (IPOs). By analyzing these factors through statistical testing, we seek to gain insights into how market conditions can impact the pricing dynamics of IPOs in the European context. Through empirical research and analysis, this study aims to contribute to our understanding of the relationship between market fluctuations and the underpricing phenomenon in European IPOs. Therefore, our research question is:

"How does market cyclicality and volatility impact short-run performance and the level of underpricing in European IPOs, and what insights can be gained regarding their characteristics of backing."

To answer our research question, we explore six hypotheses. These are constructed in a way that they test previous literature in a new setting. We thoroughly explain our procedure throughout our thesis, going through existing literature, our methodology, data and lastly the results of our analyses.

PART II. THEORY

In this section we present the background theory and existing literature on IPOs, their backing, and other factors that have previously proven helpful in predicting first day returns.

2.1 The Pandemic

On March 11th, 2020, the World Health Organization declared that the Covid-19 outbreak had reached pandemic proportions. This announcement set in motion a chain of devastating events, resulting in the loss of two million lives in the European Region alone (World Health Organization, 2022). Moreover, it marked the beginning of a period characterized by an economic downturn and profound uncertainty. The global economy witnessed a significant decline, with a 4.3% contraction in 2020 (The World Bank, 2022).

2.1.1 Exploring the Impacts on IPOs

In contrast to previous crises, the COVID-19 pandemic prompted a substantial and resolute economic policy reaction that effectively mitigated its most severe immediate consequences. Governments and central banks around the world swiftly implemented measures to stabilize economies, protect jobs, and support businesses. These responses aimed to alleviate the immediate impacts of the pandemic, ensuring a measure of stability during these uncertain times. However, these emergency measures have also introduced new risks, including a significant increase in both private and public debt (WDR, 2022).

The heightened uncertainty caused by the pandemic has encouraged scientists to examine the impact of the pandemic on various facets of the financial markets. One contribution towards understanding the impact of the COVID-19 pandemic on IPOs comes from the study conducted by Mazumder and Saha in 2021 (Mazumder & Saha, 2021). Using a comprehensive index that measures daily COVID-19 cases and deaths in the United States, the researchers examine the relationship between pandemic-related fear and the short-term performance of IPOs. The findings of Mazumder and Saha's study hold particular significance, especially considering the unprecedentedly high initial returns witnessed in 2020. Their research contradicts the findings of Baig and Chen (2022), which will be discussed in detail later in this chapter. Baig and Chen's study identified a positive association between underpricing, volatility, and the extent of the COVID-19 pandemic, in which we explore in a broader European context in our analysis.

2.2 Private Equity

2.2.1 Definition

There are many definitions of PE. Cendrowski et al. (2012) define it as follows: "PE is a medium or long-term equity investment that is not publicly traded on an exchange". These firms raise funds from institutional investors, such as pension funds, endowments, and wealthy individuals, to invest in companies and generate a return on investment over the long term. Typically, PE investments involve a long-term investment horizon. Further, while PE includes venture capital, buyout transactions, hedge funds, fund of funds, and debt securities, we will focus on PE and VC firms that invest in equities. Later on, we use the definitions of these types of backing as a means of testing their distinct features and relationship to first day returns.

2.2.2 Structure

Private equity funds are usually organized with limited duration. The average lifetime is 10 years, normally ranging between 8 and 12 years (Cendrowski et al., 2012). PE is structured between three key players consisting of the General Partner (GP), Limited Partners (LPs), and the Portfolio Company.

1. ***The General Partner (GP)*** *assumes the role of managing an entity in a private equity fund, with the main responsibility of making investment decisions, overseeing portfolio companies, and managing fund operations. The goal of the GP is to enhance the value of the target investments by implementing value-add enhancements and operational efficiencies (Cendowski et al., 2012).*
2. ***Limited Partners (LPs)*** *are investors who contribute capital to a private equity fund but do not participate in its daily management**.** Typically, these investors are institutional entities such as pension funds, endowments, or high-net-worth individuals.*
3. ***The Portfolio Company*** *is a private enterprise in which a private equity fund invests. These firms are typically unlisted, and the holding period typically lasts from 2 to 7 years before divestment (Cendowski et al., 2012).*

However, it is worth mentioning that the structure can vary depending on the size of the fund, the investment strategy, and the preferences of the investors and general partners.

2.2.3 Life Cycle

As previously stated, private equity funds typically have a lifespan of 8 to 12 years, with an average of 10 years. Over the course of the fund's lifetime, it goes through four stages: "Organizing/Fundraising", "Investment", "Management", and "Harvest/Exit" (Cendrowski et al., 2012).

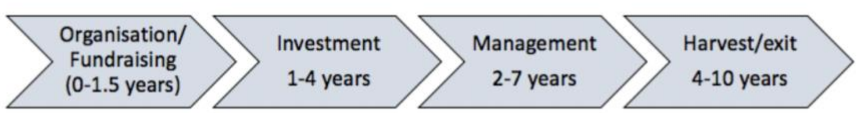


Figure 1: Lifecycle of private Equity Funds (Cendrowski et al., 2012).

1. ***Fundraising (0-1.5 years):*** Private equity funds raise capital from institutional investors to create a pool of funds for investments.
2. ***Investment (1-4 years):*** The fund searches for investment opportunities, conducts due diligence, and negotiates deals with legal experts.
3. ***Management (2-7 years):*** The fund implements strategies, provides support and advice to portfolio companies, and aims to increase their value.
4. ***Harvest/Exit (4-10 years):*** The fund seeks to realize its investments through various strategies, such as secondary buyouts, trade sales, or initial public offerings. The choice depends on market conditions and capitalization.

2.2.4 Venture Capital

Venture capital, also known as the "money of invention," is a critical component in driving the success of entrepreneurial investments by offering value-added resources to startup firms (Cumming & Johan, 2013). This type of investment focuses on providing financial support to innovative, early-stage companies with the potential for high growth, which is the distinction that separates them from private equity firms.

In general, venture capital investments usually take place at the seed stage, providing the necessary funds for research, evaluation, and the development of initial concepts prior to the startup phase (Cumming, 2013). Nevertheless, small and medium-sized enterprises often face challenges in securing external financing through avenues like loans, capital markets, and other means. As stated by Zider (1998), the difficulty in finding external sources of funding stems from factors such as the company's limited operating history and the perceived risks associated with its future earnings.

Further, venture capital does not only provide liquidity to the portfolio company but also generates value through other sources such as managerial and technical expertise. According to Johnson (n.d.), venture capital (VC) can be considered a type of private equity from a technical standpoint.

2.2.5 Exit Strategies

In the realm of PE and VC investments, various exit strategies have emerged over the years. According to Povaly (2006), the most traditional exit routes for PE funds are trade sales, secondary buyouts, and IPOs.

The trade sale is an exit strategy in which a PE firm sells its stake to a strategic buyer, aiming to maximize its investment returns. This approach facilitates the transfer of ownership to a well-suited acquirer who possesses the capabilities to enhance the company's value and foster its growth potential. Alternatively, secondary buyouts offer a middle ground for companies seeking an exit strategy. In this scenario, a PE firm orchestrates a transaction by leveraging a combination of debt and equity. This approach allows for the transition of ownership to another private equity firm, enabling the company to benefit from a fresh injection of capital and strategic guidance.

Further, the last of the three strategies is an exit through an initial public offering (IPO). Ritter & Welch (2002) describe an IPO as a private company entering public trading by listing on a stock exchange. This allows investors to easily buy and sell the company's shares, providing them with liquidity and the opportunity to make a profit from their investment. Simultaneously, the company gains access to capital, which can support its growth and expansion plans. According to Schöber (2008), the utilization of IPOs as an exit strategy varies depending on market conditions. When valuation multiples for IPOs are high and increasing, financial sponsors are more inclined to consider going public to exit their investments. Conversely, when valuation multiples are low or decreasing, financial sponsors are less likely to choose an IPO as an exit strategy. Additionally, private equity firms often capitalize on these peak periods by exiting their investments through IPOs to maximize their returns (Berger and Udell, 1998). However, in the upcoming chapter dedicated to IPOs, we will delve deeper into their characteristics.

2.3 Initial Public Offering

2.3.1 Definition

As mentioned in the previous chapter, an IPO, or Initial Public Offering, is the first time a company offers its shares to the public on a stock exchange to raise capital. Investment banks act as underwriters, setting share prices and facilitating sales to investors. Once the IPO is complete, the company's shares can be traded publicly on the exchange. Going public is a significant milestone for companies transitioning from the private sector to public capital markets. There are two primary reasons why companies choose to go public: to raise capital through the IPO process and potential future offerings, and to provide investors with the opportunity to diversify their portfolio by investing in a newly public company (Berk & DeMarzo, 2014). Further, the rise and decline in activity are tied to capital demand, but also sentiment in the market, where recessions and crises have pushed investors to walk away from risky assets (Berk & DeMarzo, 2014).

2.3.2 The Process of Going Public

As stated in the previous section, the company's decision to go public represents a significant milestone. Nevertheless, it is important to acknowledge that the process itself can be time-consuming. Jenkinson and Ljungqvist (2001) indeed proposed a framework dividing the process of going public into five stages.

1. ***Market selection:*** In the initial stage of the process, the company identifies a suitable market in which it intends to conduct its IPO. The market selection is further influenced by various factors, including the liquidity of

the respective stock exchange, the listing requirements of the market, the relevance of the industry, and the institutional environment of the chosen market (Moore et al., 2012). Finally, several stock exchanges are also considered, domestically as well as globally, albeit smaller exchanges may have less listing requirements.

2. ***Choice of underwriter:*** During the second stage, the issuing company is tasked with selecting an investment bank to serve as their underwriter. In many cases, particularly with larger IPOs, the underwriting team consists of multiple investment banks, with one taking the lead role. The company evaluates various investment banks and ultimately chooses the one(s) that best align with their needs and objectives.
3. ***Prospectus design:*** In the third stage, the prospectus must be designed, which is the document that introduced the company to the public. The prospectus plays a vital role as it provides potential investors with essential information needed to make informed decisions regarding the issuing company. It encompasses comprehensive details about various aspects of the company, presenting a holistic view that enables investors to assess the company's strengths, potential risks, financial performance, business strategy, and other relevant factors.
4. ***Information gathering:*** Once the prospectus is finalized, the underwriters proceed with marketing the issuing company to the public. The primary objective of this stage is to gather relevant information and indications of interest from potential investors. By generating investor interest, the underwriters can gauge demand and set the most accurate price for the offering. This can be achieved through the book-building process, where investors submit their desired allocation and price range, or through a fixed price determined by the underwriters based on market conditions.
5. ***Share allocation:***

   In the final step, the underwriters allocate shares to the investors. However, in cases where the demand for shares exceeds the available supply (oversubscription), investors may not receive their full desired allocation.

Despite aiming to secure a specific number of shares, investors may receive a reduced allocation based on the oversubscription level. This means that the total demand for shares surpasses the number of shares available for allocation. In such situations, the underwriters carefully determine the allocation process, considering factors like investor preferences, order size, and any predetermined allocation rules. The objective is to allocate shares in a fair and efficient manner, considering the limitations imposed by oversubscription.

2.4 Underpricing

The mispricing of IPOs can result from several factors, such as market conditions, differences in valuation methods, and the financial performance of the company. In this context, underpricing is a specific phenomenon that occurs when the offer price of a newly issued stock is lower than its first trade price, resulting in the stock being considered underpriced in the IPO literature. Underpricing is traditionally viewed as a market anomaly, which raises questions about the market efficiency hypothesis (Berk & DeMarzo, 2014). The theoretical aspects of the ECMH, which indicate that market prices reflect the knowledge and expectation of all investors, the issue price should not or at least very low deviate from the first day performance and the days after (Reiche, 2014). However, previous studies suggest that this is often not the case, and there is typically a significant difference between the issue price and the first-day performance. For example, a study conducted by Krigman, Shaw, and Womack in 1999 examined 1,232 large-cap IPOs from 1988 to 1995 and found that 12% of them had a first day return of 30% or more (Krigman & Womack, 1999). Jay Ritter has been updating and refining these findings on his website, which contains comprehensive IPO data from around the world. Ritter's analysis of a sample of 13,826 IPOs in the United States spanning 1960 to 2022 reveals an average first-day return of 17.7%, suggesting that IPOs have generally provided significant returns to investors (Ritter, 2022).

2.5 Factors that explain underpricing

2.5.1 Asymmetric Information

The theory of asymmetric information is one of the most recognized explanations for underpricing in IPOs. Investment banks, acting as underwriters, play a crucial role for the issuing firm. The presence of an information asymmetry between the underwriter and investors regarding the issuer's fair value can result in the IPO price failing to accurately reflect the true value of the security.

Baron's (1982) agency-based account of information asymmetry sheds light on the factors contributing to underpricing in IPOs. According to the article, underpricing can be attributed to the issuer's reliance on the investment bank's knowledge and expertise to set the IPO price, as the issuer may lack the ability to accurately assess the fairness of the recommended price. Furthermore, underpricing is a consequence of the investment bank possessing more information about the true value of the company than the issuer. As a result, the theory posits that the issuer, unable to effectively monitor the underwriter without incurring additional expenses, may end up with lower offer prices. In addition, Baron (1982) suggests that the greater the degree of uncertainty surrounding the IPO among issuers, the more expensive the services provided by the investment bank will be.

Rock's (1986) theory on underpricing highlights the information asymmetry between investors, issuers, and underwriters in the IPO process. Rock argued that neither the underwriter nor the issuer has complete knowledge of the value of the securities being issued, resulting in an information bias. To compensate for this asymmetry, underwriters may underprice the IPO to attract investors as well as undertaking additional risk (Jenkinson & Ljungqvist, 2001). This theory is in line with Ibbotson, Sindelar, and Ritter's (1994) concept of the "winner's curse," where the winning bidder in an auction overpays for the item due to an overestimation of its value. In the context of IPOs, uninformed investors may overestimate the value of the securities, leading to a market inefficiency that is ultimately reflected in the underpricing of the IPO.

Finally, a common argument in contemporary IPO literature is that issuers must "leave money on the table" to attract investors, as noted by Bergström (2006). Loughran and Ritter's (2002) study further explores this concept and examines why issuers may not be concerned about underpricing. Despite sacrificing potential profits, issuers may still benefit from increased visibility and liquidity that a successful IPO can bring. Ritter analyzes the various factors that contribute to issuers accepting underpricing as a necessary cost of going public and evaluates potential trade-offs between underpricing and other factors, such as long-term shareholder value.

2.5.2 *Hot Issue Market*

In addition to information asymmetry, market cycles are among the factors that contribute to and may influence the degree of underpricing, as well as other market attributes. Market cyclicality has been researched by scientists for many years, and studies by Ibbotson and Jaffe (1975) and Ritter (1984), who were the first to document this reason for underpricing, have suggested that underpricing is particular to specific times and sectors. “Hot issue" markets are periods in which new issues, on average, provide abnormally high returns in the aftermarket during the first month (Ibbotson & Jaffe, 1975). Conversely, "cold issue" markets are defined as periods when new issues perform below the market average in the aftermarket. In relation to hot issue markets, this “window” of opportunities causes companies to experience a higher degree of overvaluation if they go public which in turn predicts higher returns (Ritter, 1991). This pattern is exemplified by the Dot-com bubble, where Ljungqvist and Wilhelm (2003) found that internet companies were underpriced by an average of 89% during the peak of the bubble in 1999 and 2000. Further, they found three possible explanations consisting of change of risk composition, realignment of incentives, and change of issuer objective. This underscores the significant impact that market cycles can have on IPO underpricing.

2.5.3 Underwriter´s Reputation

Carter and Manaster (1990) developed a model that sought to explain the relationship between underpricing and the quality of IPOs. They argued that companies of high quality are motivated to reveal their low risk to the equity market to avoid the expensive underpricing associated with IPOs. They also suggested that investment banks tend to choose IPOs of low-risk companies because they have fewer informational investors to protect their reputation and less incentive to obtain information.

The success of IPOs and the quality of underwriting are often linked to the reputation of underwriters. Underwriters with a strong reputation are known to attract a larger pool of potential investors, leading to greater demand for shares and potentially higher prices. Chua (2014) conducted a study that developed a model to explain the behavior of underwriters when setting prices for IPOs. The study found that reputational concerns were particularly important for top-tier underwriters, and there was a correlation between the initial day return and the relative valuation. In periods of high valuation and reputational concerns, these underwriters tend to adjust the initial offer price valuation downwards to match the lower historical industry valuation. This strategy increases the first day return but decreases the long-term underperformance of the IPO.

Michaely and Shaw (1994) also found that reputable investment banks underwrite IPOs that experience significantly less underpricing and perform better in the long run. Thus, underwriters with a strong reputation are typically associated with IPOs that have lower returns and less underpricing.

2.5.4 Underpricing in PE-Backed IPOs

As the issue of underpricing gained more attention, some authors investigated the role of backing and its correlation with this prevalent phenomenon. We anticipate a reduced incidence of underpricing since PE-backed IPOs are known to contribute to less adverse selection due to their certificated position and higher information transparency. Bergström, Nilsson, and Wahlberg (2006) examined a sample of 1'370 unsponsored and 152 PE-backed initial public offerings (IPOs) listed on the London and Paris Stock Exchanges between 1994 and 2004. They could draw the conclusion that, consistent with their hypotheses, IPOs sponsored by PE experienced underpricing of 9.33% against 12.87% for non-PE backed IPOs (Bergström et al., 2006).

Part III. METHOLODGY

The methodology section of this thesis explains how we intend to explore the phenomenon of underpricing in European IPOs, with a particular focus on the impact of the COVID-19 pandemic and its differences compared to the financial crisis of 2008. The existing literature on underpricing primarily revolves around the North American IPO market, and this study seeks to provide fresh insights into the European IPO market, evaluating existing findings in a new updated setting. The study utilizes data from SDC Platinum and Refinitiv, employing R Studio and ordinary least squares regression to estimate coefficients and examine the relationship between underpricing and selected variables. Robustness tests are conducted to ensure the reliability of the results. By evaluating the explanatory power of each variable, the study aims to contribute to the understanding of underpricing and its determinants in the context of recent global market turmoil. The hypotheses explore various aspects such as the levels of underpricing during different periods, the influence of market volatility, market return, industry-specific effects, and the characteristics of "hot issue" markets.

3.1 Analysis Structure

Our thesis explores the phenomenon of underpricing in European IPOs. Its contribution to the existing literature is to explore the broader European IPO market, and to evaluate existing findings and variable significance in a new updated setting. Existing literature is highly focused around the North American IPO market, and we aim to provide further insight into the European IPO market and its differences, if any. We put emphasis on the recent COVID-19 pandemic and explore its difference with previous periods. More specifically, we focus our research on the financial crisis in 2008, the recent pandemic, and the period in between.

To conduct our analysis, we have gathered relevant data from SDC Platinum and Refinitiv. These data sources provided the necessary information to construct the chosen variables in testing our hypotheses. In our cross-sectional study, we employ R Studio and the ordinary least squares method to estimate the unknown coefficients. By regressing the dependent variable (underpricing) on the explanatory variables, we can ascertain the relationship between underpricing and the selected variables, as well as determine their levels of significance. To ensure the reliability of our results, we conduct robustness tests to address any potential econometric issues. To evaluate whether there is significance in our separate subsamples we utilize univariate analysis and t-tests for significance.

Based on our findings, we evaluate the explanatory power of each variable and draw conclusions in comparison to existing theories of underpricing and their relation to the European IPO market. Hypotheses are rejected if the corresponding variable exhibits a small coefficient and/or lacks statistical significance. Through this analysis, we aim to contribute to the existing understanding of underpricing and its determinants in the context of the recent global market turmoil.

3.2 Hypotheses

In the existing literature, numerous theories regarding underpricing have been proposed. However, due to limitations in data accessibility and time constraints, we are only able to test a limited number of these theories. Our selection of theories for further examination is influenced by factors such their relevance to the European market, our research interests and their prevalence in previous studies.

Furthermore, prior researchers have observed various patterns of high initial returns on a global scale. Therefore, the aim of our hypotheses is to determine whether investors can effectively differentiate and identify offerings that are more susceptible to underpricing in Europe, exploring also potential new explanations in times of global volatility. Below, we present our hypotheses and the underlying motivations behind them.

We define initial return as first day returns after offering. An initial return of 0% implies that the underwriter's valuation is the same as the market sentiment after the first trading day. Ritter (2022) finds an average initial return of 17,7% in a U.S. market sample spanning from 1960 to 2022. Other authors find supporting evidence highlighted in section 2.5.4. Hypothesis 1 below is motivated by the conventional notion in the literature that IPOs are generally underpriced, which we expect to hold in the European market as well, regardless of which periods the IPO went public. Our first hypothesis is therefore:

Hypothesis 1*: European IPOs between 2006-2021 had statistically significant positive initial returns.*

The COVID-19 pandemic has had a profound impact on global financial markets, raising intriguing questions about the performance of IPOs during this extraordinary period. Evidence has suggested that the pandemic had an adverse impact on the IPO market (Baig & Chen, 2022). Baig & Chen (2022) found a positive relationship between governmental response intensity and IPO underpricing, indicating that pandemic IPOs were prone to higher levels of information uncertainty. We therefore aim to investigate this in the broader European sense, and to distinguish the causes and effects in the different periods through hypothesis 2:

Hypothesis 2*: European IPOs during the pandemic had higher levels of underpricing than those during "normal times" and the financial crisis in 2008.*

Ritter (1984) and Beatty & Ritter (1986) proposed that underpricing tends to be higher in IPOs characterized by greater pre-IPO uncertainty. According to their perspective of pre-IPO uncertainty, the winner's curse becomes more pronounced, and uninformed investors demand greater initial return/underpricing to participate in the offering.

Supporting the theories of Beatty and Ritter, Derrien and Womack (2003) found very large positive coefficients for market volatility’s effect on the mean and variance of underpricing when analyzing French IPOs. Lowry, Officer and Schwert (2010) find a positive link between market volatility and IPO underpricing in the U.S. market, but only a weak one. Drawing upon these findings, we posit that there might exist similar relationships in the broader European market. This theoretical basis forms the foundation and motivation for our third hypothesis:

Hypothesis 3*: European IPOs following periods of higher market volatility are more underpriced.*

To gain deeper insights into the drivers of underpricing in the European IPO market, we explore the industry-specific effects. Loughran and Ritter (2004) suggest that riskier IPOs are likely to exhibit higher levels of underpricing to compensate investors for the associated risk. Furthermore, previous research such as Ljunqvist & Wilhelm (2003) and Loughran & Ritter (2004) find that the technology industry is riskier than the others, indicating that the secondary market investor demands a higher level of underpricing for these IPOs specifically.

In relation to hypothesis 2, Baig & Chen (2022) also find that the higher level of underpricing in the pandemic is driven by the technology and healthcare sector, by drawing data on IPOs from NYSE and NASDAQ. Considering earlier studies find such a relationship, we expect this relationship to hold for at least the technology sector, and possibly for the healthcare sector in the European market. This in turn gives foundation for our fourth hypothesis:

Hypothesis 4*: European IPOs in the technology sector and the healthcare sector performed better than other sectors during the pandemic*.

The phenomenon of underpricing in "hot issue" markets, characterized by periods with a high number of IPOs, substantial issue volumes, high volumes of equity issue, and significant initial returns, has been extensively documented in the literature. This concept was initially introduced by Ibbotson and Jaffe (1975) and later further documented by Ritter (1984) and Ibbotson, Sindelar and Ritter (1988). The literature has consistently identified a higher prevalence of underpricing during periods of elevated equity issue volumes in larger economies, such as the U.S. markets, China and Germany (Günther & Rummer, 2006).

Considering the broader European IPO market, we explore whether the characteristics of "hot issue" markets persist across different regions. This becomes even more interesting in the context of the COVID-19 pandemic, as it allows us to explore the impact of both dynamics. By investigating the interplay between these factors, we can gain a deeper understanding of the drivers of underpricing and explore the dynamics that emerge in the European IPO market through hypothesis 5:

Hypothesis 5*: "Hot issue" market IPOs are susceptible to higher underpricing than "cold issue" and "normal" market IPOs in Europe.*

Related to hypothesis 3, we explore the impact of market movements prior to the listing of the company. In addition to market volatility, we want to also examine the impact of recent market returns on the level of underpricing, investigating different time periods leading up until the IPO. Similarly, to hypothesis 3, Derrien and Womack (2003) found also that recent market return have a positive impact on underpricing. We expect to find similar results for the European IPO market, and that the most recent market movements to have the greatest impact when testing hypothesis 6:

Hypothesis 6: *IPOs that are listed following an up-movement in the general stock market are associated with a higher level of underpricing.*

PART IV. DATA

In this section, we will provide an overview of the process of collecting data, preliminary data analysis of the different subsamples, as well as the methodology and motivation for developing testable models and regression variables.

4.1 The process of sorting data

The final sample for this thesis comprises 1215 IPOs from various exchanges across Europe in the time period from 01.01.2006 to 31.12.2021. The initial dataset was obtained from the equity data available on the Refinitiv Workspace, the Refinitiv Excel Add-in and SDC Platinum, all of which draws from the reputable Thomson Reuters database. To cross-check, we draw the data from both SDC Platinum and Refinitiv Workspace, to assure as little missing data entries as possible.

The initial screening consisted of IPOs that went live during the period, also filtered by the European region. This list included the founding date of the company, issue date of the IPO, proceeds amount, offer prices, total assets pre-IPO, flags to distinguish their sponsorship (PE/VC/NS), number of book-runners (by unique parents), company sector and closing price on the first trading day for all included IPOs. To test our hypotheses, we include also the time leading up until the financial crisis to further distinguish the effects of different crises in our dataset. Through this initial sciential we end up with a list of over 3000+ IPOs.

Although we had a substantial number of IPOs in our initial dataset, we concluded that a lot of IPOs had insufficient data after cross-checking. Furthermore, we had many duplicates, including both data entry errors and secondary listings. We removed these to reduce bias related to IPOs being priced in the market from before.

4.2 Preliminary Data Analysis

The following section shows presents the overview of the collected sample, as well as descriptive statistics for the different subsamples. We discuss patterns and possible explanations for each subsample.

4.2.1 *Sample Overview*

Table 4.1.1 below provides data on IPO activity in Europe from 2006 to 2021, including the number of IPOs, the amount of proceeds in millions of euros, and the level of underpricing for each year. The data is also broken down by the type of IPO, including PE-Backed, VC-Backed, and No Specification and their respective occurrences.

Table 4.2.1 Yearly Sample Overview

Table 4.1.1 presents a broad sample overview categorizing by the number of IPOs each year, further also divided by their respective sponsorship. For each year, we also present the amount of equity issued. The total sample consists of 1207 IPOs listed on various exchanges across Europe from the period 2006-2021. These are further distributed through 142 PE-backed, 151 VC-backed and 914 NS IPOs.

Year	*No. Of IPOs*	*PE-Backed*	*VC-Backed*	*No Specification*	*Proceeds (EUR, Millions)*	*Underpricing*
2006	114	16	25	73	19 664	8,3%
2007	123	15	13	95	22 457	11,1%
2008	25	2	0	23	1 395	-0,8%
2009	10	0	2	8	373	26,7%
2010	48	3	6	39	7 119	21,1%
2011	37	4	5	28	11 260	8,6%
2012	24	3	5	16	2 237	5,4%
2013	44	14	8	22	12 653	9,0%
2014	87	22	14	51	16 740	4,0%
2015	93	15	18	60	26 873	7,7%
2016	58	4	10	44	14 581	7,1%
2017	81	5	7	69	16 762	12,1%
2018	84	4	9	71	15 034	18,9%
2019	63	3	2	58	7 695	19,6%
2020	86	5	1	80	9 348	20,6%
2021	230	27	26	177	46 764	17,1%
Total	1207	142	151	914	230 955	12,8%
Yearly Average	75	9	9	57	14 435	12,3%
Yearly Median	72	5	8	55	13 617	10,1%

Over the period covered in the table, we have had 1,207 IPOs in Europe, with total proceeds of 230,955 million euros. The average number of IPOs per year is 75 in our sample, with average proceeds of 14,435 million euros per year. The unweighted average yearly initial return was 12,3%, while the sample average was 12,8%. The yearly median initial return was 10,1%, indicating some skewness.

There is significant variation in the level of underpricing across the years. The highest level of underpricing was in 2009 at 26,7%, followed closely by 2010 and 2020 at 21,1% and 20,6%, respectively. The lowest level of underpricing was in 2008 at -0.8%, which is highly likely due to the abnormal behaviors of the global financial crisis. Overall, the average level of underpricing at 12.8% indicates that there is underpricing in our sample period.

There are several potential explanations for the variation in initial returns between the years. One possibility is the state of the economy and the financial markets during each year. For example, years with high levels of underpricing may be associated with periods of economic growth, optimism and high subscription rates to IPOS, while years with low levels of underpricing may be associated with economic uncertainty and pessimism.

Another possible explanation is the type of IPOs that were prevalent in each year. We divide the IPOs into subgroups of PE-Backed, VC-Backed, and No Specification IPOs for each year. For example, in 2011, there were only 4 PE-Backed IPOs and 5 VC-Backed IPOs, while in 2014, there were 22 PE-Backed IPOs and 14 VC-Backed IPOs. These variations may have contributed to the differences in initial returns between the years.

Overall, the data suggests that IPOs in Europe were typically underpriced during the period covered in the table, and there were variations in the level of underpricing between the years, which may be explained by economic and market conditions as well as the types of IPOs being offered.

4.2.2 Crisis Times

Table 2 shows the number of IPOs, the proportion of PE-backed, VC-backed, and unspecified IPOs, and the underpricing levels for four different periods: Pre-

Financial Crisis (January 2006 - November 2007), Financial Crisis (December 2007 - June 2009), Normal Times (July 2009 – December 2021), and The Pandemic (January 2020- December 2021). The periods are divided with the purpose of clarifying differences between crisis and non-crisis times.

Table 4.2.2 Overview of Crisis Periods vs. Normal Times

Table 4.1.2 presents the sample overview distributed by our categorizing of crisis periods and normal periods. The pre-financial crisis period consists of 227 IPOs, the Financial Crisis consists of 38 IPOs, the period in between of the financial crisis and the pandemic entailed 626 IPOs, while the pandemic has 316 IPOs.

Sample Type	*Period*	*No. Of IPOs*	*PE-Backed*	*VC-Backed*	*No Specification*	*Underpricin*
Pre-Financial Crisis	Jan 2006 - Nov 2007	227	29	37	161	10,1%
Financial Crisis	Dec 2007 - June 2009	38	4	1	33	1,1%
Normal Times	July 2009 - Dec 2021	626	77	86	463	11,8%
The Pandemic	Jan 2020 - Dec 2021	316	32	27	257	18,0%

During the Pre-Financial Crisis period, there were 227 IPOs, with 29 of them being PE-backed, 37 being VC-backed, and 161 being unspecified. The underpricing level was relatively high at 10.1%. During the Financial Crisis period there is a significant drop in the number of IPOs, with only 38 taking place. Of these, only 4 were PE-backed, 1 was VC-backed, and 33 were unspecified. The underpricing level was extremely low at only 1.1%.

During the Normal Times period, there were 626 IPOs, with 77 of them being PE-backed, 86 being VC-backed, and 463 being unspecified. The underpricing level was 11.8%, which is higher than during the Financial Crisis but somewhat lower than during the Pre-Financial Crisis period. The Pandemic period has 316 IPOs, with 32 being PE-backed, 27 being VC-backed, and 257 being unspecified. The underpricing level was 18,0%, which is higher than all the other periods defined.

Overall, the table shows that the number of IPOs fluctuated over time and with the economic status, with a significant drop during the Financial Crisis period. The proportion of PE-backed and VC-backed IPOs also varied, with the highest proportion of PE-backed IPOs occurring during the Normal Times period and the highest proportion of VC-backed IPOs occurring during the Pre-Financial Crisis period. The underpricing levels also varied, with the highest levels occurring during the Pre-Financial Crisis and Pandemic periods.

Potential explanations for the variation in initial returns between the different periods could be differences in market conditions, investor sentiment, and economic stability/instability. For example, during times of economic uncertainty, such as the Financial Crisis and the Pandemic, investors may demand higher returns to compensate for the increased risk, causing lower offer prices and higher initial returns. On the other hand, during times of economic growth, such as the Normal Times period, investors may be more willing to accept lower returns, which could result in lower levels of underpricing. The variation in the proportion of PE-backed and VC-backed IPOs could also reflect differences in investor preferences and market conditions.

From an investment perspective, higher levels of underpricing can indicate potential opportunities for investors to benefit from initial price increases shortly after the IPO. However, it's important to note that high underpricing levels could also reflect market inefficiencies or over-optimistic pricing by subcribers, which may pose risks to investors in the long run instead.

4.2.3 Market Cycles

Table 3 concerns market cyclicality as explained in chapter 2.5.2. High market activity, such as the dot com bubble and its high degree of underpricing, has been found to create overvaluations (Ljungqvist & Wilhelm, 2003). To analyze this effect further we divide the IPOs into two groups: high market activity (HMA) and low market activity (LMA). The table below provides data on a selection of months for illustration, where a certain amount of equity was issued, representing both abnormally high and low amounts issued. Consequently, we also present the classification of the period, in addition to the average level of underpricing and gross proceeds during the respective month. The table includes the 5 lowest and 5 highest levels of underpricing in each subgroup.

Table 4.2.3 Highlights of Market Cyclicality

Table 4.1.3 presents the highlights of the classification of market cyclicality. IPOs listed during High Market Activity (HMA) and Low Market Activity (LMA) months are presented with their respective average level of underpricing for the month, in addition to the number of IPOs and the amount of equity issued (gross proceeds) in millions of EUR

	Month	No. Of IPOs	Underpricing	Classification	Gross Proceeds (EUR, millions)
Top 5 in each sub-group	Jan - 21	8	60,8%	HMA	5018,1
	Apr - 21	15	32,5%	HMA	4194,4
	May - 07	17	28,1%	HMA	3479,8
	Feb - 21	26	27,4%	HMA	5522,7
	Oct - 13	7	26,8%	HMA	3951,2
	Oct - 10	6	118,4%	LMA	2532,5
	Jan - 19	4	85,6%	LMA	42,4
	Aug - 20	5	66,4%	LMA	219,4
	May - 20	4	64,7%	LMA	474,1
	Jun - 18	19	59,1%	LMA	3272,9
Bottom 5 in each sub-group	Oct - 17	12	3,6%	HMA	3542,8
	Mar - 18	9	3,1%	HMA	5539,9
	Dec - 07	10	2,8%	HMA	7314,1
	Oct - 16	7	2,2%	HMA	4821,8
	Jul - 14	13	-1,6%	HMA	2380,2
	Jun - 06	10	-7,0%	LMA	853,7
	Dec - 11	2	-9,4%	LMA	28,3
	Aug - 18	1	-21,6%	LMA	2,7
	Aug - 08	2	-30,7%	LMA	3,3
	Nov - 08	2	-45,4%	LMA	359,5

The number of IPOs, as mentioned before, varies greatly between each year and month. Generally, there is an increasing trend in the number of IPOs over the years as seen in table 1, with occasional fluctuations. HMA months is shown above to generally have high levels of underpricing, varying from -1,6% on average in July 2014 to 60,8% in January 2021. LMA years on the other hand shows greater variance in monthly average underpricing, ranging from -45,4% in November 2008 to 118,4% in October 2010.

Table 4.2.4 Summary of Market Cyclicality

Table 4.1.4 presents the summary statistics of our sample distributed by market cyclicality. High Market Activity (HMA) and Low Market Activity (LMA) IPOs are presented with their number of occurences, average rate of underpricing, skewness and kurtosis.

Market Cycle	*No. Of IPOs*	*Underpricing*	*Skewness*	*Kurtosis*
HMA	415	13,2%	5,25	38,9
LMA	792	12,5%	9,70	134,4

Table 4 summarizes the two distinct groups and their respective levels of underpricing, skewness, and kurtosis. This shows some interesting suggestions for our two sub-groups. On average, we observe an underpricing of 12,5% for LMA IPOs and 13,2% for HMA IPOs. Although this supports previous literature, we observe that both sub-groups have a positive skewness, with a higher skewness for LMA IPOs. More interestingly, there seems to be a higher kurtosis for LMA IPOs, indicating a higher occurrence of positive outliers. This could potentially be a driver for the high average underpricing, in which we will examine this pattern in detail in our hypotheses testing.

4.2.4 Sector-Specific Underpricing

Table 5 presents our sample categorized by the number of IPOs in each economic sector. The categorization is done through SDC Platinum and their function “TRBC Economic Sector”. It is worth mentioning that the function was not able to retrieve the information for all our IPOs, leaving 103 IPOs with unknown sectors.

Table 4.2.5 Industry Overview

Table 4.1.5 presents the summary statistics of IPOs categorized by industry. Fo reach industry, the respective number of occurences and average level of underpricings is presented.

Industry	*No. Of IPOs*	*Underpricing*
Industrials	183	10,1%
Technology	224	18,3%
Basic Materials	75	19,3%
Consumer Cyclicals	149	9,4%
Real Estate	55	7,6%
Energy	55	2,4%
Financials	94	10,2%
Healthcare	166	16,3%
Consumer Non-Cyclicals	63	15,0%
Utilities	39	5,4%
Academic & Educational Services	4	22,0%

The technology sector had the highest number of IPOs with 224 followed by Industrials with 183 IPOs. In terms of underpricing, Basic Materials had the highest level at 19,3%, closely followed by Technology at 18,3% and healthcare at 16,3%. The energy sector had the lowest level of underpricing at 2,4%.

One possible explanation for the variations in underpricing across different industries could be related to investor perceptions and market dynamics within each sector. Industries that are perceived as high-growth and innovative, such as Technology and Healthcare, may attract more investor interest, leading to higher demand for IPO shares and potentially driving up the level of underpricing. We know from the last years and the pandemic that the two sectors have been highly active in later time. On the other hand, industries that are traditionally more stable or less attractive to investors, such as Energy and Utilities, may experience lower demand and, consequently, lower underpricing levels.

In summary, we are presented with variations in IPO underpricing across different industries. These variations could be attributed to industry-specific factors, market dynamics, and investor sentiment.

4.2.5 Underpricing by Sponsorship

As previous literature suggests, the sponsorship of IPOs could affect the level of underpricing on the first trading day. More specifically, PE-backed IPOs are often more transparent and offer less adverse selection, resulting in less information asymmetry (Bergström et al., 2006). Table 7 presents our sample categorized by sponsorship, and shows the respective underpricing, skewness and kurtosis.

Table 4.2.5 Summary of Sponsorship Categorization

Table 4.1.5 presents the summary statistics of our sample distributed by their sponsorship. PE-backed, VC-backed and non-specified IPOs are presented with their number of occurences, average rate of underpricing, skewness and kurtosis.

Sponsorship	*No. Of IPOs*	*Underpricing*	*Skewness*	*Kurtosis*
PE	142	8,7%	2,0	23,2
VC	151	7,6%	5,5	43,3
No Specification	914	14,2%	8,7	111,0

When divided by sponsorship, the sample supports the previous literature. PE-backed IPOs show less underpricing than non-sponsored IPOs. Furthermore, they present a lot less skewness and kurtosis, indicating a higher concentration around the mean. However, VC-backed IPOs also indicate the same behavior as PE-backed firms, with less underpricing, skewness and kurtosis than that of non-sponsored IPOs.

4.3 Developing Models

In this section we present our econometric models and statistical methods for testing our hypotheses. We must establish whether the data is normally distributed or not. We perform a Jarque-Bera test to examine this in section 5. We intend to utilize both multivariate regressions and one- and two-sample t-tests to perform hypotheses testing, all of which require that the assumption of normality hold. If this does not hold, we will instead have to use other procedures that do not assume normality in the sample. However, due to the large sample size, we expect normality.

4.3.1 Statistical Tests

We intend to test hypothesis 1, 2 and 5 using one-sample and two-sample t-tests. We use a one-sample t-test to test hypothesis 1; whether the European IPO market experience underpricing across the whole sample and subgroups. We proceed by using two-sample t-tests to test whether there is a difference in the average level of underpricing between crisis and non-crisis times, and whether IPOs issued during periods of higher market activity experience higher levels of underpricing. Furthermore, we also test whether there are differences in average levels of underpricing across the different subgroups that concern sponsorship, to see whether there is a significant difference across time periods and sponsorship, as to further investigate distinct features regarding our research variables.

4.3.2 Multivariate Regressions Models

To test hypotheses 3, 4 and 6 we perform multivariate ordinary least squares (OLS) linear regression analysis. We created 3 separate models that differ in whether they include research variables, research and control variables, and research, control and dummy variables, respectively. The control variables and dummy variables mentioned in chapter 4.2 are only in the two last models, while the research variables are tested separately in model 1. We include control variables in model 2, and control and dummies in model 3 as they have shown significance in previous studies, with the intention of capturing as much explanatory power as possible, in addition to reducing the risk of suffering from omitted variable bias. Moreover, this will help us better isolate the potential effects of our research variables. Consequently, we have the following models where independent variables are categorized by β_n and dummies by γ_n:

(1) *Research variables:*

$$MAR_i = \beta_0 + \beta_1 21VOL_i + \beta_2 MRET21d + \beta_3 MRET3m + \beta_4 MRET100d + \gamma_0 HMA + \gamma_1 Pandemic + \gamma_2 FinancialCrisis + \varepsilon_i$$

(2) *Research and control variables:*

$$MAR_i = \beta_0 + \beta_1 21VOL_i + \beta_2 MRET21d + \beta_3 MRET3m + \beta_4 MRET100d + \gamma_0 HMA + \gamma_1 Pandemic + \gamma_2 FinancialCrisis + \beta_5 Ln(Size)_i + \beta_6 Ln(Age)_i + \beta_7 Ln(Proceeds)_i + \varepsilon_i$$

(3) *Research, control and other dummy variables:*

$$MAR_i = \beta_0 + \beta_1 21VOL_i + \beta_2 MRET21d + \beta_3 MRET3m + \beta_4 MRET100d + \gamma_0 HMA + \gamma_1 Pandemic + \gamma_2 FinancialCrisis + \gamma_3 Tech - \gamma_{12} Utilities + \beta_5 Ln(Size) + \beta_6 Ln(Age) + \beta_7 Ln(Proceeds) + \gamma_{13} 2006 - \gamma_{28} 2021 + \gamma_{29} PEdummy + \gamma_{30} VCdummy + \varepsilon_i$$

4.4 Construction of Regression Variables

In this chapter, we will outline the methodology employed to classify the regression variables, considering the relevant literature on IPO determinants, and chosen underpricing factors for further study. We draw upon established theories and empirical evidence to construct a framework that captures distinct features of the European IPO market. Moreover, we will discuss the rationale behind the selection of specific classification criteria.

4.4.1 Dependent variable

The primary focus of our thesis is to explore various underpricing theories and their applicability specifically in the context of the European IPO market and the recent COVID-19 pandemic. Underpricing, a crucial aspect of our analysis, is measured by calculating the disparity between the offer price and the first day's closing price. To ensure comparability across different IPOs, we construct the initial return as a standardized measure.

By dividing the closing price of the first trading day by the offer price and subtracting 1, we obtain a percentage change that represents the magnitude of the price deviation from the offer price to the closing price in the secondary market. This formula enables us to estimate the simple initial return of the IPOs included in our sample:

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

IR_i: The initial return of IPO “i”

$P_{i,t}$: Closing price on the first trading day of IPO “i”

$OP_{i,t-1}$: Offer price of IPO “i”

However, the formula for the initial return assumes that the first trading day occurs on the same day as issuance, which is not always the case. This gap allows for the possibility of other new market movements affecting the level of underpricing in between the offer price being announced on the first trading day. To analyze the effects on the most accurate estimate of the initial return we therefore choose to adopt the common literature approach of making a market-adjusted initial return. This method is support by researchers such as Ritter (1991), Logue (1973) and Bansal & Khanna (2012):

$$MAR_i = IR_i - MR_i = \frac{P_{i,t} - OP_{i,t-1}}{OP_{i,t-1}} - \frac{Ind_{i,t} - Ind_{i,t-1}}{Ind_{i,t-1}}$$

MAR_i: The market-adjusted initial return of IPO "i"
MR_i: Market return on the first trading day of IPO "i"
$Ind_{i,t}$: Index closing price on the first trading day of IPO "i"
$Ind_{i,t-1}$: Index closing price on the issue day of IPO "i"

The formula presented above illustrates the computation of the market-adjusted initial return, which is a crucial measure in analyzing IPO performance. Selecting an appropriate market index is important as it should accurately represent the alternative investment options available to investors who subscribe to an IPO (Hunger, N/A). We choose to adjust the initial return using a market index instead of a true comparable risky investment, in favor of reflecting the market-wide influence on IPO underpricing instead of creating a pure risk adjustment. Implementing an inappropriate market index can introduce bias in the calculation of the market-adjusted initial return. For this analysis, we have gone forward with the MSCI Europe Stock Index, which includes both large and mid-cap stocks across 15 developed markets across Europe (MSCI, 2023). We consider this to be a stable benchmark index that represents the alternative European investment.

To calculate the market-adjusted initial return, we calculate the index return for each IPO by comparing the index closing price on the first trading day with the index closing price on the day the offer price was determined, relative to the index closing price on the day the offer price was set. By subtracting the market return from the simple initial return of each IPO, we derive the market-adjusted initial return, which serves as our measure of underpricing for the purpose of testing our hypotheses and enables us to analyze the isolated effect on IPO underpricing. As a means of treating outliers without excluding data, we choose to use a continual price adjustment, following the methodology of Ljungqvist (1997):

$$logMAR_i = IR_i - MR_i = ln\left(\frac{P_{i,t}}{OP_{i,t-1}}\right) - ln\left(\frac{Ind_{i,t}}{Ind_{i,t-1}}\right)$$

$logMAR_i$: The logarithmic market-adjusted initial return of IPO “i”

4.4.2 Explanatory Variables

The regression analysis in our study incorporates three types of variables: research variables, control variables, and year- and industry-specific dummies. Research variables are important in examining our hypotheses and form the primary focus of our regression analysis. On the other hand, the control variables, while not directly aligned with our hypotheses, are included in the analysis to account for their potential influence on underpricing, as have been shown significant in previous studies.

To enhance the goodness of fit of our regression model, we have implemented logarithmic transformations on the explanatory variables that exhibit significant skewness in their original form. This approach, utilizing the natural logarithm, offers several advantages. Firstly, it helps mitigate the impact of extreme observations, which is particularly beneficial given our limited sample size (Wooldridge, 2019). Additionally, logarithmic transformation aids in achieving a more symmetrical distribution of the variables, thereby bolstering the reliability of the regression results. A detailed explanation of the variable construction process is provided below.

4.4.3 Research Variables

To test our hypotheses, we construct five research variables. These are directly linked to our hypotheses and form the main subjects of study for this thesis.

Market volatility (21VOL): To examine the potential relationship between market volatility ex-ante an IPO and its impact on initial returns, we use the standard deviation of MSCI Europe Stock Index daily returns as a proxy. We employ the same methodology as Derrien and Womack (2003) and proceed with the most recent 21-day standard deviation of daily index returns preceding the IPO. This serves as a proxy for the market uncertainty leading up until the IPO. In this thesis we use only the standard deviation of daily index returns for the 21 preceding trading days, as it has shown the highest significance in previous studies (Derroem & Womack, 2003).

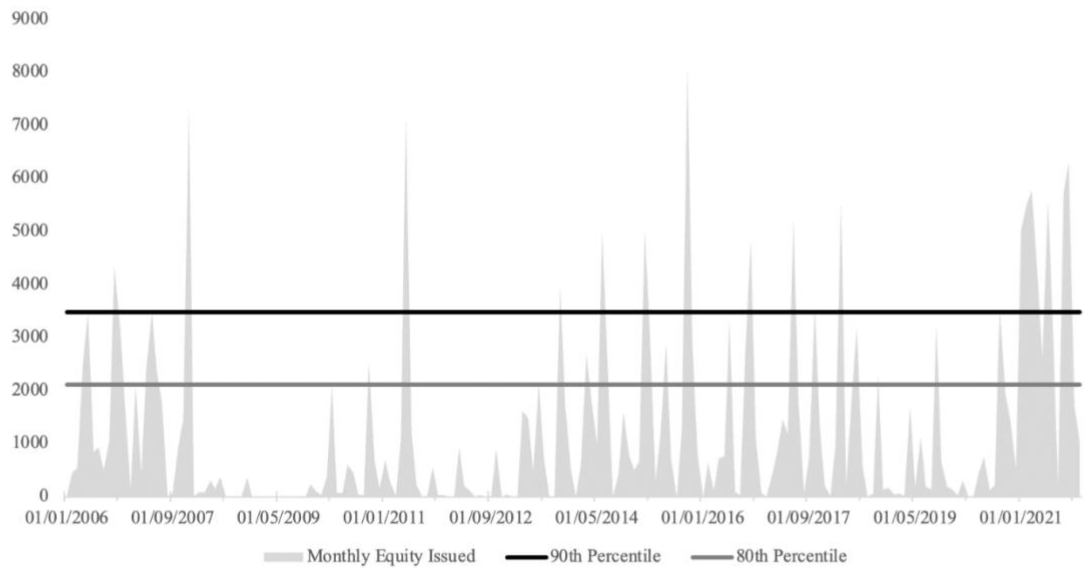
High Market Activity (HMAdummy): To further capture distinctive effects of timing in relation to IPO underpricing we adopt the methodology of earlier studies that find significance for market cycles. Our aim in this instance is to further granulize the severity of the effects each of the individual variables has on the level of underpricing, testing them in several different time periods as to deepen our knowledge in how timing of an IPO can influence the level of return an investor can expect from subscribing to an IPO.

We therefore introduce a dummy variable that categorizes the IPOs into two sub-groups, which depends on whether the IPO occurred during times where the amount of equity issued was high or not. This dummy takes the value 1 if it was issued during “high market activity” and 0 otherwise for “Low market activity” and “neutral markets”.

To identify these IPOs, we would be inclined to assess the volume of IPOs that occur each year, month, and successive period. However, due to uncertainty in the sample regarding missing variables that exclude some IPOs during some years, we opt instead in the amount of equity issued during a month as an estimate of the IPO activity. We consider this to be a better reflection of the true IPO activity in our specific sample, rather than IPO volume. We therefore calculate the total equity issued during each month from January 2006 to December 2021, followed by categorizing “hot months” as months where the equity issue volume falls within the 90th percentile, or if two successive months fell within the 80^{th} percentile. This methodology leaves us with 415 HMA IPOs and 800 LMA IPOs. The monthly equity issue volume and percentile indicators are shown below.

Figure 4.4.3 Monthly Equity Issued

Figure 4.2.3 presents the distribution of issued equity for each month during 2006-2021. The levels of issued equity is presented in grey, while the black line represents the 90th percentile and dark grey represents the 80th percentile



Crisis dummies: To differentiate between the levels of underpricing that occur during times of crises and normal times, we use dummy variables for each specific categorized period. Here, we define the pandemic start as the beginning of 2020, in line with the first known cases of COVID-19 in Europe, which lasts until the end of our sample (December 2021). The financial crisis is defined as the period between the end of 2007 and June 2009. Our total sample length is the period from January 2006 and December 2021, where the periods excluding the pandemic and the financial crisis of 2008 are defined as "normal" periods. We create one dummy each for the pandemic and the financial crisis.

Market return (MRET): To test hypothesis 6, we construct three variables that all represents the buy-and-hold return (BAHR) for their respective time periods, using the same benchmark index as for the *21VOL* variable. The variables are created using the index prices 21 days, 3 months and 100 days prior to the first trading day, calculating the BAHR for each IPOs respective time periods.

4.4.4 Control Variables

To better capture the isolated effects of our research variables, we include control variables (Woolridge, 2019). In our thesis we include a total of three control variables. The distributions of the chosen control variables are all positively skewed, in which we take the natural logarithm for the same reasons as for market-adjusted initial returns.

Ln (Size): The first control variable concerns the firm size before the offering. We use the company's total assets prior to going public as a proxy for the company size.

Ln (Age): The second control variable is the natural logarithm of the age of the company prior to the offering, which represents the years the company has been in operation before going public. This variable helps account for the maturity and experience of the firm. According to Ritter (1984), more experienced firms will have a lower level of underpricing because of a higher information availability, which reduces asymmetric information.

Ln (Proceeds): Lastly, we incorporate the natural logarithm of the gross proceeds from the offering as a control variable. This variable reflects the amount of capital raised through the IPO and serves as a proxy for the company's growth opportunity and issuers perception of market value. We interpret this as the conveying of the perceived growth opportunities from the issuer.

4.4.5 Year, Sponsorship, and Industry Dummies

Year dummies: Additionally, we make dummies that categorize the IPO by the year they were issued. These are included to control for the well-known, but largely unexplained, time variation in underpricing (Ljungqvist, Jenkinson & Wilhelm, 2003).

Industry: In relation to hypothesis 4 we construct industry dummies based on Thomson Reuters economic sector classification. As discussed earlier, some industries have been shown in earlier studies to have a statistically significantly higher level of underpricing than others, where one study by Baig & Chen (2022) found that the Technology and Healthcare sector had a higher level of underpricing during the COVID-19 pandemic. We chose to exclude the sector of Academic & Educational Services due to only having 4 IPOs.

Sponsorship dummies: Lastly, we create dummies based on the backing of the IPO. More specifically, whether they are backed by private equity (PE), venture capital (VC) or no specification (NS). This flagging is based on the Thomson Reuters categorization of pre-IPO sponsorship. As discussed earlier in the construction of variables and the theory part, the sponsorship has the potential to influence the degree of underpricing.

4.5 Data Criticism

It is important also to acknowledge potential sources of error that may introduce bias into our empirical study. These errors primarily relate to the data collection process and data selection. Ensuring the validity and reliability of the data sources is of utmost importance. Therefore, a thorough assessment of the reliability of our data sources is conducted to validate the empirical findings.

The secondary data utilized in our study has been gathered from reputable sources such as Refinitiv, SDC Platinum, Yahoo Finance and individual financial statements and annual reports. The former is recognized for their credibility and lack of incentive to manipulate information, thereby ensuring the reliability of the data. The latter is always exposed to the possibility of “creative accounting” and manipulation. However, in the data sample we have mainly extracted data from Refinitiv and SDC Platinum, using financial statements as means of cross-checking. We therefore consider the data to be as robust as Refinitiv and SDC Platinum allow, and the effects of the errors to be minimal due to the number of IPOs in our sample. Through our cross-checking procedure however, some observations have been impossible to replicate through other sources than Refinitiv and SDC Platinum. We therefore exclude said observations from the sample.

Furthermore, it is important to note that certain firms have been excluded from the sample due to lack of available information. This has the potential to introduce some bias to the data. More specifically, the number of IPOs and the analysis that relates to either yearly or monthly IPO activity is considered more prone to some bias. This concerns especially the older data entries, which we consider contain the most potential errors/bias. Moreover, the data underwent some manual processing throughout its journey to our data sample, which will always be exposed to the risk of human error. Nonetheless, the authors of this thesis conducted a rigorous double-checking process to minimize such errors, making the risk of suffering from them as small as possible.

Moreover, there is also some uncertainty regarding the classifications and definitions of variables extracted from both Refinitiv and SDC Platinum. Firstly, there is some unclarity in how the platforms define the ownership-structure of a company pre-IPO. In our classification of the sample, we define three sub-groups: PE-backed, VC-backed and NS (not specified) based on the pre-defined filtering options in the Refinitiv Workspace and SDC Platinum. Some companies in the sample could potentially have been classified as either PE-backed or VC-backed, even though they only have a minority shareholding and are not involved in the day-to-day operations. This can potentially result in an unclear reflection of the effect of ownership. Secondly, there seems to be some inconsistency in how prices and numerical values are converted across currencies. When double-checked, we find that offer prices and first day closing prices show some deviation when calculating initial return. However, we choose to be consistent with EUR values.

Part V. ANALYSIS AND RESULTS

In the upcoming section, we will present the empirical results and findings of how the volatility induced by various events between 2006-2021 has influenced the short-term performance of European IPOs and the degree of underpricing. Building upon the variables and models introduced in earlier sections, we will examine the regression outputs, provide explanations, and evaluate their alignment with previous studies.

5.1 Descriptive Statistics

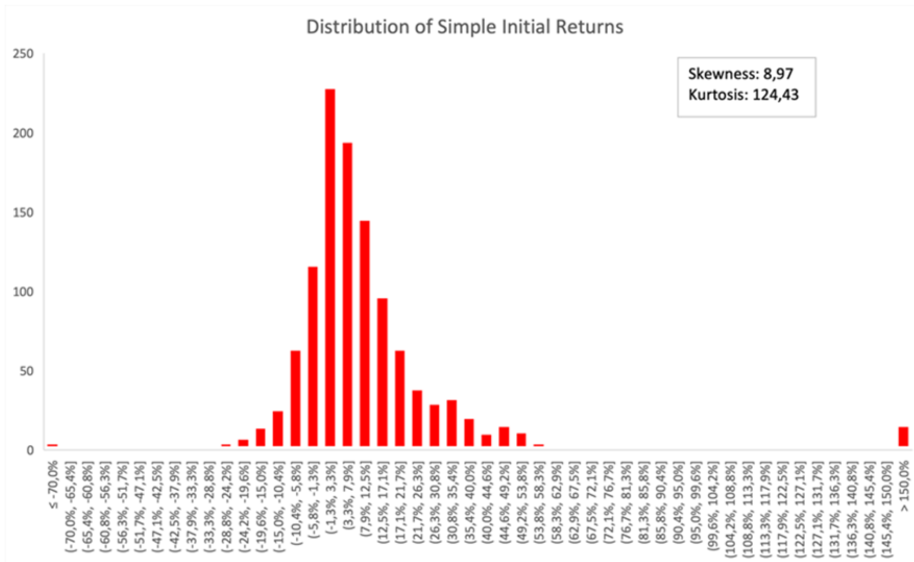
In this section we present the analysis and results of our univariate analysis and t-tests for significances. We thoroughly test our different subsamples, testing both their individual significance and the significance of their differences when put up against each other.

5.1.1 Distribution of first-day return

Table 5.1.1 presents the distribution of our first-day returns. As mentioned before, the sample shows an average rate of initial return that is greater than the median, indicating skewness. The distribution supports this with a skewness of 8,97. This also explains the asymmetry of our initial returns, as a skewness of 0 would be centered around an initial return of 0%. This means that there are signs of positive levels of underpricing in our sample. Moreover, the there is also some degree of outliers, especially positive outliers. This is explained by our kurtosis, which is 124,43, where we have a noticeable number of positive outliers that have over 150% initial return.

Table 5.1.1 Distrubution of first-day return

Table 5.1.1 displays the distribution of first-day returns. It reports a skewness of 8.97 and kurtosis of 124.43. The distribution is positively skewed, which can be explained by large first-day returns.



5.1.2 Statistical test of first day returns

One-sample t-tests across sample

In the examination of various subgroups, it was discovered that European IPOs from January 2006 to December 2021 consistently yielded positive average initial returns, indicating the presence of underpricing. While the average market-adjusted initial return was statistically significant at the 1% level in all subgroups, it suggests that the degree of underpricing varied among different IPOs. The analysis of marked-adjusted first-day returns strongly supports our first hypothesis of underpricing throughout the study period. In other words, the average marked-adjusted returns provide evidence for the existence of underpricing in European IPOs. The results of a one-sample t-test, as presented in Table 5.1.2, demonstrate that the average marked-adjusted return for all firms significantly differs from zero at the 1% significance level. This statistical finding reinforces the claim of underpricing in European IPOs and enhances its robustness. Moreover, in line with the findings of previous studies, including Ibbotson (1994) mentioned in the second chapter, our research also confirms the presence of underpricing and short-run underpricing in all segments of the stock market. Additionally, as reported by Ritter (2022), he found an average initial return of 17,7% in a U.S. market sample spanning from 1960 to 2022. Our sample indicates an average underpricing rate of 12.8%, which aligns with the observations reported in the literature. Finally, we conducted tests on subsamples to determine whether the average underpricing is statistically significant compared to zero. The results indicate that PE-backed, VC-backed, and NS-backed IPOs exhibit underpricing rates of 8.65%, 7.36%, and 14.21% respectively. All subgroups support the first hypothesis at 1% significance, implying that there are statistically significantly positive levels of underpricing in the European IPO market from 2006-2021.

Table 5.1.2 Descriptive Statistics

*Table 5.1.2 Using one-sample two-sided t-tests to test if the mean is statistically significantly different from zero. * Represents significance at 10%, ** represents significance at 5%, and *** represents significance at 1%. Descriptive coefficients are presented to summarize the data collected. The sample size comprises a total of 1207 Initial Public Offerings (IPOs), with 142, 151, and 914 IPOs backed by Private Equity (PE), Venture Capital (VC), and Not Specified (NS), respectively.*

	PE	*VC*	*NS*	*All Firms*
Observations	142	151	914	1207
Average Initial Return	8,7%	7,6%	14,2%	12,8%
Average Market-Adjusted Return	8,65%***	7,36%***	14,21%***	12,7%***
Median	6,0%	1,7%	6,6%	6,0%
Standard Deviation	20,0%	27,3%	44,7%	40,7%
Maximum	149,2%	250,6%	728,4%	728,4%
Minimum	-99,6%	-27,8%	-98,2%	-99,6%
Kurtosis	22,806	43,5	112,795	126,364
Skewness	1,858	5,475	8,766	9,061
Degrees of Freedom	141	150	913	1206
T-Statistic	5,15	3,31	9,61	10,83
P-Value	0,000	0,001	0,000	0,000

T-test of difference in the average first-day returns between selected subgroups

Furthermore, we want to see if the difference in ownership prior to the IPO has any impact on the degree of underpricing. Our two-sample t-test in table 5.1.3 reports an average underpricing for PE-backed IPOs which is higher compared to

VC-backed IPOs, but not statistically significantly different. However, NS-backed IPOs report even higher underpricing than PE-backed and VC-backed IPOs, with an average of underpricing of 14.21%, which is statistically significantly higher than both PE- and VC-backed IPOs. Chapter two provides insights into a study conducted by Bergström et al. (2006), which highlights the underpricing trends in IPOs focusing on backing. According to their findings, IPOs backed by private equity (PE) experienced an underpricing of 9.33%, while non-PE-backed IPOs had a higher underpricing rate of 12.87%.

Table 5.1.3 T-tests of difference in avergae of first-day returns between selected subgroups

*Table 5.1.3 below shows the two-sample t-tests to cross-test the differences between the subgroups. * represents significance at 10%, ** represents significance at 5%, and *** represents significance at 1%. The total sample size consists of 1207 Initial Public Offerings (IPOs), with 914 non-sponsored IPOs (NS), 142 private equity-backed IPOs (PE), and 151 venture capital-backed IPOs (VC).*

Subgroups	***PE***	***VC***	***PE***	***NS***	***VC***	***NS***
Observations	142	151	142	914	151	914
Mean	8,65%	7,36%	8,65%	14,21%	7,36%	14,21%
Standard Deviation	20,02%	27,31%	20,02%	44,67%	27,31%	44,67%
P-Value	0,322		0,0067***		0,0054***	

In our sample, all subgroups show a statistically significantly level of underpricing that is different from zero, but a contradicting pattern to relative to each other when compared to previous literature. That is, VC backed IPOs seem relatively less underpriced compared to PE backed IPOs. Furthermore, we anticipated a reduction in the frequency of underpricing in PE-backed IPOs due to their certified position and improved information transparency, which helps minimize adverse selection (Bergström, 2006). However, it is important to note that the demand for private equity can sometimes lead to aggressive pricing of PE firms, resulting in a higher degree of underpricing (Levis, 2011). The table below shows the two-sample t-tests to cross-test the differences between the subgroups. Here, our subgroups partly support the previous literature, showing that PE backed IPOs are consistently less underpriced than NS IPOs as expected. However, the same pattern holds for VC backed IPOs, and we find no statistically significant difference between the two subsample means (VC vs. PE), which is surprising compared to previous literature.

One-sample t-tests across different time periods

Table 5.1.4 T-tests of differences of first-day returns between selected events

*Table 5.1.3 presents the results of the two-sample t-tests conducted to compare the variances between the chosen events. The significance levels are indicated by asterisks: * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%. The total number of observations for each event category is as follows: 316 for the pandemic, 38 for the financial crisis, and 853 for normal times.*

	Pandemic	***Financial Crisis***	***Normal Times***
Observations	316	38	853
Average Market-Adjusted Return	17,96%	1,98%	11,22%
Median	9,86%	4,63%	4,8%
Standard Deviation	36,98%	20,11%	42,49%
Maximum	274,4%	28,50%	728,42%
Minimum	-89.15	-95.46	-99.65%
Kurtosis	16,98	14,74	148,43
Skewness	3,29	-3.15	10,51
Standard Error	0,02	0,03	0,01
Degrees of Freedom	315	37	852
T-Statistic	8,64	0,61	7,71
P-Value	0***	0,55	0***

Table 5.1.4 indicates notable differences in underpricing levels during different periods. IPOs during the pandemic period exhibit a substantial average marked-adjusted first-day return of 17.96%, indicating a significant degree of underpricing. Similarly, in normal times, IPOs demonstrate an average marked-adjusted first-day return of 11.22%, suggesting a moderate level of underpricing

compared to the pandemic. However, during the financial crisis period, IPOs show a lower average marked-adjusted first-day return of 1.98%. The last observation indicates a relatively modest degree of underpricing, and the results for this period are not statistically different from zero. Moreover, it is worth mentioning that the lower number of observations during the financial crisis period may impact the result in terms of explanatory power.

Two-sample t-test across time periods

Table 5.1.5 T-tests of difference in avergae of first-day returns between selected events

*Table 5.1.3 below shows the two-sample t-tests to cross-test the differences between the events. * represents significance at 10%, ** represents significance at 5%, and *** represents significance at 1%. The total number of observations for each event category is as follows: 316 for the pandemic, 38 for the financial crisis, and 853 for normal times.*

Subgroups	*Pandemic*	*Financial Crisis*	*Pandemic*	*Normal Times*	*Financial Crisis*	*Normal Times*
Observations	316	38	316	853	38	853
Mean	17,96%	1,98%	17,96%	11,22%	1,98%	11,22%
Standard Deviation	36,98%	20,11%	36,98%	42,49%	20,11%	42,49%
P-Value	0***		0,0041***		0,0062***	

The results of our analysis support our second hypothesis, as they reveal significant variations in the first day returns between the pandemic, financial crisis, and normal times. IPOs during the pandemic experienced a notably higher degree of underpricing, which aligns with previous research indicating the impact of information uncertainty in uncertain market conditions (Baig & Chen, 2022). Similarly, the Dot-com bubble serves as another example of a unique market situation that led to substantial underpricing in internet companies (Ljungqvist and Wilhelm, 2003).

The supporting patterns observed in our analysis underscore the influence of specific economic circumstances on IPO underpricing. The pandemic period, characterized by heightened uncertainty and volatility, contributed to increased underpricing levels. On the other hand, the financial crisis period demonstrated lower levels of underpricing, potentially influenced by factors specific to that period, which is a distinct difference compared to the pandemic. The two subsamples differ in the degree of the crisis that was observed during the period. The financial crisis can be defined as having a more severe impact on financial markets and the market activity, while the pandemic influenced the volatility of the market.

T-tests for "hot issue" vs "cold issue" and neutral markets

Table 5.1.6 One-sample T-tests "hot issue" vs. "cold issue" and neutral markets

*Table 5.1.6 presents the one-sample t-tests to test the significances of each sub group. We compare each sponsorship sub groups, and categorize by "hot issue" and "cold issue" and neutral markets to test individual sub group significance. * represents signficance at the 10% level, ** denotes significance at 5%, and *** denotes significance at the 1% level.*

Sub Groups	PE		VC		NS		All Firms	
	HMA	LMA	HMA	LMA	HMA	LMA	HMA	LMA
Observations	64	78	54	97	297	617	415	792
Average Marked-Adjusted Return	10,92%	6,79%	10,81%	5,44%	13,89%	14,36%	13,03%	12,52%
Median	8,38%	3,41%	5,09%	1,51%	6,78%	6,46%	6,90%	5,56%
Standard Deviation	13,27%	24,12%	22,46%	29,61%	38,52%	47,38%	33,97%	43,86%
Maximum	53,66%	149,24%	120,70%	250,55%	357,04%	728,42%	357,04%	728,42%
Minimum	-7,31%	-99,65%	-26,29%	-27,78%	-89,15%	-98,25%	-89,15%	-99,65%
Kurtosis	1,67	20,31	9,82	49,89	32,70	125,55	39,77	136,01
Skewness	1,34	1,95	2,39	6,28	4,95	9,63	5,30	9,78
Standard Error	0,02	0,03	0,03	0,03	0,02	0,02	0,02	0,02
Degrees of freedom	63	77	53	96	296	616	414	791
T-Statistic	6,58	2,48	3,54	1,81	6,21	7,53	7,81	8,04
P-Value	0***	0,0151**	0,0009***	0,0733*	0***	0***	0***	0***

To test our fifth hypothesis, we employed a t-test analysis. We categorized the markets into "hot" and "cold" issue markets and examined the results accordingly, across backing. The significant levels utilized for our analysis were set at 1%, 5%, and 10%. Upon analyzing the data, we discovered intriguing results regarding the impact of market cyclicities on underpricing. When the markets were not divided by sponsorship, we found that market-adjusted initial returns significantly different from zero at the 1% significance level, regardless of market cycle/activity. This trend persisted across all sponsorship subgroups, except for PE LMA and VC LMA, which exhibited significant differences from zero at the 5% and 10% significance levels, respectively.

Contradicting previous literature, our findings did not support the inference that IPOs listed during hot issue markets are considerably more underpriced compared to markets with lower activity. This contrasts with the research conducted by

Ritter (1991), who highlighted the occurrence of a "window" of opportunities, resulting in higher degrees of overvaluation for companies going public, subsequently leading to higher returns.

Table 5.1.7 Two-sample T-tests "hot issue" vs. "cold issue" and neutral markets

*Table 5.1.6 presents the two-sample t-tests to test the significances of differences between each sub group. We compare each sponsorship sub groups, and categorize by "hot issue" and "cold issue" and neutral markets to test individual sub group difference. * represents signficance at the 10% level, ** denotes significance at 5%, and *** denotes significance at the 1% level.*

Sub Groups	PE		VC		NS		All Firms	
	HMA	LMA	HMA	LMA	HMA	LMA	HMA	LMA
Observations	64	78	54	97	297	617	415	792
Mean	10,92%	6,79%	10,81%	5,44%	13,89%	14,36%	13,03%	12,52%
Standard Deviation	13,27%	24,12%	22,46%	29,61%	38,52%	47,38%	33,97%	43,86%
P-Value	0,099*		0,1066		0,4357		0,4126	

Our analysis focused on evaluating the significance levels associated with the differences in subsample means. We wanted to determine if any substantial differences existed in the underpricing of sponsorship subgroups between hot and cold issue markets. The results indicated that only PE-backed IPOs exhibited a significant difference in market-adjusted returns at the 10% significance level. This suggests that PE-backed IPOs tend to be more underpriced during hot issue markets compared to cold issue markets. Importantly, these findings align with the prior research conducted by Bergström et al. (2006). However, on a general basis, we do not find support to the notion that IPOs are more underpriced during “hot issue” markets.

5.2 Regression Model Results and Interpretation

In this section we present the results of the regression models used to test hypotheses 3, 4 and 6. We start off by summarizing our regression model variables, with a description of each variable and our expectations regarding their signs, which will be related to previous research. We continue by presenting our variables coefficients, their respective t-statistics and statistical significance. Furthermore, we comment on their economic significance and compare to previous literature findings. Throughout this, we address our hypotheses and how our results relate to these. Lastly, we discuss the validity of our models and econometric issues. Table 5.2.1 below presents the regression variables.

Table 5.2.1 Summary of Research and Control Variables

Table 5.2.1 presents the research and control variables of the multivariate regression models. Regression model 3 additi contains dummy variables for years, industries and sponsorship. We present a summary of the different research and co variables, with our respective expectations of the coefficient signs.

Variable	*Explanation*	*Expected Effect on Dependent Va*
LNMAR	The natural logarithm of the relative price difference between the closing of first trading day and the offer price, minus the natural logarithm of market closing prices	Dependent Variable
21VOL	Standard deviation of the market return the 21 days preceding the first trading day of the IPO (MSCI Europe index utilized as European market benchmark)	Positive coefficient
MRET21d	21 trading day (1 month) market return preceding the first trading day of the IPO.	Positive coefficient
MRET3m	3 month market return preceding the first trading day of the IPO.	Positive coefficient
MRET100d	100 day market return preceding the first trading day of the IPO.	Positive coefficient
HMAdummy	Dummy variable indicating whether the IPO was issued during a "hot issue" market or not	Positive coefficient
PandemicDummy	Dummy variable indicating whether the IPO was issued during the pandemic	Positive coefficient
FinancialCrisisDummy	Dummy variable indicating whether the IPO was issued during the financial crisis	Negative coefficient
Ln(Size)	The natural logarithm of the total assets of the firm prior to the IPO.	Negative coefficient
Ln(Age)	The natural logarithm of the firm age prior to the IPO.	Negative coefficient
Ln(Proceeds)	The natural logarithm of the gross proceeds from the IPO issue.	Negative coefficient

5.2.1 Multivariate Regression Model Results

As presented in 4.2.3, our regression analysis consists of 3 models. The first model contains the research variables, the second contains both research and control variables, while the last model includes also dummy variables for years, industries and sponsorship. The models are constructed in a way that we can better analyze the isolated effects of our variables. Table 5.2.2 below summarizes the results for all three models, presenting their coefficients, t-statistics and statistical significance.

Table 5.2.2 Results of Multivariate Regression Models

*Table 5.2.2 presents the OLS coefficients of the three regression models presented in 4.2.3, with the respective t-statistics in parantheses. "***" indicates a significance at 0% level, "**" at 0,1% level, "**" at 1% level, "*" at 5% level and "." at 10% level.*

Regression Model	*(1) LNMAR*	*(2) LNMAR*	*(3) LNMAR*
Intercept	0,045879	0,28273	0,3038436
	(3.332)***	(5,117)***	(5,021)***
21VOL	-0,1977059	-2,245466	-2,265256
	(-1,639)	(-1,879) .	(-1,554)
MRET21d	-0,05681	-0,030845	-0,0820491
	(-0,490)	(-0,268)	(-0,699)
MRET3m	0,2878	0,278819	0,3027697
	(-3,044)**	(2,977)**	(3,15)**
MRET100d	-0,050096	-0,054609	-0,0159585
	(-0,707)	(-0,779)	(-0,208)
HMAdummy	-0,009936	-0,001237	0,0039032
	(-1,021)	(-0,126)	(0,362)
PandemicDummy	0,024959	0,020206	0,0004433
	(-2,395)*	(1,937) .	(0,02)
FinancialCrisisDummy	-0,023293	-0,031979	-0,0222214
	(-0,935)	(-1,293)	(-0,517)
Ln(Size)		0,002104	0,0038778
		(0,781)	(1,357)
Ln(Age)		-0,001486	-0,0025248
		(-0,516)	(-0,851)
Ln(Proceeds)		-0,013832	-0,0139181
		(-4,015)***	(-3,869)***
Industry Dummies	No	No	Yes
Year Dummies	No	No	Yes
Sponsorship Dummies	No	No	Yes
R-squared	2,84%	5,04%	7,11%
Adj. R-squared	2,28%	4,25%	4,25%
F-value	5,014	6,351	2,488

Firstly, the intercept in all models have a positive sign and is statistically significant at the 0% level. Due to the construction of our dummy variables, the intercept captures the effect of the level of underpricing during both “normal times” and LMA. The sign and significance of the intercept therefore indicates that the IPOs during normal times and LMA periods in total are statistically significantly different from zero. This supports our one-sample t-tests done in the previous section for both subgroups. Economically, this means that when all other variables are zero, the IPOs in these categories show a positive level of underpricing.

Second, we have some interesting findings compared to previous literature. Volatility, which has been shown by Derrien and Womack (2003) to have a large and positive statistically significant coefficient, is not transferable to the broader European market. In model (1) and (3) we find no statistical significance, but in model (2) we find a statistical significance at the 10% level when introducing control variables. Moreover, the sign is negative, which also contradicts the findings of Derrien and Womack (2003). In economic terms, this is also contradicting to Loughran and Ritters (2004) research in how risk is related to the level of underpricing. They argue that increased risk results in higher levels of underpricing, as a means of compensating the investor. However, our results indicate that higher volatility during the 1 month (21 trading days) leading to the IPO decreases the level of underpricing. However, due to the minuscule significance in individual models we cannot infer that our measure of volatility is a good predictor of the level of underpricing in our analysis.

Market return show some differing results. 21-day market return (MRET21d) prior to the first trading day exhibit no significance at any levels and low t-statistics (in absolute terms). However, MRET21d does show the same patterns as the 21VOL variable, having negative coefficient signs in all models. The same pattern holds for the 100-day market return (MRET100d). In contrast, we find that 3-month market return have relatively large and positive coefficients, that are statistically significant at the 1% level in all models. The coefficients range from 0,2788-0,3028 in the regression models, exhibiting a large and positive effect on the LNMAR. Among our variables, this showcases the largest economic effect on the level of underpricing, which is surprising when compared to previous research. In contrast the 21VOL variable, this indicates what Loughran and Ritter (2004) finds, that higher risk results in higher levels of underpricing. By comparing with the different horizons of the market returns, we can also infer that investors are perceptive of market movements on a longer-term basis than 1 month.

Our dummy variables do not exhibit much significance. Supporting our two-sample t-tests from the previous section, we do not find that IPOs that are issued during "hot issue" markets are statistically significantly different. We do, however, find that IPOs issued during the pandemic are consistently more underpriced compared to the financial crisis, where coefficients are even negative (though not statistically significant). We do not find any significance in either year, industry or sponsorship dummies. Due to the larger intercept coefficient in model 3 (0,3038>0,2827) we can infer that IPOs that are not backed by either PE or VC have higher levels of underpricing. Although, the distinct effect is unclear as there are several dummy variables that are captured by the intercept in this model.

For our control variables, we surprisingly find that gross proceeds is the only statistically significant predictor of underpricing, being significant at the 0% level in both model (2) and model (3). Interestingly, we find no significance in neither size nor age. The latter being contradicting to what Ritter (1984) finds.

Overall, we have high F-values in all models. This indicates that despite the individual variables being mostly insignificant, the models are jointly significant at the 0% level. On the other hand, we have very low values for adjusted R-square, indicating that the error terms in contains most of the variations in underpricing for all our models. We find that when adding control variables, we are able to somewhat increase our explanatory power, but not when including year, industry or sponsorship dummies.

5.2.2 Econometric Issues

In this section we discuss the validity of our models. We have employed multivariate regression models as to ascertain whether there are observable linear relationships between our dependent variables and our explanatory variables. For the results of this analysis method to be valid, we rely heavily on that the assumptions of the Classical Linear Regression Model (CLRM) are met (Brooks, 2019). We do not consider autocorrelation, as we are not dealing with time-series data in our case. In the appendix we only present the results for the first model with the research variables. However, tests for models 2 and 3 were conducted, and yielded similar results as for model 1.

Normality

The assumption of normality in the residuals is not a necessary requirement for Ordinary Least Squares (OLS) to provide unbiased estimates. OLS can still generate unbiased estimates even if the residuals do not follow a normal distribution. However, the assumption of normally distributed errors becomes crucial for valid hypothesis testing. When the residuals are not normally distributed, it can introduce bias into the standard errors, leading to incorrect conclusions in terms of confidence intervals and significance tests. It is important to note that in this case OLS standard errors may no longer be the smallest, which means that OLS is no longer the Best Linear Unbiased Estimator (BLUE). In such cases, alternative methods like Weighted Least Squares (WLS) may offer more efficiency in estimation. Therefore, while normality of residuals is not necessary for unbiased estimates, it plays a significant role in ensuring the validity of hypothesis testing and the accuracy of standard errors.

To approach the problem of normality, we utilize a Jarque-Bera test to test whether there is non-normality or not. When doing so, we find a t-statistic that exceeds the critical value. In simpler terms, the result suggests that there is evidence of non-normality in the residuals, and the distribution may exhibit skewness and kurtosis that deviate from what would be expected in a normal distribution. Our standard errors may be biased, and while we are aware of this, we have not taken any corrective measures to fix this. Due to our large sample size, and the central limit theorem, we believe this violation will not introduce significant bias into our results.

Multicollinearity

Multicollinearity occurs when there is a high correlation between two or more independent variables in a regression model. It is important to note that multicollinearity does not violate the assumptions of ordinary least squares (OLS) regression, and the OLS estimators remain unbiased and consistent, known as BLUE (Best Linear Unbiased Estimators). However, multicollinearity can introduce challenges in interpreting the significance and precision of individual variable coefficients.

The presence of multicollinearity can lead to inflated variance in the estimated slope parameters, making it difficult to discern the true relationship between independent variables and the dependent variable. This increased variance can result in larger standard errors and, consequently, wider confidence intervals for the coefficients. Consequently, it becomes more challenging to identify statistically significant variables, potentially leading to the rejection of variables that may have true explanatory power.

Addressing multicollinearity can be a complex task with no one-size-fits-all solution. One approach is to carefully examine the correlation between independent variables and consider dropping highly correlated variables from the model. However, this approach should be taken with caution, as it may introduce omitted variable bias and overlook important relationships (Woolridge, 2019).

A correlation matrix is shown in Appendix 7.1.1. Here, the highest correlation is between the Ln(Proceeds) and Ln(Size) variable at 0,75. The relationship is not surprising, considering larger firms naturally have larger capital needs. However, we do not put efforts into sorting this problem, as both variables are used as control variables. The second notably high correlation occurs naturally between the 3-month and 100-day buy-and-hold return for the MSCI Europe index, with a correlation of 0,67.

Moreover, to consider whether the last case introduces problems or not, we calculate VIF values. The intentions for this are to consider whether the degree of correlation introduces any multicollinearity problems in the models that we should consider (Corporate Finance Institute, 2020). According to CFI (2020), a rule of thumb is that VIF values above 4 might mean there exist multicollinearity, especially when above 10. Appendix 7.1.2 shows the VIF values from our research and control variables, showing no values that concern us.

Heteroscedasticity

One of the key assumptions for the Ordinary Least Squares (OLS) estimator to be considered the Best Linear Unbiased Estimator (BLUE) is the assumption of homoscedasticity. Homoscedasticity implies that the variance of the error term remains constant across all values of the explanatory variables and across different segments of the population. When this assumption is violated, and the variance of the error term is not constant, we refer to it as heteroscedasticity (Wooldridge, 2019).

Heteroscedasticity, if present, does not introduce bias or inconsistency in the OLS estimators themselves. However, it does affect the standard errors associated with the estimated coefficients. The standard errors become biased, leading to incorrect inference and invalid hypothesis tests. Specifically, confidence intervals, t-statistics, and F-tests may not provide reliable information in the presence of heteroscedasticity (Wooldridge, 2019).

To test whether there is heteroscedasticity in our models we employ White's test for heteroscedasticity. The results can be found in Appendix 7.1.3. The test gives a p-value of 0,137, which is not low enough to reject the null hypothesis at the 10% level. In other words, we keep the null hypothesis that we have homoscedasticity.

PART VI. CONCLUSION

6.1 Conclusion

In conclusion, this thesis has explored the impact of market volatility resulting from various events in Europe on the short-run performance and underpricing levels of IPOs. The research question guiding this study was: *"How does market cyclicality and volatility impact short-run performance and the level of underpricing in European IPOs, and what insights can be gained regarding their characteristics of backing."* Moreover, to gain a comprehensive perspective, this study delved into the extensively researched field of IPO underpricing, with a specific focus on IPOs issued during the pandemic.

Our analysis of European initial public offerings (IPOs) from 2006 to 2021 reveals several key findings. Firstly, we observed a consistent pattern of positive underpricing, with an average of 12.8%, and 12,7% when adjusted for market return.

Secondly, we found that IPOs conducted during the COVID-19 pandemic experienced higher underpricing compared to those during the financial crisis. The average underpricing for pandemic IPOs stood at 17.96%, indicating greater market volatility and investor enthusiasm during uncertain times.

Finally, while market cyclicality and volatility had a limited impact on underpricing, we identified two influential factors. IPOs with higher gross proceeds tended to have higher underpricing, suggesting that larger offerings attract greater investor interest. Additionally, positive market returns were found to positively influence underpricing levels.

6.2 Limitations and future research

The results contribute to the existing body of knowledge in finance and offer implications for investors, issuers, and regulators in navigating the European IPO market amidst market cyclicality and volatility. Further research in this area could delve into specific event types in a broader context looking further into correlations in between volatility and level of underpricing in the long run and short run. Due to the scope of this thesis, we have not been able to use different measurements of market volatility and test their individual relationship to IPO underpricing.

Furthermore, in this thesis there are several effects that have been captured in the intercept, that has the potential to provide further insight into what level of underpricing one can expect in given market conditions. Specifically, we have not delved deeper into the distinct effects of "normal times" and LMA, and how they might relate to each other. A more thorough data scraping to ensure a complete data set could bring more insight into IPO activity and how it relates to the level of underpricing, backing and other variables.

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Appendix

Appendix 7.1.1 Correlation Matrix

Appendix 7.1.1 presents the correlation matrix of model 1. The purpose is to investigate whether there is multicollinearity between two or more variables. The largest correlation is observed between Ln(Proceeds) and Ln(Size), and between MRET3m and MRET100d. High (in absolute terms)values would indicate that there is a multicollinearity problem.

	LNMAR	***21VOL***	***MRET21d***	***MRET3m***	***MRET100d***	***Ln(Proceeds)***	***Ln(Age)***	***Ln(Size)***
LNMAR	**1**							
21VOL	-0,10	**1**						
MRET21d	0,07	-0,24	**1**					
MRET3m	0,15	-0,49	0,53	**1**				
MRET100d	0,10	-0,50	0,37	0,68	**1**			
Ln(Proceeds)	-0,14	-0,10	0,07	0,06	0,06	**1**		
Ln(Age)	-0,01	0,01	0,00	0,02	0,00	-0,02	**1**	
Ln(Size)	-0,10	-0,06	0,05	0,03	0,02	0,75	0,13	**1**

Appendix 7.1.2 VIF Values

Appendix 7.1.2 presents the variance inflation factors. As a rule of thumb, a number exceeding 4 should be given attention.

Variable	***VIF***
21VOL	0,70
MRET21d	0,71
MRET3m	0,42
MRET100d	0,50
Ln(Proceeds)	0,42
Ln(Age)	0,95
Ln(Size)	0,42

Appendix 7.1.3 White's Test for Heteroscedasticity

Appendix 7.1.3 presents the results from running White's test for heteroscedasticity on model 1.

P-value	***Significance Level***	***Test Statistic***	***Critical Value***
0,1366	5%	19,7979	23,6848