The Post-IPO Performance of Venture Capital-backed Companies – Evidence from the European High-Tech Industry*

An Empirical Study

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Abstract

This thesis focusses on the question whether VC-backing is positively related to the long-term post-IPO performance of companies. It thereby aims to contribute to the clarification of the broader question whether VC funds create lasting value for European high-tech companies through their financing and continued provision of monitoring and advise services. To help answer this question, our empirical analysis compares the post-IPO operating and market performance of 102 Venture Capital-backed IPOs to a control group of 397 IPOs without a financial sponsor. We measure post-IPO operating performance as changes in operating return on assets and post-IPO market performance as buy-and-hold abnormal returns. We provide an up-to-date assessment by considering all European high-tech IPOs between 2001 and 2014. Our results indicate no significant positive relationship between Venture Capital sponsorship and the improvement in operating return on assets as well as abnormal market returns and are robust when accounting for differences in offering and firm characteristics. On the one hand, our findings are similar to previous papers examining the European Venture Capital market around the dot-com bubble without focusing on the high-tech industry. On the other hand, our findings differ to previous literature examining the US market which show a superior performance of Venture Capital-backed IPOs compared to non-Venture Capital-backed IPOs, also for high-tech companies in specific. Potential reasons include a lower quality of the services provided by VC funds to their European portfolio companies and a shortage of "superstars" among European high-tech start-ups.

Keywords: Venture Capital, Operating Performance, Market Performance, Post-IPO, High-Tech
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List of Abbreviations

BHAR	Buy-and-Hold Abnormal Return
BHR	Buy-and-Hold Return
CFOA	Cash Flow on Assets
EIF	European Investment Fund
FS	Financial Sponsor(ship)
FYE	Fiscal Year End
IPO	Initial Public Offering
LP	Limited Partner
NFS	Non-Financial Sponsor(ship)
OLS	Ordinary Least Squares
P/B	Price-to-Book
PE	Private Equity
R&D	Research and Development
ROA	Return on Assets
SDC	Securities Data Company
SIC	Standard Industrial Classification
UK	United Kingdom
US	United States
VC	Venture Capital

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1 Introduction

The European Venture Capital (VC) industry has received substantial public funding over the last twenty years in an effort to increase European VC activity. However, private investments into VC funds have only partially picked up, with the European VC market continuing to lag behind the world's leading VC market, the United States (US). "Europe's economy is about the same size as that of the US. […] Our venture capital market [size is] only a fifth [of the US market size]." (Lord Hill speaking at the Bruges European Business Conference on 18 March 2016). Further, most of today's globally successful VC-backed high-tech companies have their origin in the US and increasingly China, the rising star of the VC market, while Europe continuously fails to create its own global tech giants. In recent years, a common conclusion drawn by media, politicians and business leaders is that Europe is falling behind in technology and innovation. This development evokes interest to look closer at the impact of VC-backing on high-tech companies in Europe and whether it creates lasting value for technology-intensive companies and fosters the innovativeness as well as competitiveness of the European economy, respectively.

A common approach for studying the long-term, i.e. three years or more, value potential of VC-backing is to look at performance of VC-backed companies after they undergo an initial public offering (IPO) and are listed on public stock exchanges. Advantages of this approach are that in addition to being able to analyse market performance, i.e. the investors' expectations, the higher disclosure requirements for public companies provide access to pre- and post-IPO accounting figures, additionally enabling an analysis of the operating performance. One of the main downsides, however, is that only a portion of VC-backed companies undergo an IPO, while the bigger share of portfolio companies is excited via the sale to strategic buyers (trade sale) (Acevedo et al., 2016).

Several papers have studied the long-run performance of VC-backed IPOs. Studying the most mature VC market, the US, Brav and Gompers (1997) detects a positive effect of VC-backing on the long-run aftermarket performance of IPOs. Moreover, Jain and Kini (1995) finds similar evidence for the operating performance of VC-backed companies. The superior performance of VC-backed IPOs is often attributed to VC fund's monitoring role and the existence of better management teams in VC-backed companies. Previous European studies primarily focus on the period around the dot-com bubble. In a study of the French, German and British "new markets", Rindermann (2003) finds no significant difference in neither operating nor market performance between VC and non-VC-backed companies post-IPO. The differing results between US and European studies are generally attributed to the relatively

immature European VC industry in the 1990s and the beginning of the 2000s, which may limit VC funds in their ability to create long-lasting value for their portfolio companies.

Due to the maturation of the European VC industry in the last ten to twenty years, our study aims to provide an up-to-date assessment of the long-term value creation potential of VC-backing for European companies by analysing post-IPO performance of companies undergoing an IPO in the period from 2001 to 2014. We focused on high-tech companies since the structure of VC funds is targeted towards these high risk and high information asymmetry facing companies. Brown (2005) reports that VC-backed high-tech companies in the US survive longer, have a better operating performance when considering growth rates and profitability ratios, and have a greater cumulative impact on the US high-tech industry than non-VC-backed companies. According to the best of our knowledge, there is no published study with a sole focus on the post-IPO performance of European high-tech companies to date.

To examine the relationship between VC-backing and post-IPO performance, we compared the long-run operating and market performance of VC-backed companies to Non-Financial Sponsor (NFS)-backed companies. We analysed differences in operating performance by comparing the improvement in profitability, measured as changes in operating return on assets (ROA). However, a sole focus on accounting ratios would be misleading since the value added by VC-backing may also be related to future growth opportunities and hence market's expectations about future profitability. Thus, we aimed to study the effects of VC-backing on market's expectations by analysing buy-and-hold abnormal returns (BHARs). We studied a period of three years post-IPO, considering all European high-tech IPOs between 2001 and 2014.

Our empirical study provides valuable insights to four key stakeholders: Firstly, entrepreneurs, who are seeking VC funding. Secondly, IPO investors, who invest into IPO company stocks on the secondary market shortly after the IPO and continue to hold these for a long-term period. Thirdly, VC funds that hold stock for some time beyond the IPO, and the investors of VC funds (limited partners), who frequently receive IPO shares when the fund ultimately exits from its investment in portfolio companies. Lastly, European governments and public institutions, which invested heavily in the past twenty years in an effort to develop the European VC market.

The rest of our thesis is structured in the following way: In section 2, we provide background information on the (European) VC industry, its importance for the high-tech industry and the VC fund's exit through an IPO. Section 3 guides through the previous literature on post-IPO performance focussing on the role of VC-backing in post-IPO performance. This section will also present the deduced hypotheses. In section 4, we introduce our data and

discuss its characteristics as well as potential limitations. In section 5 we explain our methodological approach and in section 6, we present our results and analysis. This is followed by a discussion of our main findings, limitations and potential further research in section 7, and a conclusion in section 8.

2 Background Information

2.1 The Venture Capital Industry

VC funds are a subcategory of Private Equity (PE) funds, with the other main subcategory being buyout funds. While a typical buyout fund obtains a majority control of a mature company, VC funds typically invest in young, high growth companies, without obtaining a majority control (Kaplan and Strömberg, 2009). Due to their high risk and information asymmetry as well as unstable cash flows, these early stage companies, in the following referred to as start-ups, are usually unable to obtain funding from the public market and have difficulties to raise debt. In addition, VC funds support their portfolio companies with market-specific business development knowledge (Bottazzi and Da Rin, 2002), take concentrated equity positions and sit in the boards of their portfolio companies (Barry et al., 1990).

Similar to other PE funds, VC funds are primarily organized as limited partnerships. While the limited partners (LPs) provide almost all the fund's capital, the general partners (the fund's managers) are the decision makers regarding the investments of the fund (Bottazzi and Da Rin, 2002). LPs are often large financial institutions, family offices, or public institutions. VC funds typically have a fixed lifespan of around ten years, after which they exit their portfolio companies. The most common exit routes of VC funds are trade sales, followed by IPOs (Acevedo et al., 2016).

2.2 The Development of the European Venture Capital Industry

Until the 1990s, VC remained a phenomenon in the US, where it had originated in the 1960s (Gompers, 1994; Bottazzi and Da Rin, 2002). With the launch of the European Investment Fund (EIF) in 1992, as the leading public provider of VC to young and innovative companies, the European VC market emerged and developed steadily with a peak right before the new millennium (Kraemer-Eis et al., 2016). At the same time, around 1996, Europe's "new stock markets" were launched in Amsterdam, Brussels, Frankfurt, Paris and Milan, to encourage IPOs of innovative companies with high growth potential (Bottazzi and Da Rin, 2002). The role model of the European "new markets" was the American Nasdaq. Bottazzi and Da Rin (2002) documents that the involvement of VC funds in companies listed on Europe's "new stock markets" was substantial. In the subsequent years, the creation of these "new markets" led to a very active European IPO market, which was fuelled by the emergence of the internet. However, after the burst of the so-called dot-com bubble in 2000[1] and the following recession,

[1] The dot-com bubble, also referred to as the internet bubble, refers to the period between 1995 and 2000, when investors were triggered by the rise of the internet and pumped money into internet-based start-ups, many of which went public without ever generating any revenue, achieved huge market capitalizations and then died (Waters, 2018; Tucci, 2018).

investments into VC funds as well as the European IPO level declined, and the “new markets” partly failed. In an attempt to stimulate the European VC market, the European Commission subsequently provided €2 billion to the EIF in 2001, making it Europe’s largest venture investor with a share of 50% of total investments in European VC funds that year (Lerner, 2009). In 2007, total VC funding in Europe reached its peak at €7 billion but slumped below €5 billion due to beginning of the financial crisis in the upcoming year. It reached its low in 2009 and 2010 with €3 billion invested and since then slowly recovered towards an investment size of €5 billion in 2015 (Kraemer-Eis et al., 2016). In comparison, the US VC market tripled until 2015 from its lowest point in 2009 (Acevedo et al., 2016). The United Kingdom (UK) currently represents Europe’s largest VC market, accounting for a quarter of all European VC investments in 2007 – 2015.

Despite many national and European-wide public initiatives since the early 1990s aimed at promoting funding for entrepreneurs, i.e. the founders of start-ups, and VC funds, the presence of the VC sector in Europe lacks behind its counterpart in the US (Lerner, 2009). The amount of VC in the US as a percentage of gross domestic product is more than seven times larger than in Europe. Furthermore, capital provided by government agencies is still the most important capital source for VC funds in Europe (35% of total amount in 2014), while public capital only plays a minor role in the US (below 1% of total amount in 2014), where pension funds provide the majority of VC funding (29% of total amount in 2014) (Brigl and Liechtenstein, 2015).

2.3 The Importance of Venture Capital for Young High-Tech Companies

VCs focus their investments primarily on early stage high-tech companies in which the information asymmetries are the highest and the control and guidance provided by VCs is especially valuable (Gompers, 1995). To overcome high information asymmetries, VCs spread their financing over several stages in the start-up’s development instead of providing companies with the full required investment amount upfront (Bottazzi and Da Rin, 2002; Barry et al., 1990; Gompers, 1995). This allows the VC to periodically revalue the investment and to discontinue projects with little probability of a successful exit. An abandonment option like this is especially valuable for the high-tech start-up industry, as most funds are spent on research and development (R&D), where the outcome is associated with a high degree of uncertainty (Hall, 2002). Further, the relaxation of capital constraints enables VC-backed high-tech companies to seize growth opportunities as they arise and to invest into equipment, R&D and personnel when needed (Brown, 2005). In addition, the VC’s active involvement and support helps high-tech companies to overcome some of their typical problems, such as moving from prototype development to production, marketing and distribution (Black and Gilson, 1998). Especially high-tech entrepreneurs often lack business experience and thus supporting the

start-ups in for example the recruitment of key personnel or relationships to potential suppliers and clients can provide additional value. Evidence shows that VC-backed companies produce more, as well as more valuable, patents and are faster at developing their products and bringing them to market (Hellmann and Puri, 2000; Kortum and Lerner, 2001). This is especially important for innovative high-tech companies, for which speed to market is crucial to gain market leadership.

2.4 The Venture Capital Funds' Exit through an IPO

In most cases, an IPO can only be considered as an event that enables a VC fund to exit in the (near) future instead of being the actual time of exit, i.e. the actual moment when the VC fund sells its stake in a portfolio company or passes it on to its LPs (Gompers and Lerner, 1998). Due to the fixed lifespan of a VC fund, it is required to eventually pay back its LPs, but may however not do so immediately at IPO due to various reasons. The main reason is the negative signalling effect (Ang and Brau, 2003). Insiders selling large stakes may signal that the company is overvalued, which depresses the offer price and decreases the proceeds raised in an IPO. Further, previous studies show that VCs even continue to hold significant ownership and board seats beyond one year post-IPO (Barry et al., 1990; Jain and Kini, 1995). A reason is that VC funds want to ensure that portfolio companies do not fail in the aftermarket, as this would send a bad signal to the key stakeholders of VC firms and ultimately harm their reputation. This could damage a VC firm's ability to raise follow-on funds, convince entrepreneurs of their value added and finding reputable investment banks that are interested in underwriting their future portfolio companies' IPOs.

3 Previous Literature

3.1 Post-IPO Performance

General studies in the US, which focus on operating as well as market performance long-run post-IPO, identify significant underperformance of IPO companies. In an analysis about post-IPO market performance, Ritter (1991) discovers that an investment after the first day of trading would leave the investor with a smaller return than investing in a group of companies that has been listed already. This result is predominantly driven by relatively young growth companies and holds especially for those going public during years with high IPO activity. The findings support the theory of investor over-optimism and their positive sentiment towards IPOs, especially during years with high IPO activity. This is consistent with the findings by Lee et al. (1991) who argues that more companies undergo an IPO when the investor sentiment is high, taking advantage of the company's overvaluation. Brav and Gompers (1997) and Brav et al. (2000) argue against the hypothesis of the underperformance of IPO companies by showing that small and high growth companies in general underperform the index. This implies that IPO companies do not perform worse than similar companies, i.e. small and high growth companies. Additionally, their evidence is consistent with the possibility that investors favour small and high-growth company stocks (Ljungqvist et al., 2006).

Jain and Kini (1994) studies the post-IPO operating performance for a period of five years and finds that after companies go public, their profitability measures, such as operating ROA, show a substantial decline. The paper connects its findings to Ritter's (1991) conclusion and argues that investors overvalue the company's post-IPO development because they assume the superior pre-IPO profit margins to sustain or even to increase after the company went public while they actually decline over time. A similar study by Coakley et al. (2007) in the UK yields related results that show a stronger underperformance if the company went public during bubble years, i.e. years with a strong investor sentiment. Connecting these findings to Lee et al.'s (1991) argument that companies undergo an IPO when the investor sentiment is high, it can be concluded that companies prematurely undergo an IPO when the market timing is right.

3.2 The Role of Venture Capital-Backing in the Post-IPO Performance

Previous studies have analysed whether VC sponsorship has a long-term effect on the post-IPO performance of companies. Especially in the US, evidence indicates that VC-backed companies outperform non-VC-backed companies in a period of three to five years post-IPO, when analysing both, operating as well as market post-IPO performance. Jain and Kini (1995) provides evidence that VC-backed companies show superior post-IPO operating performance compared to non-VC-backed companies, measured by changes in operating ROA and operating cash flow from pre- to post-IPO, when analysing a period of up to three years post-

IPO. Moreover, Jain and Kini (2000) finds evidence that VC participation improves the survival profile of IPO companies by analysing failure rates of VC-backed and non-VC-backed companies in a period of five years post-IPO. Brav and Gompers (1997) is among the first that studies aftermarket buy-and-hold returns (BHR) of VC-backed companies and finds that VC-backed IPOs outperform non-VC-backed IPOs over a five-year period after the IPO, but only when returns are weighted equally. Successfully testing the validity of the paper's results against broad market indices, Fama-French industry portfolios and matched size and book-to-market portfolios supports the robustness of Brav and Gompers' (1997) findings.

Brown (2005) specifically studies the long-run impact of VC-backing on high-tech companies in the US by looking at a period of five to ten years post-IPO. The findings suggest that VC-backed high-tech companies survive longer, grow faster, are more R&D intensive and have superior operating performance, when comparing the net profit margin, return on equity and ROA. Further, VC-backed IPO companies raise more external equity and have a greater cumulative impact on the US high-tech sector. The paper measures the cumulative impact of VC-backed companies on the US high-tech sector by comparing the share of high-tech sales, R&D and market value of VC-backed to non-VC-backed IPOs. Krishnan et al. (2011) studies how the reputation of a VC firm is related to long-term post-IPO performance, defined as a period of three years following the IPO. When measuring reputation as a VC's past market share of VC-backed IPOs, the paper finds a significantly positive relation between reputation and long-run performance, even after controlling for issue characteristics and underwriter reputation. The applied measures of long-run performance are ROA, market-to-book ratio, survival and abnormal stock returns. Further, the paper finds that more reputable VCs have a higher probability of retaining shares and board seats for up to three years after an IPO and that this more active post-IPO involvement in the corporate governance of their portfolio companies has a significant positive relationship with the long-run post-IPO performance.

In Europe, few studies have analysed the effect of VC participation on post-IPO performance on a multi-country level. The initial indication is that findings of previous studies in the US on the influence of VCs on operating and market performance post-IPO cannot generally be transferred to the comparably younger European VC market. However, the existing European papers predominantly study the period around the dot-com bubble. Bottazzi and Da Rin (2002) is among the first who aims to study the general role of VC in Europe. The paper compares VC-backed companies to non-VC-backed companies on Europe's "new stock markets" and does not find any systematic differences among the two groups when comparing growth in sales and employees in a period of up to three years post-IPO. When restricting the sample to more innovative companies, i.e. those that perform R&D, the paper finds that VC-backed companies increase their sales less than non-VC-backed companies post-IPO.

Rindermann (2003) studies the German, French and UK "new markets" by analysing post-IPO operating and market performance of companies undergoing an IPO between 1996 and 1999. In line with previous studies in the US, the paper finds that IPOs underperform the market over a three-year post-IPO period. However, the analysis suggests no significant difference in post-IPO performance of VC-backed and non-VC-backed IPOs. The study analyses operating performance, defined as the average operating cash flow ROA of the two fiscal years after the IPO, and market performance, defined as the three-year wealth relative using the respective country's growth market index as a benchmark. Moreover, Rindermann (2003) finds evidence of substantial variations in the experience and sophistication of VC firms. According to the findings, international VCs are on average older, back a larger number of IPOs in the sample, are more often represented on the board, and hold larger equity positions in portfolio companies when comparing to national VCs. The paper defines international VCs as VCs that have backed companies in at least two different countries of the sample, while national VCs have only backed companies in one country of the sample. By comparing the post-IPO performance of the two types of VCs, Rindermann (2003) finds that merely international VCs appear to have a positive effect on both operating and market performance of portfolio companies, indicating a heterogeneity in the quality of VC-backing in Europe.

3.3 Hypotheses

Building upon the afore introduced literature, our study focuses on the question whether VC-backing is positively related to the long-term post-IPO performance. It thereby aims to contribute to the clarification of the broader question whether VC funds create lasting value for European high-tech companies through their financing and continued provision of monitoring and advise services. We aim to provide a more recent study on the European market focussing on high-tech due to the importance of VC for this industry.

The empirical analysis focusses on the operating and market post-IPO performance of VC-backed companies compared to NFS-backed companies. Our primary measure of operating performance is profitability measured as operating ROA. We aim to analyse whether VC-backed companies change, i.e. improve or worsen, their profitability to a different extent than NFS-backed companies. The resulting null hypothesis with regards to post-IPO operating performance is:

$H_{O\text{-}Operating}$: The change in profitability post-IPO between VC-backed companies and NFS-backed companies does not differ.

$H_{1\text{-}Operating}$: The change in profitability post-IPO between VC-backed companies and NFS-backed companies differs.

In addition, we analyse whether VC-backed companies exhibit a different post-IPO market performance by comparing buy-and-hold abnormal stock returns as our primary market performance measure. The resulting null hypothesis with regards to post-IPO market performance is:

$H_{0\text{-}Market}$: Abnormal stock returns between VC-backed companies and NFS-backed companies do not differ.

$H_{1\text{-}Market}$: Abnormal stock returns between VC-backed companies and NFS-backed companies differ.

If one or both null hypotheses are rejected, we would analyse whether the difference in operating and or market performance is a result of VC-backed companies outperforming or underperforming NFS-backed companies. Further, independently of the outcome, results will be tested for robustness and underlying reasons of the observed findings will be discussed.

4 Data

4.1 Data Collection and Sources

The dataset used in this study includes operating and market performance data for three years post-IPO of European high-tech companies that underwent an IPO between 2001 and 2014. We divided the sample into three sub-samples: companies without financial sponsorship (NFS-backed), companies with VC sponsorship (VC-backed) and companies with other PE sponsorship excluding VC sponsorship (PE-backed).

The dataset only includes companies that are domiciled in a European country. We defined a European country according to Invest Europe[2] (formerly known as European Private Equity & Venture Capital Association). We did not exclude companies that list on stock exchanges outside of Europe. Further, we only included companies in our study that underwent an IPO between 2001 and 2014, setting the lower bound to exclude IPOs in the dot-com bubble years and the upper bound to access three years of post-IPO performance data for each observation.[3]

4.1.1 IPO Data

We downloaded the dataset of IPOs from Thomson Reuters Securities Data Company (SDC) New Issues database. After excluding 38 duplicates, we received a dataset of 3,340 observations. Additionally, we received a dataset of 371 IPOs backed by financial sponsors (FS-backed) from the Portfolio Company Disbursements database of Thomson VentureXpert. Appendix 1 summarizes and describes all the variables we used from SDC to establish our VC-, PE- and NFS-backed IPO sample as well as to analyse the distribution of our sample with regards to IPO timing, geography and industry. Furthermore, we accessed the year of foundation through SDC to calculate the age at IPO of each company in our sample. We complemented it with data from Bloomberg in case the year of foundation was missing in SDC for the respective company.

We further classified the FS-backed IPOs into VC- and PE-backed IPOs. Since companies in many cases have received investments from multiple funds, we defined an observation as VC-backed if the larger share of the total investments into the company stems from funds with

[2] Invest Europe includes Austria, Baltic countries (Estonia, Latvia, Lithuania), Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Other Central and Eastern Europe (Bosnia-Herzegovina, Croatia, Macedonia, Moldova, Montenegro, Serbia, Slovenia, Slovakia), Poland, Portugal, Romania, Spain, Sweden, Switzerland, Ukraine and UK in its definition of Europe.

[3] Analysing three years post-IPO performance is typically considered as the lower limit of long-run performance studies.

the investment type “Venture Capital”.[4] If information about the investment shares were not available, we classified an observation as VC-backed if the number of VC investors is the largest investor group among all investors. This approach yielded 172 VC- and 199 PE-backed IPOs.

Finally, we classified each IPO as high-tech or non-high-tech. Kile and Phillips (2009) studies the usage of Standard Industrial Classification (SIC) codes to sample high-tech companies and defines the optimal code combination that provides the closest match to the study’s benchmark classification of high-tech companies, which results in an optimal three-digit SIC code combination of eleven codes[5]. Applying this classification approach to our sample yielded 819 high-tech IPOs for the SDC New Issues database (24.52% of the total dataset), 113 high-tech IPOs for the VC-backed share of the Thomson VentureXpert database (65.70% of the total dataset) and 47 high-tech IPOs for the PE-backed share of the Thomson VentureXpert database (23.62% of the total dataset). Considering the previously discussed importance of VC for high-tech companies, and the way VC funds’ operating structure is targeted towards high-tech companies, it is unsurprising that around 2/3 of VC-backed IPOs are high-tech IPOs, while only around 1/4 of PE-backed and of all IPOs in total are high-tech. Moreover, the comparably low number of observations of PE-backed high-tech IPOs, is in line with our previous differentiation of VC and PE funds. PE funds usually invest into mature companies with stable cash flows and a low risk profile, all of which does not apply to the typical high-tech company undergoing an IPO.

4.1.2 Performance Data

We obtained accounting and market data for our study through Thomson Reuters Datastream. For all observations, we determined the corresponding Datastream symbol through a manual selection. Observations were excluded if Datastream did not provide any data on the observation, and if the calendar year of the IPO in Datastream differed from the calendar year of the IPO in SDC or VentureXpert. This method yielded 103 IPOs for the VC-backed, 42 IPOs for the PE-backed and 686 IPOs for the SDC New Issues sample. Appendix 2 summarizes all variables retrieved from Datastream, including the corresponding item code and description.

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[4] Alternative investment types are “Buyout”, “Fund of Funds”, “Generalist Private Equity”, “Mezzanine”, and “Other Private Equity”, in our study combined into Private Equity.

[5] According to Kile and Phillips (2009), we defined the following three-digit SIC codes for the main industry of the companies’ operations as High-Tech: 283=”Drugs”, 357=”Computer and Office Equipment”, 366=”Communication Equipment”, 367=”Electronic Components and Accessories”, 382=”Laboratory, Optic, Measure, Control Instruments”, 384=”Surgical, Medical, Dental Instruments”, 481=”Telephone Communications”, 482=”Miscellaneous Communication Services”, 489=”Communication Services, not elsewhere classified”, 737=”Computer Programming, Data Processing, etc.”, 873=”Research, Development, Testing Services”.

In a final step, we matched the VC- and PE-backed sample with the SDC New Issues sample to exclude the VC and PE observations from the SDC New Issues sample in order to receive the NFS-backed sample. The comparison yielded 14 VC- and two PE-backed IPOs that could not be found in the dataset from SDC New Issues Database or have a different year of IPO in both databases. We performed a case-by-case comparison leading to the exclusion of one VC- and one PE-backed IPO from the data samples, yielding a final sample of 102 VC- and 41 PE-backed IPOs. The exclusion of the matched VC- and PE-backed IPOs yielded 556 NFS-backed IPOs. To ensure that these IPOs are solely NFS-backed IPOs, we excluded all IPOs classified as PE- or VC-backed according to SDC New Issues that were not in the VentureXpert data sample. Furthermore, we excluded spinoffs as these are fundamentally different from a typical IPO. This resulted in a final sample of 397 NFS-backed IPOs. Appendix 3 summarizes the cleaning and matching process applied to receive the final samples of VC-, PE- and NFS-backed IPOs.

After receiving the corresponding Datastream symbol for every observation in the final sample of VC-backed, NFS-backed, and PE-backed IPO companies, we retrieved the needed accounting and market data from Datastream. Due to the limited availability of quarterly or interim accounting data, we downloaded yearly data. For each company undergoing an IPO, we defined t_0 as being the fiscal year in which the IPO occurs. This way we made sure that the accounting data in t_{-1} reflects the last complete fiscal year prior to the IPO and t_1 reflects the first complete fiscal year post-IPO for all companies. A limitation resulting from the unavailability of quarterly data is that the period between the IPO and the fiscal year end (FYE) may vary significantly between companies, which may decrease the comparability of post-IPO operating performance among companies especially with regards to t_0.

We included companies in our samples for which data on one or more variables is missing in Datastream but data on some is available in the comparison of performance between our sub-sample groups. A main reason is that we only have a very limited number of observations for certain variables, such as R&D, and we still want to analyse these without excluding a big part of our samples. Similarly, we included companies in the comparison that become inactive within the analysed post-IPO performance period of three years for the years prior to their inactivity to limit the effect of a survivorship bias on the results of comparison.

4.2 Sample Characteristics

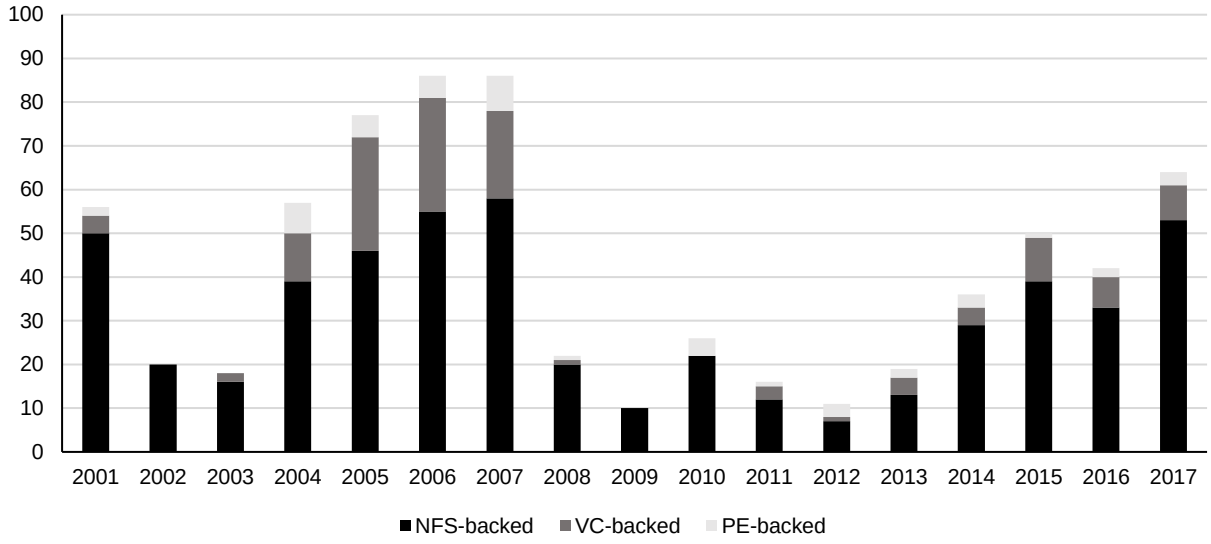
The compiled dataset provides insights into the European high-tech IPO market between 2001 and 2014. Although the following simple descriptive statistics only refer to our cleaned dataset and thus, not to all European high-tech IPOs between 2001 and 2014, we believe that the sample shows interesting differences between the three sub-sample groups regarding their

IPO timing, geographical and industry distribution, as well as regarding their company characteristics prior to the IPO and IPO offering characteristics.

4.2.1 General Characteristics

Figure 1 shows the cyclicality of the European high-tech IPO market. For illustrative purposes, we added the years 2015 to 2017 to our IPO timing analysis. Additionally, Figure 1 reports the values for the absolute and relative distribution for each of the three data samples from 2001 to 2014.

Figure 1: Distribution of IPOs by Year (2001 – 2017)



Distribution of IPOs per year for our sample of NFS-backed, VC-backed, and PE-backed European high-tech companies who underwent an IPO between 2001 and 2017. The figure illustrates the absolute distribution for each of the three data samples (NFS-backed, VC-backed, PE-backed) which combined make up the total IPOs per year.

Generally, our observed development of IPO activity seems to be largely in line with the major macroeconomic events affecting Europe, and the European IPO activity, in the period from 2001 to 2014. We can observe a decline in IPO activity from 2001 to 2003. These years are the aftermath of the burst of the dot-com bubble in 2000, reflecting the economic downturn of the “new economy cycle” from 1996 to 2003. IPO activity starts picking up again from 2004 onwards, peaking in 2006. In line with the financial crisis, beginning in 2007, IPO activity sharply declines in 2008 and 2009. The following years are marked by the European Sovereign Debt crisis beginning in the end of 2009 with IPO activity staying low. Although, IPO activity has been continuously increasing since 2012, it continues to stay behind its pre-crisis level in 2006.

Looking at the IPO activity of the three sub-sample groups separately, all three groups did not reach their pre-financial crisis IPO volume again until 2014 and continue to lag behind the levels of 2005 to 2007 for the entire post-crisis period. This is in line with findings of Ritter et al. (2013) who studies IPO activity in the main markets of the four largest European economies,

i.e. London Stock Exchange, Euronext Paris, Frankfurt Stock Exchange and Milan Stock Exchange, and observes a drop in the number of companies going public. Between 2008 and 2011, less companies go public than in 2007 alone. According to the paper, the decrease in IPO activity is mainly driven by small companies. In addition to unfavourable market conditions in those years, Ritter et al. (2013) finds evidence for a general downward trend in European IPO activity over time. The paper argues that this is caused by an increasing importance of economies of scope, making it more beneficial for smaller companies to grow fast by being acquired rather than going public and staying independent. Figure 1 shows that the decrease in IPO activity in our sample is especially severe for VC-backed high-tech IPOs. While in 2005 and 2006 around 30% of all European high-tech IPOs are VC-backed, in 2009 and 2010 none are VC-backed. Moreover, NFS-backed IPO activity in 2017 almost reaches the level of 2007 (53 vs. 58 IPOs), while VC-backed IPO activity in 2015 lags behind the level of 2006 (10 vs. 26 IPOs). A similar trend can be seen for PE-backed IPOs which also largely lag behind their peak levels in 2007 (8 IPOs in 2007 vs. 3 IPOs in 2017). An explanation for the concentration of FS-backed IPOs in the pre-crisis years may be that FSs have more experience and are therefore able to better time an IPO according to the market environment. Lerner (1994) finds evidence that VC funds help their portfolio companies to undergo an IPO during “hot” market times, when valuations are expected to be the highest.

From a geographical point of view, most of our observations are located in the UK or France. 58.94% of NFS-backed, 46.08% of VC-backed and 48.78% of PE-backed companies, which are undertaking an IPO are either British or French, with the UK being the leading company’s nationality for all three sub-sample groups (Appendix 5). This is in line with Acevedo et al.’s (2016) findings that the UK accounts for a quarter of all European VC investments in 2007-2015 and is generally referred to as Europe’s most active VC market. Overall, the NFS-backed IPOs are distributed over 19, the VC-backed over 16 and the NFS-backed over 13 countries. In line with the geographic distribution of the companies’ nation, in all of the three sample groups most IPO companies listed on the London Stock Exchange (NFS-backed 40.81%, VC-backed 23.53% and PE-backed 31.71%), followed by the Euronext Paris (NFS-backed 19.65%, VC-backed 20.59% and PE-backed 14.63%) (Appendix 6). Since we only required the company’s nation to be within our definition of Europe, our sample also includes a limited number of IPOs on stock exchanges outside of Europe such as Nasdaq and New York Stock Exchange. Overall, the NFS-backed IPOs are distributed over 25 stock exchanges in total, VC-backed over 22, and PE-backed over 15.

Appendix 7 reports the distribution regarding three-digit SIC industry codes of the IPOs for each of the three data samples. Our data is skewed towards the two industry groups “Drugs” and “Computer Programming, Data Processing, and other Computer Related Services”. While

the industry category “Drugs” forms the biggest portion of VC-backed IPOs (40.20%), it only comes second for NFS- and PE-backed IPOs, accounting for 17.13% (17.07%) in both sub-sample groups. Vice versa, “Computer Programming, Data Processing, etc.” comes second for VC-backed IPOs, accounting for 28.43% of the sample, and 46.10% (36.59%) of the NFS-(PE)-backed IPOs. Drugs being the biggest sub-industry group of VC-backed IPOs is in line with Gompers (1995), who finds that in biotechnology and medical/health, the proportion of VC-backed companies that are exited via an IPO are exceptionally high in comparison to the proportion of portfolio companies that are exited via IPO in other high-tech industries. According to Gompers (1995), this may reflect either the relative success of VC-backing in these industries or the need for large capital infusions of these companies. Initial Company and Offering Characteristics.

4.2.2 Pre-IPO and Offering Characteristics

Table 1 reports differences in company and offering characteristics for the three different sub-sample groups. We tested differences in the last fiscal year pre-IPO’s sales, total assets and R&D intensity, defined as R&D per assets, as well as company age at IPO and IPO proceeds (per assets). We calculated the company age at IPO by subtracting the calendar year of foundation from the calendar year at IPO, meaning that age at IPO is a rounded value not considering month and day. This approach is in line with Ritter (1991). We focused on the median and Wilcoxon rank-sum test or the Wilcoxon signed-rank test, respectively, to account for skewedness, which is predominant in our operating data, as well as the influence of extreme outliers on the outcome of the Welch’s t-test for relatively small sample sizes. This is similar to prior studies examining operating performance, e.g. Kaplan (1989), Jain and Kini (1995), and Brown (2005). Additionally, Barber and Lyon (1996) supports the uniformly more powerful result generation of using a median-based significance test.

Table 1: Median Statistics pre-IPO and at IPO

	Median			Difference in Median (p-value)		
	VC	**NFS**	**PE**	**VC – NFS**	**VC – PE**	**PE – NFS**
Panel A: Pre-IPO (t_{-1})						
Net sales (in $ thousand)	8,148	6,759	132,646	0.9210	0.0000***	0.0000***
(Observations)	(92)	(348)	(37)			
Total assets (in $ thousand)	17,668	7,408	111,768	0.0000***	0.0000***	0.0000***
(Observations)	(92)	(347)	(37)			
R&D / total assets (in %)	29.17	9.62	7.92	0.0042**	0.0008***	0.7737
Observations	(106)	(57)	(22)			
Panel B: At IPO						
IPO proceeds (in $ thousand)	35,597	9,256	74,609	0.0000***	0.0007***	0.0000***
(Observations)	(89)	(397)	(39)			
IPO proceeds / total assets in t_{-1} (in %)	181.11	120.93	60.02	0.0051***	0.0000***	0.0121**
(Observations)	(81)	(347)	(36)			
Age at IPO (in years)	8	8	13	0.8780	0.0002***	0.0001***
(Observations)	(101)	(356)	(41)			

Median characteristics and number of observations in the last fiscal year pre-IPO (t_{-1}) as well as at IPO for our sample of VC-backed, NFS-backed, and PE-backed European high-tech companies who underwent an IPO between 2001 and 2014. Panel A reports the summary statistics for the last fiscal year pre-IPO (t_{-1}). Panel B reports the summary statistics at IPO. The test for differences (and the corresponding p-value) between the groups is based on the Wilcoxon rank-sum test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

We do not observe a significant size difference prior to IPO (t_{-1}) between median VC-backed companies and NFS-backed companies in net sales but in total assets. Median VC-backed companies roughly have 2.4 times the asset size of NFS-backed companies in their last year prior to IPO. Further, we observe a significant difference between both VC-backed and NFS-backed companies compared to PE-backed companies. Median net sales of PE-backed IPOs are approximately 16 times (6 times for total assets) the size of VC-backed companies and 19 times (15 times for total assets) the size of NFS-backed companies at the end of the last fiscal year prior to IPO. These findings are in line with Levis (2011) who shows that PE-backed IPOs in the UK are four to seven times larger than their VC- and NFS-backed counterparts in terms of total assets and sales.

The R&D intensity is significantly higher for VC-backed companies when compared to NFS-backed as well as PE-backed companies. This is in line with the findings by Bottazzi and Da Rin (2002) for IPOs on the European “new markets”, as well as findings by Brown (2005) for high-tech IPOs in the US. Brown (2005) shows that there is a strong, positive relationship between the total amount of VC received and R&D investment in the fiscal year prior to IPO. Further, Brown (2005) shows that non-VC-backed companies in comparison rely more heavily on short-term debt financing, which is not well suited to finance high-tech investments, particularly R&D. This may indicate that VC-backed companies have accumulated a considerably larger stock of knowledge capital at the time of IPO. Summing up, this can be seen as initial evidence of VC funds relaxing capital constraints for high-tech companies. Another reason for NFS-backed companies displaying lower R&D intensity pre-IPO compared to VC-backed companies may also be due to company’s “window-dressing” their balance sheet just before the IPO. Jain and Kini (1995) argues that the monitoring by VCs may keep companies from performing such measures.

The difference in age at IPO differs significantly between PE-backed IPOs and the other two datasets. While the median company age at IPO for PE-backed companies is 13 years, VC-backed companies and NFS-backed companies reach a median company age of 8 years at IPO, respectively. The observation that PE-backed IPO companies are significantly older at IPO is in line with our initial assumption that PE funds typically invest in mature companies, which are at a very different stage in their company lifecycle than the companies that are typically targeted by VC funds.

Both absolute IPO proceeds and IPO proceeds as a percentage of assets are significantly larger for VC-backed IPOs than for NFS-backed IPOs. This is in line with findings by Megginson and Weiss (1991) and Jain and Kini (1995) for the US market as well as Bottazzi and Da Rin (2002) for the European "new markets", who reports that VC-backed IPOs raised on average 60% more in IPO proceeds. As seen before, a larger portion of our VC-backed sample have their IPO in the pre-financial crisis years, when equity markets peaked. Connecting this to the higher proceeds as a percentage of assets raised by VC-backed companies, it can be interpreted as further evidence that VCs are able to time the market better, helping their portfolio companies to undergo an IPO in "hot" markets, which has a positive effect on IPO proceeds (Lerner, 1994). Further, Megginson and Weiss (1991) shows that VC-backed IPOs face significantly less underpricing than non-VC-backed IPOs which may be another reason why VC-backed companies raise higher proceeds. Interestingly, PE-backed companies obtain the highest absolute IPO proceeds, but the lowest IPO proceeds relative to their asset size prior to IPO (t_{-1}). Levis (2011) finds similar results when studying the UK market and argues that the lower IPO proceeds deflated by total assets can be an indication that PE-backed IPOs are valued more reasonably by investors. This is further supported by the fact that PE-backed companies are at a more mature point of their lifecycle, meaning they display more visible and reliable cash flows than young high growth companies, which makes it easier to value them.

In general, the comparison of VC-backed to PE-backed companies shows that there are significant differences within the group of IPOs backed by financial sponsors, which supports our approach of distinguishing between VC and PE sponsorship. In line with Levis' (2011) study of the UK market, we find evidence that PE-backed companies are larger, more profitable and more mature when compared to VC-backed as well as NFS-backed companies. Since future change in performance is dependent on asset size, age as well as past performance (Barber and Lyon, 1996), a comparison between VC-backed and PE-backed changes in performance post-IPO would not be a meaningful way to analyse the effect of VC-backing on post-IPO performance, since the two groups are very different from the start. Further, the number of observations for PE-backed high-tech IPOs is very limited, which we expected since

PE funds usually target companies with lower risk profiles and stable cash flows. Consequently, we excluded PE-backed companies as a control group from our empirical analysis.

4.3 Selection Issues

Our aim is to study the effect of VC participation on post-IPO performance by comparing a set of similar VC-backed and NFS-backed companies. However, differences in performance may also stem from an initial selection bias and not from the actual services and capital provided by the VC. VC-financing is not randomly distributed since some entrepreneurs are not willing to take it or not able to receive it. One may argue that VCs initially select the most promising start-ups. However, it can also be argued that the best start-ups have other financing options and thus refuse to take capital from VCs as it is very costly, forcing the entrepreneur to give up large stakes in ownership. Further, VC firms tend to focus on specific industries, which might be reflected in company and IPO characteristics like size and age (Gompers and Lerner, 2001). We partially controlled for the distribution of represented industries by solely looking at the high-tech industry for VC-backed as well as NFS-backed IPOs. However, differences in the distribution of high-tech sub categories between VC-backed and NFS-backed companies may still negatively impact the initial comparability of the two sample groups. While there are no significant differences between the age at IPO, and net sales prior to IPO among the two samples, the preceded comparison of company characteristics prior to IPO shows that our VC-backed and NFS-backed samples significantly differ in asset size, R&D intensity, as well as IPO proceeds deflated by assets in t_{-1}.

In addition, we find evidence that VC funds are better at timing the market, helping their portfolio companies to undergo an IPO in “hot” markets. Lerner (1994) further supports this view. Consequently, our two samples are distributed differently over the years 2001 to 2014, which may have an influence on post-IPO performance. On the one hand, an IPO in “hot” markets is likely to be positively related to the amount of proceeds raised, and thus creating a difference in the initial position of our two sample groups as it can be argued that the proceeds raised at IPO affect the resources available to a company to further grow and develop. On the other hand, Coakley et al. (2007) finds evidence for a decline in operating performance of companies aiming to go public in “hot” markets and shows a significant negative relationship between initial returns and post-IPO operating return of VC-backed compared to non-VC-backed IPO performance in the UK.

A third selection issue may arise from VC-backed IPO companies representing the most reputable portfolio companies with the highest return for VCs. In general, only a very small percentage of all VC-backed companies undergoes an IPO. Especially in Europe, the higher

share of portfolio companies is excited via a trade sale (Acevedo et al., 2016). However, companies undergoing an IPO are generally the most promising ones, so a potential selection bias towards more successful companies may also apply to the NFS-backed group.

We aim to control for some of these selection issues with control variables in our regression analysis (section 5.2), while we discuss other issues in the results and limitations of our study (sections 6 and 7).

5 Methodology

5.1 Post-IPO Performance Measurements

The following section gives further insights into the performance measurements used in our empirical analysis. We divided our measures in operating performance and market performance. We included an operating performance measure since it reports a snapshot of the company's current state. Additionally, in contrast to market performance measures it allows us to compare the company's pre- and post-IPO performance. However, the measurement can be influenced by the company, and differences in accounting standards across countries may weaken the measure's comparability. We additionally included a market measure since it reflects a more future-oriented assessment of the company's performance. It furthermore facilitates benchmarking against market indices and thus allows us to look at the company's abnormal return. However, irrational investors could distort the explanatory power of market measures regarding the company's future value. Concluding, we believe that we need to analyse both measures to draw a complete picture of the company's post-IPO performance.

5.1.1 Operating Performance

Our null hypothesis for the operating performance is that the change in profitability post-IPO between VC-backed companies and NFS-backed companies does not differ. By analysing the change in level, we tried to measure whether VC-backed companies improve or worsen their operating performance to a different extent during the first few years post-IPO than NFS-backed companies. Further, we naturally controlled for initial differences in the level of operating performance by comparing the change. When assessing a company's value, investors are interested in the improvement in operating performance, next to the level of operating performance (Jain and Kini, 1994). In this study we focused on the change in levels but also examined the underlying levels of these operating measures. In line with Jain and Kini (1995), we measured operating performance with the help of the profitability ratio operating ROA, calculated as operating income before depreciation and amortization divided by total assets. Operating ROA can be interpreted as a measure of the efficiency of asset utilization (Jain and Kini, 1994).

Since we are limited to FYE data, we cannot clearly attribute any changes in operating performance that we observe between t_{-1} and t_0 to either the time before or after the actual IPO date. Thus, we separately calculated and analysed the change in operating ROA from t_{-1} to t_0 and t_0 to t_3. This allows us to analyse whether any findings observed in the period from t_{-1} to t_0 persist over time. Moreover, we can be certain that any changes observed from t_0 onwards surely have its origin in the post-IPO period. Figure 2 clarifies the issue:

Figure 2: Clarification on the Studied Time Periods for Changes in Post-IPO Performance

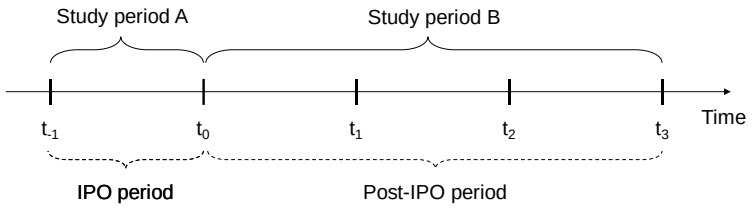


Illustration of the studied time periods for changes in post-IPO performance. t_{-1} to t_3 refer to the respective fiscal year ends of the companies in our sample. IPO period illustrates the period in which the companies in our sample undergo their IPO (between t_{-1} and t_0). *Study period A* refers to the observed period from t_{-1} to t_0. *Study period B* refers to the observed period from t_0 to t_3.

To calculate the changes in operating ROA, we subtracted the median operating return in t_0 from t_{-1} and the median operating return in t_3 from t_0. t_{-1} represents the last fiscal year prior to IPO, t_0 represents the fiscal year of the IPO and t_3 represents the third fiscal year post-IPO. As discussed before, we used the median because operating performance measures may be skewed, and the mean is particularly sensitive to outliers.

5.1.2 Market Performance

In addition to post-IPO operating performance, we analysed whether VC-backed companies exhibit a different post-IPO market performance than NFS-backed companies. Our market performance null hypothesis is that abnormal stock returns between VC-backed companies and NFS-backed companies do not differ. To test this, we measured post-IPO market performance by calculating the subsequent BHR for each IPO. This measure has been used in many previous studies of the long-run aftermarket performance of IPOs (e.g. Ritter, 1991; Loughran and Ritter, 1995; Brav and Gompers, 1997). The BHR can be interpreted as a strategy where a stock is purchased right after going public and held until the earlier of the studied time period or its delisting. To receive abnormal returns, we benchmark BHRs to index returns, which will be further specified below.

In line with previous studies, we applied an event time regime, analysing 36 months post-IPO performance for each IPO. As suggested by Brav and Gompers (1997), we calculated the aftermarket returns by compounding daily returns up to the end of the first trading month after IPO. From then onwards, we compounded monthly returns for 35 months. To ensure that we do not include any issue prices into our analysis, we started the event window of the aftermarket period one day after an equity's base date in Datastream[6]. Since our analysis focuses on the long-term market performance, we excluded the analysis of first-day return, often called underpricing, from our study[7].

[6] The base date is the date from which Datastream holds information about the issue; for the UK the base date is one day before trading in the stock starts. This allows Datastream to store the issue price.
[7] Underpricing and first-day returns are used interchangeably to reflect the relative change from the offer price of an IPO to its closing price on the first day of public trading (Loughran et al., 1994).

The BHR for each IPO company is compounded as follows:

$$BHR_{i,T} = \left[\prod_{t=1}^{T}(1 + R_{i,t})\right],$$

where $R_{i,t}$ denotes the daily return of company i on day t for the first month and the monthly return of company i in month t for the remaining 35 months over the time interval T (36 months)[8]. We used the adjusted daily closing prices, retrieved from Datastream, to calculate the returns. All prices retrieved from Datastream are adjusted for "subsequent capital actions" (Thomson Financial, 2007).

To interpret the median BHRs of VC-backed and NFS-backed IPOs, we adjusted the raw BHRs by a benchmark. We used the corresponding local market index for each IPO, retrieved from Datastream, as a broad equity index benchmark. This approach is largely in line with Rindermann (2003) who uses the respective countries' growth market as an index in a study of the German, French, and British "new markets". The BHR of each index is calculated with the same formula as the BHR of each IPO. Since our IPOs are distributed over 29 stock exchanges, we believe that using the local market index instead of one broad market index for all IPOs as a benchmark is the best method to account for general market-level effects on stock return over time. We calculated the BHAR as follows:

$$BHAR_{i,T} = \prod_{t=1}^{T}\left(1 + R_{i,t}\right) - \prod_{t=1}^{T}\left(1 + R_{m,t}\right),$$

where $R_{i,t}$ denotes the return of company i in period t, and $R_{m,t}$ is the corresponding local market index return of company i in the same period. T is the analysed holding period.

A BHAR greater than zero means that a stock is outperforming its benchmark, in our case the local market, and a BHAR smaller than zero signals the underperformance of a stock compared to its local market index. To compare the VC-backed to the NFS-backed companies we calculated the median BHAR for each sub-sample.

If an equity is delisted before the 36th month, we compounded the return and benchmark index until the delisting month and calculated the BHAR as specified above. By including delisted companies, we limited the influence of survivorship bias. This is line with approaches by Ritter (1991), Loughran and Ritter (1995), and Brav and Gompers (1997). Consequently,

[8] The first month is defined as 21 trading days post the base date (day 2 to day 22). For the remaining 35 months, the closing price of the date on the same day of the month as day 22 is used. If this day happens to be a Saturday or Sunday, the closing price of the following Monday is used.

the time interval T of each BHR calculated is the smaller of the delisting date and the event window, i.e. 36 months post-IPO. We also calculated and compared the BHAR for interim time intervals of 6, 12, 18, and 24 months to analyse potential differences in shorter-term market performance.

5.2 Regression Analysis

To further explore the relationship between VC-backing and the company's post-IPO performance, we applied a multiple ordinary least squares (OLS) regression model. This allowed us to control for other company and issue characteristics influencing post-IPO performance and to ensure that VC-backing is not a proxy for observable sample heterogeneity. Further, even if these observable company and issue characteristics are used in a VC fund's portfolio company selection process, the marginal effect of VC-backing on the companies' performance should primarily capture VC advisory, developing and monitoring activities. Therefore, we included the following explanatory variables in the regressions:

$\mathbf{ln}(\boldsymbol{proceeds_i})$ calculates the natural logarithm of the IPO proceeds of observation i and controls for its potentially positive influence on the post-IPO performance as observed by Jain and Kini (1994). We applied the natural logarithm to show the effect of a 1% increase in the IPO proceeds on the dependent variable.

$\mathbf{ln}(\boldsymbol{age_i})$ calculates the natural logarithm of observation i's age at the time of IPO. Empirical studies by Hall (1987) and Evans (1987) find age to be a key determinate in post-IPO growth. In general, age serves as a proxy for the maturity of companies, with older companies having more tangible assets, more seasoned management teams, and a more extensive and well-established customer base, all of which implies lower growth rates (Krishnan et al., 2011). We applied the natural logarithm of the age to reflect the non-linear relationship between company age and growth (Sutton, 1997).

$\boldsymbol{ln}((\boldsymbol{P/B})_{\boldsymbol{i}})$ calculates the price-to-book (P/B) ratio, calculated as the share price divided by the book value per share, of observation i at the time of IPO. Appendix 2 reports a more detailed description of the variable, including the corresponding item code in Datastream. To avoid the distortional effect of underpricing on the first day of trading (Loughran et al., 1994), we used the P/B ratio of one day after the base date, which is in line with our applied approach to calculating BHARs (section 5.1.2). The issuing company's P/B ratio is commonly used to measure the company's growth opportunities (Brav and Gompers, 1997). Brav and Gompers (1997) shows that IPO companies with a low book-to-market ratio exhibit significant post-IPO underperformance. We applied the P/B measure, which should generally be equal to the market-to-book ratio, the reciprocal of the book-to-market ratio, to control for such differences.

We applied the natural logarithm to show the effect of a 1% increase in the P/B ratio on the dependent variable.

$\boldsymbol{Country_{ij}}$ for $j \in \{1,2\}$ represents a set of two dummy variables taking on the value 1 if the IPO company's nation is either the UK or France, respectively. Appendix 5 shows a dominant representation of data from two IPO companies' nations, together accounting for 58.94% of the NFS- and 46,08% for the VC-backed samples. By applying the dummy variables, we want to control for potential correlations in the dataset on a country level for the two dominant countries. We decided against controlling for each country separately due to the limited number of observations.

$\boldsymbol{SIC_{ik}}$ for $k \in \{1,2\}$ represents a set of two dummy variables taking on the value 1 if the IPO company's three-digit SIC code is either 283 "Drugs" or 737 "Computer Programming, Data Processing, etc.", respectively. Despite our focus on high-tech, our sample still consists of nine different SIC codes, each representing different sub-industry categories of high-tech, which may imply different company and offering characteristics. For example, the size, age, level of tangible assets or R&D intensity may differ significantly between drug or computer programming and data processing focused companies. Appendix 7 shows a dominant representation of data from these two three-digit SIC codes, together accounting for 63.23% of the NFS- and 68,63% for the VC-backed samples. By applying the dummy variables, we want to control for potential correlations in the dataset on a three-digit SIC code level for the two dominant three-digit SIC codes. We decided against controlling for each three-digit SIC code due to the limited number of observations.

$\boldsymbol{Bubble_i}$ represents a dummy variable taking on the value 1 if the company underwent their IPO during the years of 2005 – 2007, and 0 otherwise, which is similar to the approach used by Coakley et al. (2007), who showed that companies experience a stronger underperformance if they undergo an IPO in "hot" markets. Our descriptive statistics display the majority of IPO activity during the years 2005 – 2007, which is similar to the observations by Ritter et al. (2013). By applying the dummy variables, we want to control for potential correlations in the dataset and the IPO during the bubble, i.e. "hot" market, years.

$\boldsymbol{VC_i}$ is a dummy variable taking on the value 1 if the IPO has been classified as VC-backed, and 0 otherwise. A significant estimate for β_3 can then be interpreted as a significant correlation between the VC sponsorship and the (improvement in) post-IPO performance. This approach is in line with previous papers analysing post-IPO performance of VC-backed companies like Brav and Gompers (1997) for post-IPO market performance or Jain and Kini (1995) for post-IPO operating performance.

Additionally, we would add R&D intensity in t_{-1}as an additional control variable to the regression since we see significant differences between the samples (section 0, Table 1). However, we ultimately decided against it because the limited number of observations for this variable would decrease the validity of the regression results.

$$P_{it} = \beta_0 + \beta_1 \ln(proceeds_i) + \beta_2 \ln(age_i) + \ln((\mathrm{P/B})_{\mathrm{i}}) + \sum_{j=1}^{2} \beta_{3\mathrm{j}} Country_{ij} + \sum_{k=1}^{2} \beta_{4\mathrm{k}} SIC_{ik} + \beta_5 Bubble_i + \beta_3 VC_i + u_i$$

represents the multiple OLS model, where β_n represents the regression coefficients, and u_i represents the error term. Observations are excluded if one of the variables is missing. $\boldsymbol{P_{it}}$ stands for the dependent variables of the regression, measuring post-IPO performance for observation i and a time period t. For post-IPO operating performance, our measure is the change in operating ROA from the last fiscal year pre-IPO to t fiscal years post-IPO (as introduced in section 5.1.1). A positive P can be interpreted as an improvement in the company's operating performance. Our measure for post-IPO market performance is BHAR for a time period t of the shorter of 36 months post-IPO or the date of delisting (as introduced in section 5.1.2). We excluded 1% and 99% levels for our dependent variables to limit the effects of outliers on our results. This approach is in line with Brown (2005).

The use of control variables to account for different characteristics between the two data samples enabled us to bypass a Megginson and Weiss (1991) matched-pair methodology to construct a matching sample of VC-backed and NFS-backed IPOs. To further support this approach, we refer to Jain and Kini (1995) who reports qualitatively similar regression results for both matched, according to IPO proceeds and industry (three-digit SIC codes), and unmatched samples. The limited size of our data sample does not support initially controlling for every year, country, and three-digit SIC code.

6 Results and Analysis

6.1 Post-IPO Performance

6.1.1 Level of Operating Performance

We focused our comparison of post-IPO operating performance on the change of operating ROA, meaning that we aim to study whether VC-backed companies change, i.e. improve or worsen, their operating ROA to a significantly different extent than NFS-backed companies. Our results aim to help answering the question whether VC sponsorship improves a company's post-IPO operating performance, creating a lasting value for its portfolio companies.

Before we begin comparing changes in post-IPO performance between VC- and NFS-backed companies, we took a look at differences in the level of operating ROA for the last fiscal year pre-IPO (t_{-1}), the fiscal year of the IPO (t_0), as well as the first three complete fiscal years post-IPO (t_1 to t_3). Table 2 reports our findings:

Table 2: Median Statistics for Operating ROA

	VC	NFS	p-value
Operating ROA (in %)			
t_{-1}	-21.38	7.85	0.0000***
(Observations)	(91)	(343)	
t_0	-13.65	4.03	0.0004***
(Observations)	(98)	(360)	
t_1	-17.44	1.31	0.0005***
(Observations)	(98)	(362)	
t_2	-11.81	3.30	0.0013***
(Observations)	(95)	(343)	
t_3	-12.10	4.22	0.0004***
(Observations)	(87)	(319)	

Median statistics and number of observations for operating ROA in the last fiscal year pre-IPO (t_{-1}), the fiscal year of the IPO (t_0), as well as the first three complete fiscal years post-IPO (t_1 to t_3) for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. Operating ROA equals operating income before depreciation and amortization deflated by total assets. The test for differences (and the corresponding p-value) between the two groups is based on the Wilcoxon rank-sum test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

Table 2 shows significant differences between the median statistics for operating ROA of the VC-backed sample and the NFS-backed sample. The median VC-backed company generates a consistently negative ROA for all fiscal years observed, while the median NFS-backed company generates a consistently positive return. To better understand where the initial difference in t_{-1} may stem from, we took a look at the afore reported sales, R&D, and asset figures in t_{-1} (section 0, Table 1). By looking at the values for t_{-1}, we see that VC-backed companies show lower median sales and higher R&D intensity, which may explain the lower observed operating ROA for the VC-backed sample. Jain and Kini (1995) as well as Bottazzi and Da Rin (2002) report similar findings in the pre-IPO period for their US and European samples, respectively. Although their VC-backed samples in comparison exhibit positive returns, they are also significantly lower than for their non-VC-backed sample. Brown (2005), who focusses on the US high-tech industry, also reports a median negative ROA for the VC- and a median positive ROA for the non-VC-backed sample in the fiscal year pre-IPO.

Furthermore, Bottazzi and Da Rin (2002) continues to observe significantly lower levels of ROA for up to three years post-IPO as well.

These similarities of findings in the pre-IPO period enable us to build upon Jain and Kini (1995)'s interpretation. The significantly lower operating ROA as well as significantly higher R&D spending deflated by assets observed in Table 1 in section 0 could origin from the fact that VCs prevent their portfolio companies to improve their accounting numbers before the IPO to attract higher valuations and proceeds from investors. The higher IPO proceeds observed in Table 1 in section 0 further support this argument and could imply that investors assign a positive value to these expenses instead. Connecting the argument, that lower returns and higher R&D expenditures characterise the early growth phase of a company lifecycle, to the findings by Brav and Gompers (1997), who concludes that investors favour young and high-growth companies, it can be argued that VC funds encourage their portfolio companies to keep their R&D expenditures at a high level to accelerate growth in order to achieve higher investor valuations and higher IPO proceeds.

An additional explanation may be that VC-backed companies are able to afford higher spending and lower returns since the VC fund removes some of the capital constraints that young and investment-intensive companies face pre-IPO. This may hold especially for high-tech companies facing high R&D investment and employee expenses (Brown, 2005). Contrarily, NFS-backed companies may have limited resources to invest and thus are incentivised to improve their profitability from early on to generate their own cash flows to finance innovation and growth.

6.1.2 Change in Operating Performance

Since we are interested in the difference in improvement of long-term post-IPO operating performance between the two samples, we continued our comparison with the median change in operating ROA and its main drivers. Since we cannot certainly attribute any of the changes in operating performance observable between t_{-1} and t_0 to either the period prior or post the actual IPO date, we analyse the period from t_{-1} to t_0 and t_0 to t_3 separately. This also allows us to analyse the changes happening when the companies move from private to public. The results are reported in Table 3:

Table 3: Median Change in Operating ROA and its Main Drivers

	Years relative to completion of IPO					
	t_{-1} to t_0			t_0 to t_3		
	VC	NFS	p-value	VC	NFS	p-value
Median change in operating ROA (in %)	4.48	-2.85	0.0000***	-6.73	-0.75	0.0060***
(Observations)	(91)	(326)		(85)	(298)	
Net sales growth (in %)	35.28	22.76	0.5263	66.96	67.87	0.4507
(Observations)	(86)	(331)		(82)	(290)	
R&D growth (in %)	38.47	23.58	0.2595	58.21	43.33	0.3002
(Observations)	(54)	(82)		(55)	(84)	
Total asset growth (in %)	152.97	101.39	0.0404**	17.07	45.51	0.0108**
(Observations)	(91)	(336)		(85)	(293)	

Median change/ growth rates and the number of observations of operating ROA and its main drivers for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. Operating ROA equals operating income before depreciation and amortization deflated by total assets. Net sales growth equals the growth in net sales and is calculated as the net sales of the respective t divided by the net sales of t_{-1} minus 1. R&D growth and asset growth are calculated using the same method as for net sales growth and can be interpreted accordingly. Year t_{-1} equals the last fiscal year pre-IPO. The test for differences (and the corresponding p-value) between the two groups is based on the Wilcoxon rank-sum test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

The results in Table 3 show significant differences in the change of operating performance for the median VC-backed company compared to the median NFS-backed company from t_{-1} to t_0, as well as from t_0 to t_3. While the median VC-backed company substantially improves its profitability from t_{-1} to t_0 by 4.48%, the median NFS-backed company decreases its profitability by 2.85%. Furthermore, while both sample groups decrease their profitability from t_0 to t_3, VC-backed companies decrease it to a significantly larger extent (-6.73% vs. -0.75%).

Neither net sales growth nor R&D growth are able to help us explain the significantly higher improvement in profitability of VC-backed companies from t_{-1} to t_0 since neither exhibits a significant difference in growth between the two data samples. Furthermore, total assets of VC-backed companies even grow significantly more than NFS-backed companies from t_{-1} to t_0, which means that VC-backed companies need to grow their sales per assets or decrease their operating costs per assets or both to a significantly larger extent than NFS-backed companies. The significantly higher growth in total assets may to a large extent be caused by the higher IPO proceeds of VC-backed companies. Since we do not observe any significant difference in sales growth, it seems that a significantly higher decrease in operating costs (excluding R&D expenses) for the VC-backed companies allowed operating ROA to improve by such high levels. However, especially the limited number of R&D observations limits its interpretability, as does the general fact that we have different number of observations for every figure. Consequently, our analysis should only be seen as indicative rather than confirming. Further, as mentioned previously, the change in performance from t_{-1} to t_0 has a limited interpretability since the actual period between the IPO date and FYE may vary largely among the companies.

Capital constraints of young and high growth high-tech companies potentially explain the negative development in operating ROA of NFS-backed companies (Brown, 2005). As discussed earlier, we expect NFS-backed companies to be more capital constrained pre-IPO,

which forces them to generate sales and to limit their expenses and investments, ultimately aiming to operate profitable from early on. Our previous findings in Table 1 in section 0 show for t_{-1} that the median NFS-backed company in our sample has lower total assets, higher sales per assets, lower R&D spending per assets, and a positive operating ROA pre-IPO. When moving from private to public, we expect the existing capital constraints for NFS-backed companies to relax. Although we are not able to attribute the negative change in operating ROA to a specific driver, the overall trend serves as an indication that the IPO allows NFS-backed companies to increase operating costs, including investments into R&D, to a relatively higher extent than net sales, resulting in a negative change in operating ROA.

Although the negative development in post-IPO operating performance from t_0 to t_3 for both of our samples is in line with Jain and Kini's (1995) findings, the paper observes VC-backed companies to worsen their operating ROA less than NFS-backed companies. Furthermore, Jain and Kini (1995) are able to mainly attribute the significantly better change in operating ROA of VC-backed companies to significantly higher sales growth rates for VC-backed companies. Since we only observe a significantly negative difference in asset growth for VC-backed companies, we are not able to explain the significantly higher negative change in operating ROA. One potential reason for this significantly more negative development in operating performance of VC-backed companies might be related to overinvestments, which lead to a rise in competition, negatively impacting sales, and ultimately returns. Especially the high-tech industry often faces overinvestments, with competitors rushing to simultaneously implement new technology (Jensen, 1993). Since we see differences in industry concentration among our two data samples, overinvestment might be especially persistent in high-tech industries with a high concentration of VC (Appendix 7). Jain and Kini (1995) does not focus its analysis solely on the high-tech industry and thus especially the paper's VC-backed sample might not be as affected by overinvestments as ours. Another reason builds up on Brown's (2005) argumentation that the focus of VC funds on short-term return maximization might ultimately hurt the company's long-term performance.

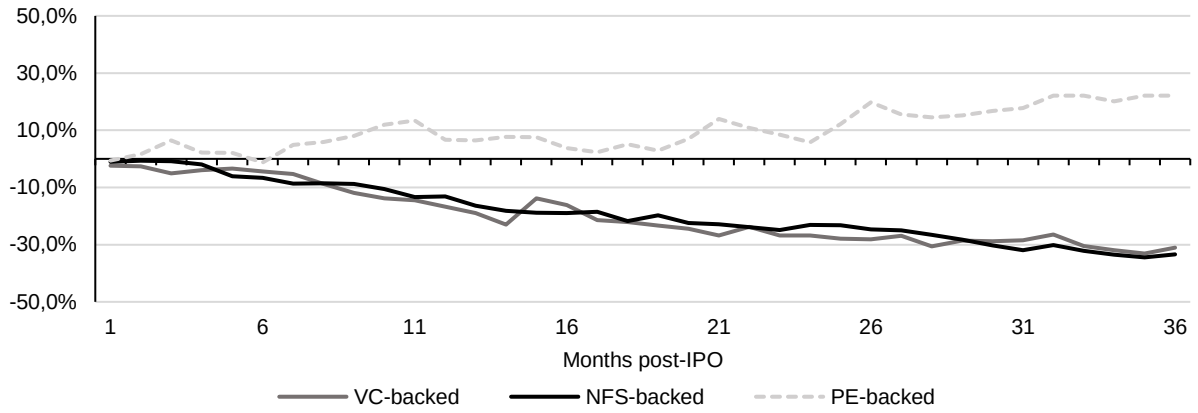
To conclude, the evidence leads to our initial conclusion to reject our null hypothesis $H_{O\text{-}Operating}$. VC-backed companies improve their operating ROA to a significantly larger extent from t_{-1} to t_0 and worsen their operating ROA to a significantly larger extent from t_0 to t_3 when compared to NFS-backed companies. This can be seen as an initial evidence that VC sponsorship significantly improves the company's change in operating performance in the year of IPO but fails to uphold this improvement in the long-run. However, at this point, we cannot be sure if this difference in operating performance is primarily driven by the VC's participation, or other factors that may be related to operating performance, such as the significantly higher IPO proceeds raised by VC sponsored companies. To further explore the relation between VC

sponsorship and post-IPO performance, we performed a regression to control for cross-sectional factors influencing our results (section 6.2.1).

6.1.3 Market Performance

We additionally compared the market performance of VC-backed companies with NFS-backed companies for three years post-IPO. We calculated BHARs on a monthly basis for the 36 months post-IPO period. However, the implicit holding period is below 36 months as some of the companies delisted before the 36th month post-IPO. The average holding period for the NFS-backed companies is approximately 35.1 months and 35.5 for VC-backed. Figure 3 visualizes their performance. For illustrative purposes, the figure includes the median BHAR of PE-backed companies, who have an implicit average holding period of 35.0 months.

Figure 3: Median BHARs for the 36-Months Post-IPO Period



Median BHARs for the period of 36 months post-IPO for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. For illustrative purposes, we additionally report the median BHARs of our sample of European PE-backed high-tech companies who underwent an IPO between 2001 and 2014. The BHAR can be interpreted as the comparison of a strategy where the stock is purchased right after going public and held until the earlier of the studied time period or its delisting and a strategy where the corresponding stock market index is purchased at the same date and held until the earlier of the studied time period or the corresponding company's delisting. Concluding, a BHAR greater than zero means that a stock is outperforming its corresponding local market index, and a BHAR smaller than zero signals the underperformance of a stock compared to its local market index.

Figure 3 indicates for both, VC-backed and NFS-backed IPOs, an underperformance compared to the respective local market indices in every of the 36 months post-IPO, since the BHARs is continuously below 0%. Furthermore, the median level of underperformance increases as time passes, reaching an underperformance level of more than 30% in the 36th month. The figure indicates similar abnormal returns for the VC-backed and NFS-backed IPOs.

In addition to the graph, Table 4 reports significance test statistics for the median BHARs in the 36 months post-IPO period to confirm the indicative findings in Figure 3. We tested the difference to zero (left side of the table), to test for significant under- or overperformance when compared to the benchmark and the difference between the three sub-samples (right side of the table), to test for potential significant outperformance of one sample group when compared to each other. The results are reported for 6, 12, 18, 24, 30, and 36 months post-IPO.

Table 4: Median BHAR Statistics

	Median			Difference in Median (p-value)		
	VC	NFS	PE	VC – NFS	VC – PE	PE – NFS
Months post-IPO						
6	-0.0446	-0.0660	-0.0125			
p-value	0.0000***	0.0000***	0.6116	0.9158	0.2329	0.1909
12	-0.1666	-0.1315	0.0670			
p-value	0.0000***	0.0000***	0.0004***	0.8320	0.0293**	0.0268**
18	-0.2208	-0.2174	0.0515			
p-value	0.0000***	0.0000***	0.1270	0.9755	0.0045***	0.0070***
24	-0.2684	-0.2315	0.0577			
p-value	0.0000***	0.0000***	0.6116	0.4759	0.0014***	0.0050***
30	-0.2882	-0.3027	0.1678			
p-value	0.0000***	0.0000***	0.0000***	0.9202	0.0010***	0.0007***
36	-0.3108	-0.3344	0.2211			
p-value	0.0000***	0.0000***	0.0004***	0.7274	0.0004***	0.0002***

Summary statistics for median BHARs for 6, 12, 18, 24, 30, and 36 months post-IPO for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. For illustrative purposes, we additionally report the median BHARs of our sample of European PE-backed high-tech companies who underwent an IPO between 2001 and 2014. The BHAR can be interpreted as the comparison of a strategy where the stock is purchased right after going public and held until the earlier of the studied time period or its delisting and a strategy where the corresponding stock market index is purchased at the same date and held until the earlier of the studied time period or the corresponding company's delisting. Concluding, a BHAR greater than zero means that a stock is outperforming its corresponding local market index, and a BHAR smaller than zero signals the underperformance of a stock compared to its local market index. The test for differences (and the corresponding p-value) on the left side of the table tests for significant differences from zero and is based on the Wilcoxon signed-rank test. The test for differences on the right side of the table tests for significant differences between the groups and is based on the Wilcoxon rank-sum test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

The findings in Table 4 confirm the indicated significant underperformance to the respective local market indices for both VC-backed and NFS-backed companies in Figure 3 as well as the similar development of both data samples. The significant underperformance of VC-backed and NFS-backed IPOs to the respective local market indices is consistent with prior studies documenting the general long-run underperformance of IPOs (Ritter, 1991; Loughran and Ritter,1995). Ritter (1991) shows that the underperformance is predominantly driven by relatively young growth companies, which may explain the significant underperformance observed for both of our samples. Studying the German, French and British growth markets, Rindermann (2003) also finds median abnormal returns in all three countries underperforming the respective growth market index in the three years following the IPO. However, it should be noted that our study, as well as the one by Rindermann (2003), only employed stock market indices for the calculation of abnormal returns. Thus, it cannot be confirmed whether the underperformance persists when portfolios of the same size or book-to-market ratio, as suggested by multiple previous studies, are built. For example, Brav and Gompers (1997) finds that the underperformance is especially driven by small and low book-to-market companies.

The comparison to the PE-backed sample puts our results further into perspective. The sample's 36 months BHR significantly outperforms the corresponding local market indices on a median level. This supports the afore mentioned interpretation of the underperformance of VC- and NFS-backed companies. As previously stated in section 0, PE-backed companies are on a median level over 60% older at IPO, as well as 15 to 19 times larger in sales and 6 to 15 times larger in assets at the FYE prior to IPO. This is in line with Levis (2011), who studies the

three-year aftermarket performance of IPO companies by comparing VC-backed, PE-backed and NFS-backed IPOs on the London Stock Exchange. According to Levis' (2011) findings, PE-backed IPOs outperform market benchmarks over a period of 36 months, while VC-backed and NFS-backed IPOs underperform. The paper links these differences in aftermarket performance to differences in market size and key operating characteristics at the time of IPO. According to Levis' (2011) and our evidence, PE-backed IPOs are larger in terms of sales and assets, more profitable, and more reasonable valued with lower IPO proceeds per total assets, leading to a better aftermarket performance in comparison to VC- and NFS-backed IPOs as well as the entire market.

As mentioned before, when comparing VC-backed to NFS-backed IPOs we do not observe any significant difference in the level of underperformance. On the one hand, this is inconsistent with findings of Brav and Gompers' (1997) study on the US market, who discovers a significant outperformance of VC-backed companies over NFS-backed companies in the aftermarket, when using equally-weighted returns. On the other hand, our results are in line with previous studies of European markets (Rindermann, 2003; Levis, 2011). Therefore, potential reasons for the lack of significantly superior post-IPO market performance of VC-backed compared to NFS-backed IPOs are market differences between Europe and the US. Rindermann (2003) argues that a difference in quality among VCs investing into European companies is the cause for the lack in performance differences by showing that IPOs backed by international VCs display significantly higher three-year abnormal returns than IPOs backed by national VCs.

Summing up, we cannot reject our null hypothesis $H_{0\text{-}Market}$ of VC-backed companies having significantly different abnormal returns 36 months post-IPO compared to NFS-backed companies at this point. For further validation, we performed a regression to control for potential cross-sectional characteristics, such as the P/B ratio or the age at IPO, influencing our results (section 6.2.1).

6.2 Robustness Checks

The previous analyses are suggestive in rejecting our post-IPO operating and confirming our post-IPO market performance null hypotheses from section 3.3. However, the results cannot be considered conclusive at this point. Thus, we performed a variety of checks to validate the significance of our results.

6.2.1 Regression Analysis

First, we conducted a multiple OLS regression to control for company and offering characteristics, as introduced in section 5.2, in order to further validate the role of VC-backing on post-IPO performance. Table 5 reports selected results of the OLS regression for our

primary operating and market performance measure, respectively. The OLS regression for operating performance focusses on the change in operating performance from t_{-1} to t_0 as well as t_0 to t_3. The OLS regression for market performance focusses on the BHAR for 36 months post-IPO. As mentioned before, we excluded the 1% and 99% levels for our dependent variables to reduce the influence of skewedness and outliers on our regression results.

Table 5: OLS Regression for Primary Measures of Post-IPO Performance

Dependent variables	**Operating ROA**		**BHAR**
Independent variables	**t_{-1} to t_0**	**t_0 to t_3**	**36 months**
Intercept	0.2107	0.0173	-0.2961
p-value	0.0507*	0.7849	0.0650*
$\ln(proceeds_i)$	-0.0032	-0.0099	0.0082
p-value	0.8490	0.3364	0.7428
$\ln(age_i)$	-0.1128	0.0000	0.0755
p-value	0.0016***	0.9988	0.1574
$\ln((P/B)_i)$	-0.0064	0.0324	-0.0470
p-value	0.8403	0.0609*	0.2645
$Country_{iUK}$	0.2146	-0.0775	-0.1221
p-value	0.0007***	0.0415**	0.2119
$Country_{iFrance}$	0.0429	-0.0748	0.1150
p-value	0.5846	0.1033	0.3410
SIC_{i737}	-0.1150	-0.0214	0.1240
p-value	0.0710*	0.5690	0.2087
SIC_{i283}	0.1600	-0.0611	0.2454
p-value	0.0271**	0.1533	0.0327**
$Bubble_i$	0.0818	-0.0115	0.0032
p-value	0.1570	0.7392	0.9711
VC_i	0.1194	-0.0953	-0.1482
p-value	0.0952*	0.0277**	0.1854
Adjusted R^2	0.1143	0.0379	0.0167
F-value	5.6582	2.3006	1.6569
Degrees of freedom	316	288	339

Results for the multiple OLS regression analysis for our primary performance measures, operating ROA and BHAR, for our cleaned sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. We excluded the 1% and 99% levels for our dependent variables to reduce the influence of skewedness and outliers on our regression results. The variable $\ln(proceeds_i)$ represents the natural logarithm of the IPO offer amount. The variable $\ln(age_i)$ represents the natural logarithm of the company age (in years) at time of IPO. The variable $\ln((P/B)_i)$ represents the natural logarithm of the price-to-book equity ratio at the time of IPO. The market value is the closing price of the second day of trading. The $Country_i$ variables represent dummy variables taking on the value 1 if the IPO company's headquarters are located in that country (either UK or France), and 0 otherwise. The SIC_i variables represent dummy variables taking on the value 1 if the IPO company operates in the specific three-digit SIC code (either 737 or 283), and 0 otherwise. The $Bubble_i$ variable represents a dummy variable taking on the value 1 if the company underwent their IPO during the years 2005 – 2007, and 0 otherwise. The variable VC represents a dummy variable taking on the value 1 if the IPO has been classified as VC-backed, and 0 otherwise. The results are estimates for the β_n coefficients and can be interpreted as the change of the dependent variable if the related independent variable increases by 1, all other variables equal. The p-value is the significance level for each estimate and is based on the student's t-test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level. The adjusted R^2 can be interpreted as the fraction of the variation in the dependent variable that is accounted for by the independent variables. It is adjusted to increase only if the addition of a new independent variable improves the model more than adding a random variable and decreases otherwise. The F-value tests for the overall significance of the regression analysis. The degrees of freedom represent the number of observations.

Table 5 exhibits significant relationships between the VC dummy and the change in post-IPO operating performance. If a company is VC-backed, its change in operating ROA increases from t_{-1} to t_0 by 11.94 percentage points, all other variables controlled for equal. From t_0 to t_3, the change in operating return of a company decreases by 9.53 percentage points if it is VC-backed, all other variables controlled for equal. Furthermore, the results do not exhibit a significant relationship between the VC dummy and the 36 months BHAR. We neglect significant relationships between other control variables and the dependent variables because of their limited interpretability.

The results confirm our initial indication that VC-backing is significantly positively related to the change in operating performance, measured as operating ROA, from t_{-1} to t_0 and significantly negatively related to the change in post-IPO operating performance from t_0 to t_3. Furthermore, the results regarding the 36 months BHAR confirm our initial indication that VC-backing is not significantly related to post-IPO market performance. The results for all dependent variables are robust after controlling for IPO proceeds, age, P/B ratio, country effects for the UK and France, SIC code effects for 737 and 283, as well as bubble year effects. Considering these results, we can reject our post-IPO operating performance null hypothesis and accept our post-IPO market performance null hypothesis.

To further confirm our results, we also considered alternative measures of post-IPO performance. For operating performance, we also calculated the operating cash flow on assets (CFOA), defined as operating income before depreciation and amortization minus capital expenditures divided by assets[9]. Jain and Kini (1994) argues that this measure is useful when analysing operating performance since operating cash flows are a primary component in net present value calculations used to value companies. In line with our previous analysis, we ran a regression on the change in operating CFOA from t_{-1} to t_0 and from t_0 to t_3. The results are qualitatively similar, with the only difference being that the positive relation of VC-backing on change in operating performance from t_{-1} to t_0 is not significant anymore. Furthermore, we studied the P/B ratio for 36 months post-IPO. Comparing the P/B ratios between VC-backed and NFS-backed IPOs allows us to compare whether the market expects a difference in future profitability and earnings growth between the two groups (Jain and Kini, 1994). In line with the previous results on post-IPO market performance we do not see any significant relation between VC-backing and the P/B ratio. Appendix 8 reports the detailed regression results.

6.2.2 Survival Bias

Additionally, we analysed the survival profiles of both groups to make sure that different failure rates do not influence our initial results. Although, as previously mentioned, we partially controlled for survivorship bias by including all companies into our analysis until they become inactive, different failure rates may still have an influence on the difference in post-IPO performance. Further, Klepper (2002) notes that performance measures like profitability, size and growth are closely related to the survivorship of a company. Hence, if our survival analysis yields not significantly different failure rates for VC- and NFS-backed IPOs, it can be considered as a further support of VC-backed companies not performing differently to NFS-backed companies post-IPO.

[9] Appendix 2 further defines operating income before D&A, capital expenditures and assets.

We aim to assess the survival profile of VC-backed and NFS-backed IPO companies by comparing cumulative exit rates three years post-IPO. We defined survivors in line with Jain and Kini (2000) solely as companies operating independently. This approach treats acquired companies as failures since they are typically distressed. Consequently, by defining all companies that delist, get acquired, or merge as failures, our survival analysis should be understood as being a proxy of failure and not a representation of actual failure. The Datastream items used for our survival analysis are the company inactive date and the reason why the company became inactive, e.g. delisted, acquired or liquidated.

Table 6 shows the cumulative exit rates and the share of exits caused by an acquisition at three years after the IPO for the VC- and NFS-backed companies:

Table 6: Cumulative Exit Rates

	VC	NFS
Cumulative exit rate three years post-IPO (in %)	6.86	6.55
(Observations)	(102)	(397)

Cumulative exit rates three years post-IPO (in %) and the number of observations for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. The time until exit is calculated by subtracting the IPO date from the delisting date. The cumulative exit rate is calculated as the amount of companies with a time until exit of below three divided by the total amount of companies.

The results in Table 6 report only slightly higher survival rates for VC-backed companies. Three years post-IPO, 6.86% of VC-backed IPOs are inactive, compared to 6.55% of NFS-backed ones. The small difference in the survival rate between VC-backed and NFS-backed companies further supports the overall robustness of our initial findings. Moreover, it serves as an additional indication that VC sponsorship is not positively related to post-IPO performance, since we do not observe VC-backed companies surviving substantially longer than NFS-backed companies.

7 Discussion

7.1 Main Findings

We developed our research question whether VC-backing is positively related to the long-term post-IPO performance of companies to contribute to the clarification of the broader question whether VC funds create lasting value for European high-tech companies. To help answer this question, the empirical analysis focused on a comparison of the operating and market post-IPO performance of VC-backed companies and NFS-backed companies.

Our results indicate no significant difference in post-IPO market performance between the two groups. Analyses on operating performance even yield a negative difference in the post-IPO development between VC-backed companies and NFS-backed companies. Consequently, we cannot confirm that VC-backing is positively related to long-term post-IPO performance. Ultimately, our results yield no indication that VC funds create lasting value for European high-tech companies.

A main identified potential reason for VC-backing not being positively related, or even negatively related to long-term post-IPO performance for European high-tech companies in our empirical analysis is that the high-tech industry is especially prone to overinvestments, which increases the competition within specific segments, and ultimately has a negative effect on sales and returns. Since we see differences in industry concentration among our two groups, overinvestment might be especially persistent in high-tech industries with a high concentration of VC. Moreover, the services provided by VC funds to European companies may lack in quality, limiting the potential value created.

Based on our background information of the VC industry and its role for high-tech companies, we can identify three different origins of the positive relationship between VC sponsorship and post-IPO performance. First, VC funds may have the network and screening practices in place that enable them to select the best start-ups from the beginning. Second, the screening, financing, monitoring, and advise provided by a VC to its portfolio company pre-IPO, may have allowed the portfolio company to have a skilled management team and board of directors in place, promising products in a well-defined market, and access to potential client and supplier contacts. Third, VC funds might continue to stay actively involved post-IPO, which may lead to continued value creation through monitoring and advise services.

These three origins are not exclusive and can jointly lead to a positive relationship between VC sponsorship and post-IPO performance. Since we cannot or did not directly measure any of them, we would expect these to be reflected in superior post-IPO performance. However, we do not observe any superior post-IPO performance of VC-backed high-tech companies in Europe. Thus, the following arguments provide potential reasons why the three origins do not

lead to a positive relationship between VC sponsorship and post-IPO performance. First, Europe may be lacking "superstars" among start-ups and entrepreneurs, not allowing VC funds to invest into the best companies from the start. Second, the experience, reputation and ultimately quality of services provided by the VC funds will heavily impact whether monitoring and advice services create a lasting value to its portfolio companies. A lack in experience may also limit a VC fund to invest in the most promising start-ups or cause them to jump on the wrong trends. Third, it may be the case that VC funds do not tend to stay actively involved for a certain time post-IPO in their former portfolio companies, and rather sell their stake as soon as legal boundaries allow them to do so. The literature showing evidence for a continued active post-IPO involvement of VC funds stems largely from the US, and we could not find any evidence for Europe.

7.2 Limitations and Future Research

In this section, we list the main limitations to our study, and give suggestions for further research. First, we did not differentiate between the experience, reputation, and other characteristics of VC funds, which may enable one to better assess the quality of services provided as well as its impact on long-term performance. Krishnan et al. (2011) and Rindermann (2003) show that experience and reputation of VC funds have a significant influence on post-IPO performance. Furthermore, Brigl and Liechtenstein (2015) indicates especially large quality differences between VC funds in Europe, with some outweighing the positive effects of others.

Second, by using cross-country data we analysed Europe as one single VC market. However, Bottazzi and Da Rin (2002) and Rindermann (2003) argue that Europe is not one real VC market, but rather an aggregation of several markets. We did not perform any comparison of European countries due to the small number of observations per country and cannot confirm whether the European VC market became more integrated within the last two decades.

Third, we did not consider ownership stakes and board positions held by the VC pre- and post-IPO. We also did not have any information when exactly VCs exit their portfolio companies and how long they still hold board positions. As shown by Krishnan et al. (2011) more active post-IPO involvement of VC funds in the corporate governance of their portfolio companies has a significant positive relationship with the long-run post-IPO performance. This type of information could potentially be collected by hand from IPO prospectuses and published annual reports post-IPO. However, due to timing constraints, this was out of scope for our thesis.

Fourth, our study disregarded the different types of VC firms and funds, and respective representation in Europe. As mentioned in our background information about the European VC market, public resources provide a significantly larger share of investments into VC funds in Europe than in the US. This may influence the level of risk taking of VC firms in Europe. Kraemer-Eis et al. (2016) argues that public capital is often used to finance opportunities that would have otherwise been disregarded by private capital because of a higher risk aversion.

Summing up, to further draw conclusions on the effect of VC sponsorship on post-IPO performance in Europe, future studies could focus their empirical research on the heterogeneity between different characteristics of VC funds, European regions and nations, LPs, as well as ownership stakes and board positions pre- and post-IPO, respectively. Moreover, it could also be interesting to carry out a side by side comparison between Europe and the US to gain more knowledge about potential causes for the difference in long-term value creation of VC sponsorship in Europe vs. the US.

8 Conclusion

The objective of this thesis was an empirical investigation whether VC-backing is positively related to the long-term post-IPO performance of companies and thereby aims to contribute to the clarification of the broader question whether VC funds create lasting value for European high-tech companies. We empirically tested the phenomena of VC-backed companies performing superior to non-VC-backed companies post-IPO for a cleaned dataset comprising 102 VC-backed IPOs and 397 NFS-backed IPOs of European high-tech companies that went public in the period between 2001 and 2014.

Our study measured long-term post-IPO performance through operating as well as market performance measures. We measured post-IPO operating performance through improvements in operating ROA and calculated the change in ROA from the last fiscal year pre-IPO to the year of IPO, as well as from the year of IPO to three fiscal years post-IPO. We observe a significant positive relation between VC sponsorship and improvements in operating performance, while the companies move from private to public, but a significantly negative association of VC-backing with change in operating performance for the period of the year of IPO to three fiscal years post-IPO. Further, we measured post-IPO market performance through 36 months BHARs using local market indices as a benchmark. We did not observe any significant performance difference between VC-backed and NFS-backed IPOs, with both sample groups underperforming its corresponding benchmarks.

Next, we tested the robustness of our findings by controlling for the potential influence of cross-sectional factors, using the afore mentioned measures of post-IPO performance as dependent variables and a VC dummy as our independent variable, while controlling for age, proceeds, P/B, industry, country and year of IPO effects. The regression results confirm our initial findings and can thus be interpreted as further evidence of European high-tech VC-backed companies not outperforming NFS-backed companies post-IPO, apart from the fiscal year in which the companies move from private to public. Additional analyses of alternative measures of operating and market performance as well as the survival profile of VC-backed and NFS-backed companies largely confirm the robustness of our results and concludingly our initial result.

On the one hand, our findings are similar to previous papers examining the European VC market around the dot-com bubble without focusing on the high-tech industry. On the other hand, our findings differ to previous literature that examine the US market and show that VC-backed IPOs perform superior to non-VC-backed IPOs post-IPO, also for high-tech companies in specific. Identified potential reasons are a lower quality of the services provided by VC funds

in Europe to their portfolio companies or a shortage of “superstars” among European high-tech start-ups.

An extension to our work could be the examination of differences in VC firm and their impact on post-IPO performance, the VC fund’s post-IPO stake, board representation and final exit strategy, as well as a comparison among different European nations and regions or between the European and US market.

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Appendix

Appendix 1: Summary Table of Variables Retrieved from SDC

Name	Description
Panel A: SDC - New Issues database	
Issue date	Pricing date of the issue of each company
Date founded	Date on which issuing company was founded
VC-backed IPO issue flag	Whether the issuing company was VC-backed at the time of the IPO (Yes or No)
PE-backed IPO issue flag	Whether the issuing company was PE-backed at the time of the IPO (Yes or No)
Issuer	Name of each issuing company
Main SIC code	Primary SIC code of each issuing company
Nation	Nation of each issuing company
Proceeds amount – sum of all markets in $ million	Proceeds each issuing company raised through the IPO in million USD
Spinoff's parent	Name of the spinoff parent of each issuing company. Empty if IPO is not a spinoff. A spinoff is defined as an IPO by a company representing ownership in a division or subsidiary of the company that will now trade separately from its parent. Parent must own at least 50% of spinoff company prior to the issue.
Panel B: VentureXpert - Portfolio Company Disbursements database	
Company IPO date	Date on which each issuing company had its IPO
Fund total estimated amount invested in company in $ million	Total estimated amount invested in each issuing company by a specific fund prior to the IPO in million USD
Fund investment type	Category of the type of investments a specific fund makes that invested in an issuing company
Company founding year	Year in which each issuing company was founded
Company name	Name of each issuing company
Company nation	Nation of each issuing company
Company primary SIC code	Primary SIC code of each issuing company

Summary of all variables retrieved from SDC. The table shows the name and a description of each variable received. Panel A includes all variables received through the SDC – New Issues database. Panel B includes all variables received through the VentureXpert – Portfolio Company Disbursement database.

Appendix 2: Summary Table of Variables Retrieved from Datastream

Name	Item code	Description
Panel A: General		
Symbol	SYMBOL	Unique identifier of an equity in Datastream.
Company name	NAME	Name of the company as stored on Datastream's databases.
Exchange name	EXNAME	Datastream name of the exchange that is the source of the default price datatypes for a given equity.
Base date	BDATE	The base date is the date from which Datastream holds information about the issue; for the UK the base date is one day before trading in the stock starts – this allows Datastream to store the issue price. Where the nature of a company's business changed materially, due to a merger or the splitting off one or more divisions, Datastream rebases the stock.
Panel B: Operating performance		
Fiscal period end date in local currency	WC05350	Date the company closes its books at the end of its fiscal period. Here fiscal year end date as we use annual time series data.
Net sales or revenues in local currency	WC01001	Gross sales and other operating revenue less discounts, returns and allowances.
Net sales or revenues in $ thousand	WC07240	Net sales or revenues of the company converted to $ using the fiscal year end exchange rate.
Total assets in local currency	WC02999	Sum of total current assets, long term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets.
Total assets in $ thousand	WC07230	Total assets of the company converted to $ using the fiscal year end exchange rate.
Capital expenditures in local currency	WC04601	Funds used to acquire fixed assets other than those associated with acquisitions. It includes but is not restricted to additions to property, plant and equipment and investments in machinery and equipment.
Research & development in local currency	WC01201	All direct and indirect costs related to the creation and development of new processes, techniques, applications and products with commercial possibilities.
Operating income before depreciation and amortization in local currency	WC18155	Operating income of a company before depreciation and amortization expenses have been deducted. Operating income represents the difference between sales and total operating expenses.
Panel C: Survival		
Inactive date	WC07015	Day on which a company became privately held, merged, liquidated, or otherwise became inactive.
Reason why company became inactive	Footnote N of WC00000	Explanations for company becoming inactive, e.g. "Acquired by XYZ Corporation in May 97" or "Delisted - information will no longer be provided as of Jan 96".
Panel D: Market performance		
Market capitalization / common equity	WC09704	Market capitalization represents the market price year end times common shares outstanding. For companies with more than one type of common/ordinary share, market capitalization represents the total market value of the company. Common equity represents common shareholders' investment in a company.
Price (adjusted) in local currency	P	Represents the official closing price, adjusted for subsequent capital actions.
Local market index	INDXL	Code of the benchmark local stock market index for a given equity.
Price - local market index	LI	Time series data for the benchmark local price index for a given equity. Local market indices are weighted by market value.
Price to book value	PTBV	Share price divided by the book value per share. Book value per share represents the book value (proportioned common equity divided by outstanding shares) at the company's fiscal year end.

Summary of all variables retrieved from Datastream. The table shows the name, the item code and a description of each variable received. Panel A includes all general variables received. Panel B includes all variables used to measure the post-IPO operating performance. Panel C includes all variables used to analyse the company survival. Panel D includes all variables used to measure post-IPO market performance.

Appendix 3: Data Collection and Cleaning Process

	Number of IPOs	%
Panel A: SDC – New Issues database		
Original sample	3,378	
- Duplicates	38	
= Clean sample	3,340	
of which high-tech	*819*	*24.52%*
of which non-high-tech	*2,521*	*75.48%*
Panel B: VentureXpert – Portfolio Company Disbursements database		
Original sample	371	
of which VC-backed	172	
of which high-tech	*113*	*65.70%*
of which non-high-tech	*59*	*34.30%*
of which PE-backed	199	
of which high-tech	*47*	*23.62%*
of which non-high-tech	*152*	*76.38%*
Panel C: Matching of high-tech IPOs from both data sources with Datastream		
SDC – Clean sample	819	
of which matches with Datastream	686	
VentureXpert – VC-backed	113	
of which matches with Datastream	103	
VentureXpert – PE-backed	47	
of which matches with Datastream	42	
Panel D: Matching of the VC- and PE-backed samples with the sample from SDC		
SDC – matches with Datastream	686	
- Matches in VC- and PE-backed sample	130	
NFS-backed IPOs (unclean)	556	
- Spinoffs	24	
- Unmatched VC- and PE-backed sample	135	
= Final sample:	540	
NFS-backed IPOs	*397*	*73.52%*
VC-backed IPOs	*102*	*18.89%*
PE-backed IPOs	*41*	*7.59%*

Data collection and cleaning process for the datasets received from the SDC – New Issues database and the VentureXpert - Portfolio Company Disbursements database. The table shows the number of IPOs for each of the important collection and cleaning steps. Additionally, we report the ratio of high-tech IPOs and non-high-tech IPOs for each observation group, respectively. Panel A displays the cleaning process for the SDC-New Issues database. Panel B displays the cleaning proces for the VentureXpert – Portfolio Company Disbursements database. Panel C displays the matching process for all sub-samples with Datastream. Panel D displays the matching process of the VC- and PE-backed samples with the sample from SDC. The table does not report on the case-to-case comparison of VC- and PE-backed samples that were not found in SDC.

Appendix 4: Distribution of IPOs by Year (2001 – 2017)

	NFS		VC		PE	
Year	**Total**	**%**	**Total**	**%**	**Total**	**%**
2001	50	12.59%	4	3.92%	2	4.88%
2002	20	5.04%	0	0.00%	0	0.00%
2003	16	4.03%	2	1.96%	0	0.00%
2004	39	9.82%	11	10.78%	7	17.07%
2005	46	11.59%	26	25.49%	5	12.20%
2006	55	13.85%	26	25.49%	5	12.20%
2007	58	14.61%	20	19.61%	8	19.51%
2008	20	5.04%	1	0.98%	1	2.44%
2009	10	2.52%	0	0.00%	0	0.00%
2010	22	5.54%	0	0.00%	4	9.76%
2011	12	3.02%	3	2.94%	1	2.44%
2012	7	1.76%	1	0.98%	3	7.32%
2013	13	3.27%	4	3.92%	2	4.88%
2014	29	7.30%	4	3.92%	3	7.32%
Sum	**397**	**100.00%**	**102**	**100.00%**	**41**	**100.00%**
2015	39		10		1	
2016	33		7		2	
2017	53		8		3	

Distribution by year for our sample of VC-backed, NFS-backed, and PE-backed European high-tech companies who underwent an IPO between 2001 and 2014. The table reports the absolute as well as relative distribution for the respective data sample. The table additionally includes the IPOs from 2015 – 2017 but excludes them from the sum and the relative distribution.

Appendix 5: Distribution of IPOs by Company's Nation

	NFS		VC		PE	
Company's nation	**Total**	**%**	**Total**	**%**	**Total**	**%**
Austria	2	0.50%	2	1.96%	0	0.00%
Belgium	11	2.77%	7	6.86%	1	2.44%
Czech Republic	0	0.00%	1	0.98%	0	0.00%
Denmark	9	2.27%	5	4.90%	0	0.00%
Finland	5	1.26%	2	1.96%	0	0.00%
France	78	19.65%	22	21.57%	6	14.63%
Germany	24	6.05%	9	8.82%	3	7.32%
Greece	12	3.02%	0	0.00%	0	0.00%
Ireland-Rep	7	1.76%	4	3.92%	3	7.32%
Italy	17	4.28%	6	5.88%	2	4.88%
Latvia	1	0.25%	0	0.00%	0	0.00%
Luxembourg	0	0.00%	0	0.00%	1	2.44%
Netherlands	1	0.25%	4	3.92%	3	7.32%
Norway	16	4.03%	5	4.90%	1	2.44%
Poland	30	7.56%	1	0.98%	1	2.44%
Romania	1	0.25%	0	0.00%	0	0.00%
Slovak Rep	1	0.25%	0	0.00%	0	0.00%
Spain	9	2.27%	1	0.98%	2	4.88%
Sweden	15	3.78%	1	0.98%	2	4.88%
Switzerland	2	0.50%	7	6.86%	2	4.88%
United Kingdom	156	39.29%	25	24.51%	14	34.15%
Sum	**397**	**100.00%**	**102**	**100.00%**	**41**	**100.00%**

Distribution by IPO company's nation for our sample of VC-backed, NFS-backed, and PE-backed European high-tech companies who underwent an IPO between 2001 and 2014. The rows are sorted by alphabet and report the absolute as well as relative distribution for the respective data sample.

Appendix 6: Distribution of IPOs by Stock Exchange

	NFS		VC		PE	
Stock exchange	**Total**	**%**	**Total**	**%**	**Total**	**%**
Athens	11	2.77%	0	0.00%	0	0.00%
Berlin	0	0.00%	2	1.96%	0	0.00%
Bucharest	1	0.25%	0	0.00%	0	0.00%
Copenhagen	6	1.51%	5	4.90%	0	0.00%
Dublin	1	0.25%	2	1.96%	1	2.44%
Euronext Amsterdam	1	0.25%	3	2.94%	0	0.00%
Euronext Brussels	9	2.27%	6	5.88%	1	2.44%
Euronext Paris	78	19.65%	21	20.59%	6	14.63%
Frankfurt	18	4.53%	8	7.84%	0	0.00%
Hamburg	3	0.76%	0	0.00%	1	2.44%
Helsinki	5	1.26%	1	0.98%	0	0.00%
ICAP Sec.& Der.Exch.	2	0.50%	0	0.00%	0	0.00%
London	162	40.81%	24	23.53%	13	31.71%
Madrid-SIBE	8	2.02%	1	0.98%	2	4.88%
Milan	15	3.78%	3	2.94%	1	2.44%
Munich	1	0.25%	1	0.98%	0	0.00%
Nasdaq	1	0.25%	6	5.88%	5	12.20%
New York	0	0.00%	2	1.96%	3	7.32%
Norway OTC	0	0.00%	1	0.98%	0	0.00%
Oslo	18	4.53%	4	3.92%	1	2.44%
Other OTC	1	0.25%	0	0.00%	2	4.88%
Prague	0	0.00%	1	0.98%	0	0.00%
Riga	1	0.25%	0	0.00%	0	0.00%
SIX Swiss	2	0.50%	6	5.88%	1	2.44%
Stockholm	16	4.03%	1	0.98%	2	4.88%
Stuttgart	3	0.76%	1	0.98%	1	2.44%
TSX Venture	1	0.25%	0	0.00%	0	0.00%
Vienna	2	0.50%	2	1.96%	0	0.00%
Warsaw	31	7.81%	1	0.98%	1	2.44%
Sum	**397**	**100.00%**	**102**	**100.00%**	**41**	**100.00%**

Distribution by stock exchange for our sample of VC-backed, NFS-backed, and PE-backed European high-tech companies who underwent an IPO between 2001 and 2014. The rows are sorted by alphabet and report the absolute as well as relative distribution for the respective data sample.

Appendix 7: Distribution of IPOs by Three-Digit SIC Code

SIC code	Name	NFS		VC		PE	
		Total	%	Total	%	Total	%
283	Drugs	68	17.13%	41	40.20%	7	17.07%
357	Computer and Office Equipment	13	3.27%	4	3.92%	1	2.44%
366	Communication Equipment	15	3.78%	2	1.96%	1	2.44%
367	Electronic Components and Accessories	28	7.05%	6	5.88%	5	12.20%
382	Laboratory, Optic, Measure, Control Instruments	12	3.02%	3	2.94%	2	4.88%
384	Surgical, Medical, Dental Instruments	21	5.29%	6	5.88%	4	9.76%
481	Telephone Communications	38	9.57%	2	1.96%	2	4.88%
737	Computer Programming, Data Processing, and Other Computer Related Services	183	46.10%	29	28.43%	15	36.59%
873	Research, Development, Testing Services	19	4.79%	9	8.82%	4	9.76%
Sum		**397**	**100.00%**	**102**	**100.00%**	**41**	**100.00%**

Distribution by three-digit SIC codes for our sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. The rows are sorted after the three-digit SIC code and report the name of each three-digit SIC code as well as absolute as well as relative distribution for the respective data sample.

Appendix 8: OLS Regression for Alternative Measures of Post-IPO Performance

Dependent variables	**Operating CFOA**		**P/B ratio**
Independent variables	t_{-1} **to** t_0	t_0 **to** t_3	**36 months**
Intercept	0.5760	0.0240	1.4063
p-value	0.0004***	0.7321	0.1871
$\ln(proceeds_i)$	0.0292	-0.0089	-0.1422
p-value	0.2786	0.4628	0.3923
$\ln(age_i)$	-0.2609	0.0016	-0.1150
p-value	0.0000***	0.9450	0.7450
$\ln((P/B)_i)$	-0.0079	0.0324	1.7058
p-value	0.8674	0.0924*	0.0000***
$Country_{iUK}$	0.1900	-0.0739	-0.4532
p-value	0.0393**	0.0764*	0.4853
$Country_{iFrance}$	0.0798	-0.0861	0.7421
p-value	0.4963	0.1034	0.3616
SIC_{i737}	-0.1987	-0.0080	1.5545
p-value	0.0358**	0.8485	0.0175**
SIC_{i283}	0.0690	-0.0617	2.1905
p-value	0.5178	0.1986	0.0041***
$Bubble_i$	0.0494	-0.0301	-1.4887
p-value	0.5639	0.4283	0.0125**
VC_i	0.0399	-0.0875	0.7751
p-value	0.6970	0.0636*	0.3079
Adjusted R^2	0.1116	0.0296	0.1170
F-value	5.0894	1.9051	6.2138
Degrees of freedom	284	258	345

Results for the multiple OLS regression analysis for our alternative performance measures, operating CFOA and P/B ratio, for our cleaned sample of VC-backed and NFS-backed European high-tech companies who underwent an IPO between 2001 and 2014. We excluded the 1% and 99% levels for our dependent variables to reduce the influence of skewedness and outliers on our regression results. The variable $\ln(proceeds_i)$ represents the natural logarithm of the IPO offer amount. The variable $\ln(age_i)$ represents the natural logarithm of the company age (in years) at time of IPO. The variable $\ln((P/B)_i)$ represents the natural logarithm of the price-to-book equity ratio at the time of IPO. The market value is the closing price of the second day of trading. The $Country_i$ variables represent dummy variables taking on the value 1 if the IPO company's headquarters are located in that country (either UK or France), and 0 otherwise. The SIC_i variables represent dummy variables taking on the value 1 if the IPO company operates in the specific three-digit SIC code (either 737 or 283), and 0 otherwise. The $Bubble_i$ variable represents a dummy variable taking on the value 1 if the company underwent their IPO during the years 2005 – 2007, and 0 otherwise. The variable VC represents a dummy variable taking on the value 1 if the IPO has been classified as VC-backed, and 0 otherwise. The results are estimates for the β_n coefficients and can be interpreted as the change of the dependent variable if the related independent variable increases by 1, all other variables equal. The p-value is the significance level for each estimate and is based on the student's t-test. The asterisk * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level. The adjusted R^2 can be interpreted as the fraction of the variation in the dependent variable that is accounted for by the independent variables. It is adjusted to increase only if the addition of a new independent variable improves the model more than adding a random variable and decreases otherwise. The F-value tests for the overall significance of the regression analysis. The degrees of freedom represent the number of observations.