The influence of Venture Capital Reputation on the long-run performance of high-tech Initial Public Offerings:

A comparison between VC-backed and Non-VC-backed firms.

Bachelor Thesis International Economics and Business Economics

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Abstract

This paper examines the long-run performances of Venture Capital (VC)-backed and non-VC-backed Initial Public Offerings (IPOs). Using data from high-tech IPOs in the United States between 2010 and 2014, I employ several models to analyze the influence of VC-backing and VC reputation. I find that VC-backed firms experience a higher degree of underpricing and a lower firm age before IPO. These outcomes provide some evidence in favor of Gompers' (1996) grandstanding theory. Furthermore, I find that the involvement of VCs is not significantly correlated with the long-run performance measures: return on assets, market-to-book ratio and buy-and-hold abnormal returns. Additionally, using VC age, VC capital under management and VC IPO frequency as proxies for reputation, this research finds little evidence for highly reputable VCs to outperform conventional VCs.

Keywords: Venture Capital, Initial Public Offering, long-run performance

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1. Introduction

Venture Capital (VC) is one of the most essential determinants behind the going public process of high-tech firms in the United States (US). To illustrate, over 3000 Initial Public Offerings (IPOs) which were backed by Venture Capitalists (VCs) occurred from 1980 to 2016 (Ritter, 2017). Among these VC-backed IPOs are renowned tech-firms such as Apple Inc., Facebook Inc. and Alphabet Inc. (formerly Google). More recently, the popular tech-firms Uber Technologies Inc. and Snap Inc. went public with the support of VC. Since a majority of the IPOs are presently backed by VCs, it raises the question how valuable VC is during and after the going public process. Therefore, this research analyzes the contributions made by VCs and how their involvement impacts the long-run performance of high-tech firms post-IPO.

Numerous studies have documented the considerable contributions the VCs have on the firms they invest in (see e.g. Gompers & Lerner, 1997; Samila & Sorenson, 2011). Previous literature examines the aspect of screening (Kaplan & Strömberg, 2001), funding (Ferrary & Granovetter, 2009), monitoring (Bernstein, Giroud & Townsend, 2015) and governing (Sahlman, 1990) to be significant additions that VC provides. These additions have two implications. First, it could reduce underpricing as the involvement of VC reduces the information asymmetry at the time of an IPO (Bessler & Seim, 2012). Second, the contributions by VCs are often continued after the IPO, which could help the firm in achieving a superior long-run performance (Barry, Muscarella, Peavy & Vetsuypens, 1990).

Investigating the contributions made by VCs is relevant to investors, management of startup firms and VCs. Investors will be able to better assess the influence of VCs and their impact on the long-run performance of the firms. Based on this knowledge, investors could potentially create or adjust their investment strategy based on the involvement of VCs. Management of high-tech firms that struggle to obtain external financing can acquire a better understanding whether a collaboration with a VC is the most optimal approach. Not only in terms of the going public process, but also concerning the potential VC related determinants for a favorable long-run performance. At last, VCs can evaluate whether holding the stock is beneficial to them, since VCs often maintain their shares beyond the lock-up period of 180 days in which shares cannot be traded (Barry et al., 1990, Bradley et al., 2001).

This study focuses on high-tech VC-backed firms in the US that went public between 2010 and 2014. I opt for the high-tech industry because of its increased level of information asymmetry and high degree of return uncertainty (Jia, 2015). These two features induce a problematic method of acquiring capital from standard financial institutions. Additionally, the majority of VCs in the US participates in the high-tech industry (Carpenter & Petersen, 2002). The period of 2010 to 2014

allows me to utilize the most recent data available, while still maintaining a three-year period after IPO to measure the long-run performance (Ritter, 1991). Moreover, since the period starts from 2010, the irregularities from the financial crisis have largely receded (Shiller, 2012). Furthermore, the reputation of a firm is an intangible asset, which has a positive impact on a firm's performance (Iwu-Egwuonwu & Chibuike, 2010). This indicates that we can expect a highly reputable VC to improve the firm's performance to a greater extent. Therefore, I will emphasize on the reputation aspect of the VC and research whether the reputation has a significant effect on the post-IPO long-run performances.

The primary goal is to analyze whether VC-backed firms will outperform non-VC-backed firms. In this process, I consider the reputation factor of the VC and study the long-run performance after the IPO. The long-run IPO performance will be measured using regressions on the return on assets, the market-to-book value and the buy-and-hold abnormal stock returns. Thus, this paper investigates the following research question:

To what extent does the reputation of a Venture Capital affect the long-run performance post Initial Public Offering of high-tech firms in the US?

The remainder of the paper is organized as follows. First, the role of VC will be elaborated upon with emphasis on their contributions to their investment firms. Additionally, the relation between VC and IPOs is explained. Next, the data is described and the performance measures and variables are defined. The hypotheses are formulated in section 4, followed by the methodology. In section 5, the results will be described and interpreted. The last section concludes the paper and provides the limitations of this research and suggestions for further research.

2. Theoretical Framework

2.1 The role of venture capital

VCs invest in young startup firms which are risky to finance, but possess a high growth potential. Generally, these firms have difficulty accessing traditional capital markets, because they either do not possess the ability to issue debt, or their equity markets mainly consist of family and friends, or a combination of the two (Maier & Walker, 1987). High-tech firms experience increased hindrance, because in many cases their assets are intangible. Hence, financial institutions such as banks will refrain from investing as they are unable to use any tangible assets for collateral (Ozmel, Robinson & Stuart, 2013). This is precisely the market position where VC finds success. Bottazzi & Rin (2001) even claim VC to be the most suitable form of financing for innovative high-tech firms. However, VC is not a perfect substitute to the traditional equity markets, since small businesses can have difficulty to

attract VC funding unless they can convince the VCs that they have the potential to attain extraordinary returns (Maier & Walker, 1987).

Nevertheless, when firms are successful in attracting VC, there are several benefits that the firms receive before, during and after their IPO. These contributions are associated to screening, funding, monitoring and governance (Barry et al., 1990).

2.1.1 Screening

To select the optimal firms for VC to invest in, the process of screening is employed. Screening is the method in which firms are investigated per a predetermined set of criteria. Kaplan & Strömberg (2001) found that these criteria were usually related to the management team, the contract terms and the attractiveness of the opportunity, which included the market size, the strategy and the competition. In a complementing study, Macmillan (1987) researched what screening criteria would distinguish successful VC investments from the unsuccessful ones. He concluded that the two primary standards were the ability to protect against competitors and the level of market acceptance of the product. Additionally, he found that the largest cluster of successes concerned high-tech firms.

Only when the VC recognizes that the firm is deserving of financing, it will pass the screening. Therefore, the intense screening of VCs reduces the information asymmetry between the management within the firm and all outsiders. This reduction in information asymmetry was also researched by Chan (1983), who examined a market with and without screening VCs. He concluded that screening could ensure that a Pareto-preferred allocation was possible, which would increase the total welfare.

2.1.2 Funding

Presumably the main reason for a startup to seek VC participation is the requirement of financial resources (Gompers & Lerner, 2004). Especially high-tech companies will have difficulty receiving external funding as they carry high risks and lack tangible assets. Additionally, these young high-tech firms will not have established cash flows and are therefore reliant upon external financing. VCs have a monopoly on funding these companies as no other conventional financial institution would consider it to be a sensible investment (Ferrary & Granovetter, 2009).

VCs generally have the possibility to provide financial resources in different stages. In this manner, VCs can offer their funds assigned to specific developments in the firm's life cycle (Barry et al., 1990). Kane (1989) describes four stages of venture investing named the *Start-up round, the Early-stage, the Expansion stage* and *the Later stage*. Each phase has its own specific purpose and the amount of funding increases steadily with every stage. Often, VCs will re-evaluate their investment choice after every stage and are contractually permitted to halt their funding completely (Chan, Siegel & Thakor, 1990). This form of financing in stages reduces agent-principle issues, because the

management of the firm is incentivized to exhibit progress to continue to receive VC funding (Sahlman, 1988).

2.1.3 Monitoring

Often, VCs are specialized in a specific industry and they will examine and invest only in those firms which belong to their area of expertise (Ferrary & Grannovetter, 2009). Barry et al. (1990) research whether the quality of the monitoring by a VC is associated with the initial returns of IPOs. They find that superior monitoring skills are correlated with a lower degree of underpricing. Bernstein, Giroud & Townsend (2016) also investigate the impact of VC monitoring by conducting a large-scale survey. They conclude that proper monitoring could increase both the level of innovation and the probability of the firm going public.

2.1.4 Governance

VCs regularly hold positions in the board of directors of the firms. In this manner, they can provide guidance to management and supervise their activities (Barry et al., 1990). In most contracts, it is agreed upon that the VC and firm both must agree on the person to be elected to the board (Sahlman, 1990). Rosenstein (1993) investigates to what extent the outside directors from VC add value to the firm. In his research, he concludes that the CEOs did not give a higher appreciation to the advice of VCs compared to other board members. However, when the firm is collaborating with a top 20 VC, then the advice of the VCs on the board are rated significantly higher compared to the other board members. Rosenstein admits that his approach does not signify an objective measure of value added. Sapienza, Manigart & Vermeir (1996) attempt to give a more quantifiable measure of the notion of value added by VC governance. They do so by examining the determinants of value added in the US, the UK, France and the Netherlands. The key findings are that the board members coming from the VC contributed most to companies which already were operating satisfactorily. Also, companies with high uncertainty, such as firms that are in the early stages of development benefit most from VC consultation.

In technology firms, the board of directors has more influence on the management compared to other industries. This increased power can be explained by the high concentration of ownership by the VCs, their expertise and contacts accessibility, which are stronger present in tech-firms (Rosenstein, 1988). This could indicate that the value added aspect is perceived greater in the high-tech industry.

2.1.5 Other Venture Capital contributions

Ferrary & Granovetter (2009) find several other functions of VC in the high-tech industry. First there is the signaling function. When a highly reputable VC invests in a firm, it shows that they have high

confidence in that firm succeeding. This in turn gives a signal to other agents, such as highly skilled workers or suppliers, and makes it more attractive to cooperate with the firm. Podolny (1994) finds that when businesses select exchange partners, they will either engage with those they have worked with in the past or with firms that carry a similar status. The reputable VC involvement allows the firm to reach a higher status and therefore more favorable partners.

Furthermore, VCs can enable the firm to be increasingly embedded into the networks of their industry. This embedding function is derived from the large and relevant social networks, which the VCs possesses. This allows the firms to have superior access to information, resources and business partners.

2.2 Venture Capital and Initial Public Offering

For a long time, it was thought that the most meaningful and profitable manner for VC to exit their investment was through an IPO (Grompers and Lerner, 2004). However, there is also evidence that VCs maintain their shares and are still heavily involved with the firm even after the IPO (Barry et al., 1990). This in combination with the significant contributions VC provides, should ensure that, on average, the firms backed by VC have a superior operating and financial performance compared to non-VC-backed firms. Additionally, at the time of the IPO, the VC involvement should send a signal to investors, which would in turn be reflected in a lower underpricing.

2.2.1 Underpricing

There are two dominant anomalies observed during an IPO, namely *initial underpricing* and *hot issue markets* (Ritter, 1991). These are both anomalies, since they are caused by behavioral phenomena, which are not inherent to the Capital Asset Pricing Model. The initial underpricing occurs when the offer price is too low and the price will shoot up on the first trading day. This rise may even surpass the fundamental value of the stock, which causes the stock price to decline over time, resulting in a long-term underperformance. The hot issue markets indicate a period in which investor demand and confidence in IPOs are exorbitantly high. The combination of the two causes the stocks to be higher than their fundamental values on the first trading day (Shefrin, 2002).

The economic rationale behind the lower underpricing is that VCs can reduce the information asymmetry in the IPO process between the firm and investors by conveying credible information. Megginson & Weiss (1991) are among the first to research the underpricing of VC-backed IPOs. They find that the VC involvement indeed reduces the mean and median level of the IPO underpricing.

On the contrary, Lee & Wahal (2004) provide evidence that there is significant larger underpricing present in VC-backed firms compared to non-VC-backed firms. In their research, they analyze US firms from 1980 to 2000 and advocate that the larger underpricing is due to grandstanding. Grandstanding is a process in which VCs are eager to bring small firms faster to the

public, because the VCs are being graded on their ability to take companies public (Gompers, 1996). This indicates that VCs are prepared to bear the costs of a higher underpricing in return for taking the companies public earlier (Lee & Wahal, 2004).

In a more recent study, Bessler & Seim (2012) find that the level of underpricing is dependent on the firm characteristics, the underwriter and the market performance. Additionally, they state that VC-backed firms experienced a lower magnitude of underpricing. However, they are unable to prove that this is due to the reduction in uncertainty, which VC involvement should induce.

2.3 Long-run performance of Venture Capital-backed firms

Both Jain & Kini (1995) as Brav & Gompers (1997) compare the returns of one sample of VC-backed firms with another sample without VC-backing. They found that the returns of VC-backed firms were significantly higher than the returns of their non-VC equivalents. This suggests that the firms with VC involvement have a superior long-run performance. In turn, Florin (2005) researches whether VC funding is worthwhile or not for the founder of the firm. He concludes that VC-backed firms are not significantly outperforming their non-VC-backed counterparts and recommended founders to minimize VC engagement. Rindermann (2004) comes to the same conclusion, when performing a similar analysis for firms in France, Germany and the UK. However, he did find that the international VCs, which are highly reputable, are having positive effects on the operating and financial performance of their portfolio firms.

Other recent studies have been increasingly more positive on the contributions of VC on the post-IPO performance. Bessler & Seim (2012) find that investments in VC-backed IPOs would generate positive returns for almost three years. Krishnan, Ivanov, Masulis & Singh (2011) impose more emphasis on the reputation aspect and conclude that reputable VC involvement is associated with an improved post-IPO long-run performance.

3. Hypotheses and Performance Measures

Previous research has not been completely unambiguous regarding the initial underpricing of VC-backed IPOs (Megginson & Weiss, 1991; Lee & Wahal, 2004). Still, a lower underpricing can display a relationship between the VC involvement and a reduction in information asymmetry at the time of the IPO. However, it can also be argued that the grandstanding theory holds, in which VCs try to take companies public as fast as possible. In this procedure, the firms are ought to be too volatile and inexperienced. This in turn could increase the degree of underpricing. Therefore, to investigate whether there is a significant difference in underpricing, the following hypothesis is constructed:

Hypothesis 1a: VC-backed IPOs in the high-tech industry experience a significantly lower degree of underpricing compared to non-VC-backed IPOs.

The first long-run performance measure is the Return on Assets, which has previously been used by Jain & Kini (1995). Return on assets is defined as the net income divided by the book value of the total assets. It is an effective performance measure, because it incorporates aspects from both the income statement as well as the balance sheet. Additionally, return on assets is less susceptible to accounting tactics and short-term manipulations (Hagel et al., 2013). I expect that VC-backed firms are superior in managing their total assets for investments. Therefore, to analyze whether VC-backed firms are more efficient in utilizing their total assets, I formulate the following hypothesis:

Hypothesis 2: VC-backed IPOs in the high-tech industry have a significantly higher Return on Assets compared to non-VC-backed IPOs.

The second long-run performance measure is the market-to-book ratio. The market-to-book ratio is calculated as the market value divided by the book value. Following Krishnan et al. (2011), I use this ratio as a proxy for Tobin's Q, which is defined as the market value of a company's assets divided by the replacement cost of those assets. Chung & Pruitt (1994) found that the market-to-book ratio explains nearly 97% of the variability of Tobin's Q. Past research, such as Rindermann (2004) also used Tobin's Q as a long-run performance measure. I anticipate that VC-backed firms would be acquiring a higher rate of return compared to the replacement cost of the firm. Therefore, to examine whether VC-backed firms have a significantly higher Tobin's Q, the following hypothesis will be tested:

Hypothesis 3: VC-backed IPOs in the high-tech industry have a significantly higher Market-to-Book ratio compared to non-VC-backed IPOs.

The third long-run performance measure is the survivability of the firm. Krishnan et al. (2011) define this measure as a dummy variable, which takes the value of 1 if it would remain a public company listed on The New York Stock Exchange or NASDAQ Stock Exchange for three years after their IPO. the variable also takes the value 1 when the firm merges or is acquired by a listed firm on those two exchanges, and those businesses are still public after three years. When the firm has become bankrupt, liquidated, private or converted to a smaller exchange, the variable equals the value of 0. Li, Zhang & Zhou (2005) state that firms which heavily take part in pre-IPO window dressing have a greater probability to delist. I expect that VCs will discourage any negative prospects of window dressing. Therefore, to analyze whether VC-backed firms are more likely to still be a public company, the following hypothesis is constructed:

Hypothesis 4: *VC-backed IPOs in the high-tech industry have a greater possibility to still be listed compared to non-VC-backed IPOs.*

The fourth and final performance measure is the buy-and-hold abnormal stock returns. This performance measure has been the most preferred measure of long run performance for several studies, such as Ritter (1991), Brav & Gompers (1997) and Rindermann (2004). The method compares the realized buy-and-hold returns of a portfolio consisting of all IPOs to the buy-and-hold returns of a benchmark portfolio (Bessler & Seim, 2012). In this research, the market index of either the New York Stock Exchange or the NASDAQ Stock Exchange is used as the benchmark. I expect that the abnormal returns of VC-backed firms are on average higher than non-VC-backed firms. Therefore, to investigate whether VC-backed firms have a superior stock return performance in the long-run, the following hypothesis is formulated:

Hypothesis 5: *VC-backed IPOs in the high-tech industry have significantly higher buy-and-hold abnormal returns compared to non-VC-backed IPOs.*

The last hypothesis concerns the reputation of the VC. Since we can expect more reputable VCs to enhance the long-run performances of their portfolio firms, the final hypothesis is constructed:

Hypothesis 6: *The reputation of the VC has a significant positive effect on the long-run performance.*

4. Data

This study uses two samples of which the first is comprised of only VC-backed firms and the second one of non-VC-backed firms. The first sample consists of VC-backed IPOs in the US between 2010 and 2014. Only firms that are characterized by the three-digit SIC code combination deemed most preferred by Kile & Phillips (2009) to sample the high-tech industry are included. An overview of these codes with their corresponding descriptions can be found in appendix A. The second sample follows the identical criteria, except only non-VC-backed IPOs have been selected. To prevent survivorship bias, firms that have been delisted due to various reasons such as, mergers, acquisitions or bankruptcy are included until their date of delisting. Furthermore, firms of which the VC name was unidentified, the company financials were not available, or the offer price was below 1 (penny stocks) are removed from the sample.

Information on the IPO characteristics, such as IPO date, offer price, offer size and underwriter names have been extracted from the Thomson One Banker database. Information on the IPO firms including the ISIN codes, firm age and the leading VC, was also acquired from this

database. To obtain company specific information, missing ISIN codes were supplemented with their matching SEDOL codes. These firm specifics, such as return on assets, market-to-book value, as well as the stock prices of 750 trading days after the IPO, are collected from the Thomson Reuters Datastream.

The leading VC specifics, which include VC age, IPO frequency and market capital under management, is manually obtained from the Thomson One Banker Database and the VCs' websites.

4.1 Venture Capital reputation measures

The leading VC is selected based on their number of funding participation rounds. When multiple VC's have the same number of rounds, the VC with the most recent investments prior to IPO is chosen, since that VC is most associated with the firm at the time of the IPO.

The reputation of the VC's is measured per three different criteria. The first criterion is the *VC age*. Hsu (2004) discusses that the age of the VC can serve as a proxy for investment experience. The age is defined as the number of years between the year the VC was founded and the year of the IPO. The second measure is the *Capital Under Management*. This value indicates the dollar amount available to management for investments. Gompers & Lerner (1999) state that capital under management is a reputation measure, which indicates the level of fundraising a VC is capable of. They explain that older and more reputable VCs will receive greater capital commitments compared to similar younger VCs. The final criterion is the IPO frequency. This measure is computed as the number of completed IPOs over the preceding three years in all investments divided by the number of active firms in the VC's current portfolio. This method is preferred as it is not strongly affected by a small number of large IPOs (Krishnan et al., 2011).

Each VC is ranked based on each different criterion separately. The lowest 25% of VC's will receive a score of 1, the next 25% a score of 2, which continues up until a score of 4 for the top 25%. Weights will be assigned to each measurement to characterize different levels of relevance. Therefore, the score of age, capital under management and IPO frequency will be multiplied by the weights of 0.5, 0.75 and 1 respectively. Krishnan et al. (2011) show that VC age is less significantly correlated and Gompers & Lerner (1996) argue that the IPO frequency is the main criterion used to determine the success of a VC. Therefore, age is given a lower weight and the IPO frequency is given the most weight. The accumulated scores will be ranked again and this value will represent the reputation of the VC. When scores differ due to a dissimilarity in VC age caused by different IPO dates, the average score of the firm is used. The VCs are divided into four classes per their cumulative scores with 1 representing the lowest and 4 the highest reputable VCs.

4.2 Control variables

To investigate the effect of reputation on the underpricing and long-run performances of the firms in the regression analysis, several control variables must be in place. With this, I can ensure a clearly identified relationship between the independent variable and the VC reputation measure. First, a VC dummy variable will take the value of 1 when the IPO was backed by a VC and the value of 0 if not. This dummy variable allows us to observe if there is a significant effect from VC backing.

Krishnan et al. (2011) state that the offer size is a frequent issue characteristic, which is used in many prominent IPO papers. The offer size is defined as the total gross proceeds amount plus the overallotment amount sold in millions of dollars. Carter, Dark & Singh (1998) argue that larger offers are made by economically stronger firms. To reduce skewness, the natural logarithm of the gross proceeds is taken. The figures on the skewness of the offer size can be found in appendix B.

Following Rindermann (2004), I also control for the firm age and size, which should capture the effects caused by certain preferences of VCs when selecting their investment firms. Firm age is defined as the number of years between the firm founding year and the IPO year. Common proxies used for size are either total assets or market capitalization. In this paper, I have opted for market capitalization, since total assets can be influenced by accounting norms and standards (Rajan, Zingales & Kumar, 2001). Market capitalization is defined as the company's outstanding shares multiplied by the market price of a share in the year of the IPO. The age and size variables are also an indication of how well established the firm is on areas such as management and customer base (Krishnan et al, 2011). Again, the natural logarithm is taken to diminish skewness. The figures on the skewness of age can be found in appendix B.

Previous research, such as Carter, Dark & Singh (1998) and Logue et al. (2002) find significant relationships between underwriter reputation and the long-run returns. Since this might capture an effect, which would otherwise be attributed to VC reputation, it is included as a control variable in the regression. The lead underwriters are ranked per their arithmetic average score based on the most recent version of the IPO underwriter reputation rankings by Loughran & Ritter (2002). Underwriters with the highest attainable score of nine will be regarded as highly reputable, while any score below is classified as not highly reputable.

The level of underpricing can be significantly associated with the long run performance of the firm (Chan, Wang, & Wei, 2004). This ties into the concept of the stock price overshooting and returning to fundamental values explained by Shefrin (2002). Therefore, the regressions will include the explanatory variable of underpricing to account for this anomaly.

Modigliani & Miller (1963) theorize that in a system without taxes, and several other assumptions, the capital structure of a firm is irrelevant. However, since taxes do exist, various studies such as Bradley, Jarrell & Kim (1984) argue that firms have an optimal leverage ratio, which

balances the tax shield of debt against the costs of bankruptcy. According to corporate governance theory, the amount of leverage influences agency costs and thereby affects the firm's performance. Margaritis & Psillaki (2010) research the correlation between capital structure, ownership structure and firm performance. They conclude that a higher leverage is related to an increased efficiency of the firm. Therefore, to control for the influence of capital structure on firm performance, the debt over equity ratio, defined as the total debt divided by the total shareholder equity, is included as an explanatory variable.

Since the IPOs occurred in different years, there might have been factors which influenced all IPOs in a particular year. To eliminate these factors, dummy variables of the year in which the IPO occurred are added to the model.

4.3 Summary statistics

My sample consists of IPOs in the high-tech industry between 2010 and 2014 in the US. In this short time frame, there appears to be a slight upward pattern of VC-backed IPOs, which is depicted in Figure 1. In total, there are 195 VC-backed and 93 non-VC-backed IPOs. Furthermore, I observe considerable more IPOs from VC-backing than from non-VC-backing with a disparity of 102 IPOs. This could indicate that the contribution of the VC increases the possibility of going public. Yet, these numbers could also portray the VCs' eagerness to have their portfolio firm go public. This belief is affirmed with the figures in Table 1.A. There, I observe a significant difference in firm age between VC-backed and non-VC-backed at the 1% significance level. This supports the idea of Gompers (1996) and Lee & Wahal (2004), who claim that VC-backed firms tend to be younger at the time of their IPO, because VCs' dominant objective is to bring their firm public as quickly as possible and are prepared to bear the costs associated with going public prematurely.

Figure 1: Number of IPOs by Year

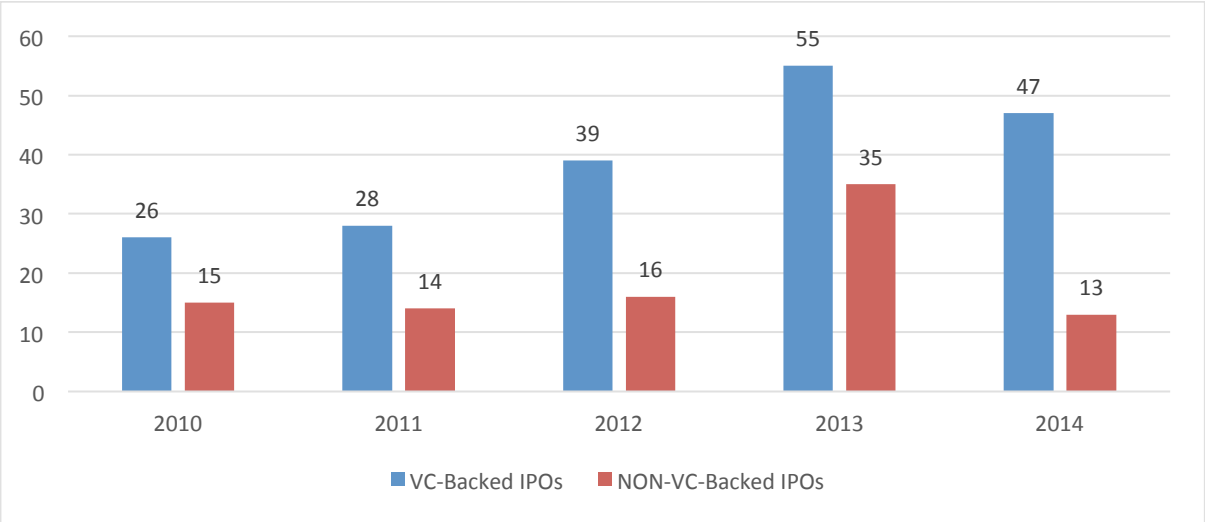

Figure 1 shows the number of IPOs by year with VC-backed IPOs in blue and non-VC-backed IPOs in red.

Table 1.A

IPO Characteristics VC-backed VS. Non-VC-backed

Table 1.A shows the mean and median values of the variables: Offer size, firm age, market capitalization, underwriter reputation and debt to equity ratio. The t-Test indicates the Student's t-Test which tests the mean difference between the two groups. N represents the number of observations.

	Mean		Median		
Variable	VC-Backed IPOs (N=193)	NON-VC-Backed IPOs (N=82)	VC-Backed IPOs (N=193)	NON-VC-Backed IPOs (N=82)	t-Test
Offer size	206	209	92	81.9	0.02
Firm age	9.77	12.62	9.23	9.4	2.76***
Market Capitalization in million $	1321	1187	440	359	-0.202
Underwriter with high reputation %	48.7	38.5			-1.53*
Debt to Equity ratio	-0.021	-1.292			-1.40*

*Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

Noticeable are the large differences between the mean and median values of Offer size and Market Capitalization. The spread of the market capitalization is documented in appendix C. I observe several outliers with the most prominent one being Facebook having a market capital of over 63 billion dollars. This causes the mean to jump to 1321 million, while without Facebook it would be 993 million. However, since it is not invalid to expect such an enormous IPO to occur periodically, the outliers are retained in the data sample. A more detailed table of these variables concerning the whole sample can be found in appendix C.

Table 1.B reports the long-run performance measures of one, two and three years after the IPO. I observe that the difference between VC-Backed IPOs and non-VC-Backed IPOs regarding return on assets increases during the years, while the reverse can be detected for the Market-To-Book value. The two performance measures mentioned show a dissimilar pattern over the years. Even though both measurements are calculated through assets being in the denominator, it does not inevitably imply that the explanation is found in the numerator. The difference between these measurements is that return on assets is calculated using total assets, while the market-to-book

value uses the net asset value. The net asset value does not include intangible assets such as patents. If VCs have a superior understanding regarding the value of patents, it is reasonable to assume that VC-backed firms would file patents more frequently. When this patent decreases in value, it would show in the return on assets, but not in the market-to-book value. Nevertheless, a more probable explanation is that the market values both type of firms similarly in the long-run, despite a disparity in net income.

Table 1.B

Long-run Performance Measures

Table 1.B shows the mean values of the variables: Return on assets- T+1, T+2 and T+3, market-to-book value- T+1, T+2 and T+3, survivability and buy-and-hold abnormal returns. The t-Test indicates the Student's t-Test which tests the mean difference between the two groups. N represents the number of observations.

	Mean		
Variable	VC-Backed IPOs (N=192)	NON-VC-Backed IPOs (N=80)	t-Test
Return on Assets T+1	-66.65	-46.76	0.82
Return on Assets T+2	-28.71	-50.73	-1.28*
Return on Assets T+3	-29.50	-80.97	-2.09**
Market-To-Book value T+1	5.67	-2.07	-2.17**
Market-To-Book value T+2	7.28	2.18	-2.22**
Market-To-Book value T+3	5.01	4.48	-0.21
Survivability %	72.5	82.1	1.65*
Abnormal Return %	9.86	1.32	-0.29

*Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

Another remarkable finding is that non-VC-backed firms have a higher probability to remain publicly listed at the 10% significance level. This outcome combats the literature regarding post-IPO monitoring and governance by VCs, which would suggest that those firms are better able to remain a public company with the guidance of VCs. However, this observation provides additional evidence in respect to the claim supported by Table 1.A. concerning the fact that VCs are eager to take their firms public. The lower percentage survivability signifies that the firms might not be mature and stable enough to be a listed firm.

Table 1.C

Venture Capital Reputation Measures

Table 1.C shows the mean values of each of the Venture Capital rankings. A rank consists of the variables VC age, capital under management and IPO frequency.

Venture Capital Rank	Age	Mean Capital Under Management	IPO Frequency
1	17.0	509	0.004
2	27.3	3487	0.125
3	23.9	1657	0.452
4	34.6	11423	0.191

Table 1.C presents the VC ranks with their average reputation measures. Per this ranking system, the VCs in the most reputable ranking do not, on average, score the highest on every aspect. The lower IPO frequency can be explained by the fact that the VCs with the both highest age and highest capital under management, are generally also the largest VCs. These VCs have the resources and capabilities to invest in numerous start-ups. Therefore, less firms will go public relatively, but in absolute numbers, these VCs still score the highest. An overview of the correlations between all the variables can be found in appendix C.

5. Methodology

In this study, several performance measures are employed to assess whether there is a significant difference in long-run post IPO performance between the two samples. First, the underpricing is calculated for the two samples. The underpricing is defined as the percentage change between the closing price on the first trading day $P_{i,CP}$ and the offer price $P_{i,OP}$ with i denoting the IPO. The underpricing is equal to the return an investor would receive when he would buy the shares immediately in the primary market and sell them at closing time in the secondary market (Bessler & Seim, 2012). This method is only valid in a market in which there is no lag between the first trading date and the application closing date (Kooli & Suret, 2001). Since there has been no evidence that this is an obstacle in this setting, I therefore use the following equation to calculate underpricing:

$$\text{Initial Underpricing}_i = \frac{P_{i,CP} - P_{i,OP}}{P_{i,OP}} \quad (1)$$

The first long-run performance measure is the return on assets. Hypothesis 2 tests the relationship between the return on assets, defined as the return on assets three years after the IPO, and the involvement of VC. The return on assets three years after IPO is taken as the dependent variable instead of the three-year average, since the latter might be subject to serial correlation (the three-year average regressions can be found in appendix D). To test the hypothesis, the following regression is performed with the ROA_{t+3} as the dependent variable*:*

(2)

$$ROA_{t+3} = \beta_0 + \beta_1 VCBacked + \beta_2 Ln(1 + OfferSize_i) + \beta_3 Ln(1 + Age_i) + \beta_4 MarketCap_i + \beta_5 URank_i + \beta_6 Underpricing_i + \beta_7 \frac{D}{E_i} + \beta_8 IPOyear_i + \varepsilon_i$$

With $VCBacked$ being the variable of interest, which is set up as a dummy variable that equals 1 when the firm is backed by a VC. The explanatory variables are the natural logarithm of the gross proceeds ($ln\ (1 + OfferSize)$), the natural logarithm of the age of the firm (ln (1+Age)), the market capitalization in the year of the IPO ($MarketCap$), a dummy variable representing the reputation of the underwriter ($URank$), which equals 1 for highly reputable underwriters, the initial underpricing ($Underpricing$) and the debt to equity ratio (D/E). Lastly, the variable $IPOyear$ represents several dummy variables for multiple years to control for events that affect all firms in that specific year.

Next, an analogous regression is performed for the third hypothesis, which tests the contribution of VC on the market-to-book ratio. For this regression, the market-to-book value of three years after the IPO is taken, since a regression on the average value of that period could be affected by serial correlation. Thus, the following regression is performed with market-to-book ratio, MtB_{t+3}, as dependent variable:

$$MtB_{t+3} = \beta_0 + \beta_1 VCBacked + \beta_2 Ln(1 + OfferSize_i) + \beta_3 Ln(1 + Age_i) + \beta_4 MarketCap_i + \beta_5 URank_i + \beta_6 Underpricing_i + \beta_7 \frac{D}{E_i} + \beta_8 IPOyear_i + \varepsilon_i \quad (3)$$

To test the relationship between VC involvement on the survivability, I employ a logit regression. A logit procedure would be preferred over other methods such as probit, as I can clearly interpret the results as odd ratios. The dependent variable is $Survival$, which equals 1 if the firm remained public for three years after their IPO. The explanatory variables are the same as the previous regressions.

$$\hat{p} = Survival = \beta_0 + \beta_1 VCBacked + \beta_2 Ln(1 + OfferSize_i) + \beta_3 Ln(1 + Age_i) + \beta_4 MarketCap_i + \beta_5 URank_i + \beta_6 Underpricing_i + \beta_7 \frac{D}{E_i} + \beta_8 IPOyear_i + \varepsilon_i \quad (4)$$

The final long-run performance measure is based on the buy-and-hold abnormal stock returns. This measure compares the difference between the realized buy-and-hold returns to the average buy-and-hold returns of the market index. The returns will be computed daily per the following formula:

$$BHAR_{750td} = \frac{1}{n}\sum_{i=1}^{n}\left[\left(\prod_{t=1}^{\tau}(1 + R_{i,t})\right) - \left(\prod_{t=1}^{\tau}(1 + R_{M,t})\right)\right] \quad (5)$$

where $(1 + R_{i,t})$ stands for the return of firm i at time t and $(1 + R_{M,t})$ represents the return of the market index for the same date. The returns will be calculated from the second trading day to avoid incorporating the initial underpricing effects. These abnormal returns are then regressed against the same explanatory variables as in the previous hypotheses:

(6)

$$BHAR = \beta_0 + \beta_1 VCBacked + \beta_2 Ln(1 + OfferSize_i) + \beta_3 Ln(1 + Age_i) + \beta_4 MarketCap_i + \beta_5 URank_i + \beta_6 Underpricing_i + \beta_7 \frac{D}{E}_i + \beta_8 IPOyear_i + \varepsilon_i$$

Ultimately, the quality of the VC is examined. The rank average of the determinants of the VC reputation (age, capital under management and IPO frequency) are the variables of interest in the following regression:

$$LRP = \beta_0 + \beta_1 VCRank + \beta_2 Ln(1 + OfferSize_i) + \beta_3 Ln(1 + Age_i) + \beta_4 MarketCap_i + \beta_5 URank_i + \beta_6 Underpricing_i + \beta_7 \frac{D}{E}_i + \beta_8 IPOyear_i + \varepsilon_i \quad (7)$$

where LRP represents the four long-run performance measures: return on assets, market-to-book, survivability and buy-and-hold abnormal returns. $VCRank$ stands for the reputation of the VC and is constructed as a categorical variable, which is divided into four ranks. These reputation measures will also be regressed individually, to observe the direct correlation between the performances and the VC characteristics.

6. Results

In this empirical analysis, the hypotheses are answered in sequence. Thus, I will start by examining the underpricing at the time of the IPO, followed by the analysis of VC contribution on long run performance measures. Ultimately, these performance measures will be investigated further by focusing on the impact of VC reputation.

6.1 Underpricing

Table 2 presents the Student's t-Test analysis of the underpricing between the two types of IPOs. In a total of 275 observations, I find that the mean for the VC-backed IPOs is higher than the non-VC-backed IPOs at the 1% significance level. This finding contradicts previous research, such as Megginson & Weiss (1991), which claim that the VC involvement reduces information asymmetry and therefore decreases the level of underpricing. Yet, my sample displays the opposite effect and is in accordance with Lee & Wahal (2004). This effect can be explained by the grandstanding theory, also witnessed in the summarizing statistics. When VCs are rated on the number of firms they take public, they will presumably also take too immature and inexperienced firms public. This results in an increase in information asymmetry between the firm and investors and thus an increase in the level of underpricing.

Table 2

Underpricing of VC-backed- and Non-VC-backed IPOs.

Table 2 shows the mean value of underpricing and standard deviation of VC-backed firms

and non-VC-backed firms. The t-Test indicates the Student's t-Test which tests the mean difference between the two groups

	Number of Observations	Mean	Standard Deviation	t-Test
Venture Capital Backed	193	0.227	0.353	-3.35***
Non-Venture Capital Backed	82	0.081	0.245	

*Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

6.2 Long-run performance measures result

6.2.1 Return on assets performance measure

The cross-sectional regression on the return on assets in first, second and third year after the IPO can be found in table 3. The first noticeable outcome is the insignificance of VC-backing on the performance measure. It appears that the contributions of VC in terms of monitoring and governance, do not have a significant impact on the profit a firm can gain relative to its assets. However, it can also be argued that VC involvement still is valuable, but that the management of the non-VC-backed firms are not inferior to VCs. If those managers could build the company up by themselves and even get the company listed, they would also have the capabilities to acquire a similar amount of net income relative to their total assets. Nevertheless, this finding does indicate that VC-backed firms do not outperform non-VC-backed firms on the criterion of return on assets, which is in conformity with prior findings, such as Krishnan et al (2011).

The two control variables, LNOFFERSIZE and LNAGE, remain significant throughout the three years. The positive effect of the offer size does weaken as the period increases, which should be expected, as the effect from the IPO diminishes. The effect of age stays fairly constant over the three years. Furthermore, I find that the market capitalization is negatively correlated with return on assets in the first two years after IPO. Since market capitalization is a proxy for firm size, it is closely related to total assets. Therefore, when market capitalization increases, I can expect the total assets to increase as well and the return on assets to decrease. Underpricing shows a correlation at the 5% significance level in year one and three. Additional research is required to assess whether this is due to the slow long-term adjustment proposed by Shefrin (2002).

Several IPO years show a significant effect on the return on assets compared to the base year of 2010. Only for 2013, this effect is still significantly present at 5% in the third year after the IPO. This suggests that the IPOs which occurred in 2013 have a significantly lower long-term firm performance in terms of return on assets compared to IPOs in 2010.

Table 3

Return on Assets performance measure on VC-Backing

Table 3 shows the cross-sectional regression estimates of a sample of 259 and 253 US high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable ROA T+i is defined as the net income divided by the total assets for one, two and three years after the IPO. VCBACKED is a dummy variable, which equals 1 if the IPO is backed by a VC. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. UNDERPRICING is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

	(1)	(2)	(3)
VARIABLES	ROA T+1	ROA T+2	ROA T+3
VCBACKED	-17.59	22.74	59.63
	(19.28)	(17.66)	(46.04)
LNOFFERSIZE	72.01**	21.68**	26.80*
	(31.40)	(10.15)	(14.71)
LNAGE	32.23***	40.87**	36.56**
	(11.57)	(17.78)	(17.94)
MARKETCAP	-0.661*	-0.174*	-0.172
	(0.341)	(0.0940)	(0.148)
URANK	13.69	4.933	10.22
	(14.07)	(11.75)	(8.539)
UNDERPRICING	32.53*	41.64	21.13*
	(17.54)	(27.41)	(12.48)
D/E	1.444	8.263	-6.932
	(3.782)	(11.18)	(4.731)
2011	44.92***	-15.16	-16.38
	(16.64)	(11.97)	(17.86)
2012	-25.43	-19.99	-7.288
	(15.78)	(13.13)	(14.59)
2013	54.79***	-48.30**	-47.82**
	(16.98)	(19.85)	(20.49)
2014	140.2***	-44.13**	-85.05
	(44.25)	(21.71)	(54.44)
Constant	398.9***	-221.9***	-265.5**
	(131.9)	(62.04)	(114.6)
Observations	249	249	243
R-squared	0.190	0.133	0.097

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

6.2.2 Market-to-book value performance measure

Table 4 reports the cross-sectional regressions performed on the proxy for Tobin's q, namely the market-to-book value. I find that virtually none of the control variables are significantly correlated with the dependent variable. However, I do observe a positive effect for the variable of interest, VC backing, on the market-to-book value in the second year at the 5% significance level. This could suggest that in a new and tumultuous phase of the firm, such as the year after the IPO, even VC guidance is not influential enough to achieve a significantly better market-to-book value. To have this phenomenon occur in the second year can be attributed to a delay in investor evaluation. The insignificance in the third year is explained by the diminishing effect of the VC in the long-run. Still, we should not rule out the possibility that this significance is due to a coincidental correlation. Yet, further research is necessary to provide a concise explanation.

In the model, the regression of $VCBACKED$ on only $MTBV_{t+1}$ and $MTBV_{t+3}$, already showed the insignificance of $VCBACKED$. Adding more explanatory variables to the model, did alter the beta-coefficient, but did not prove to be any worth in making the variable significant. Since we do assume that these variables are usually correlated with the dependent variable based on previous research, I opt to retain these variables in the regression model. The long-run insignificance of VC is not consistent with the findings of Lin et al. (2017) for the high-tech industry specifically. However, since their sample consists of IPOs between 1983 and 2013, a difference in results might be expected. The IPOs that took place in 2012 and 2014 both show a positive correlation with the market-to-book value in the third year after IPO at the 5% significance level. This indicates that the IPOs in these two years have on average a higher market-to-book value compared to the base year of 2010.

Table 4

Market-to-book value performance measure on VC-backing

Table 4 shows the cross-sectional regression estimates of a sample of 258 and 257 US high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable MTBV T+i is defined as the number of shares times the share price, divided by the net asset value for one, two and three years after the IPO. VCBACKED is a dummy variable, which equals 1 if the IPO is backed by a VC. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

VARIABLES	(1) MTBV T+1	(2) MTBV T+2	(3) MTBV T+3
VCBACKED	9.047	5.832**	-1.392
	(6.692)	(2.499)	(4.461)
LNOFFERSIZE	3.233	-0.0324	-3.003
	(2.205)	(1.233)	(3.013)
LNAGE	1.144	-1.909	3.701
	(1.711)	(1.558)	(3.555)
MARKETCAP	-0.0160	0.00511	0.0317
	(0.0205)	(0.0125)	(0.0276)
URANK	-7.655	-3.807	2.058
	(5.075)	(2.408)	(1.835)
UNDERPRICING	-0.286	2.536	4.884
	(1.944)	(3.165)	(3.471)
D/E	-0.0343	-0.434	0.0239
	(0.211)	(0.296)	(0.346)
2011	2.096	-0.917	3.237
	(4.576)	(2.053)	(2.911)
2012	-2.924*	1.663	3.757**
	(1.713)	(1.744)	(1.616)
2013	-6.911	2.782	-1.301
	(4.994)	(3.167)	(3.054)
2014	-2.623	2.339	3.860**
	(2.171)	(2.093)	(1.811)
Constant	-13.86	5.735	7.306
	(11.32)	(6.343)	(10.88)
Observations	248	248	247
R-squared	0.056	0.051	0.042

*** Significance level is 1%.

**Significance level is 5%.

* Significance level is 10%.

6.2.3 Survivability performance measure

The findings regarding the survivability of the firms are presented in Table 5. The logit model does not indicate that there is a significant relationship between $VCBACKED$ and the ability to remain listed. This, again, provides some evidence towards the grandstanding disposition ascribed to VCs. The supervision and counseling provided by VCs after the IPO could be offset by the number of immature firms going public. Furthermore, it shows that the management of the firms which are not backed by VCs, are equally capable of maintaining a public status. This is consistent with the results from Chou, Cheng & Chien (2013), who conclude that IPOs backed by conventional VCs were equally likely to remain public. Yet, they did find that highly reputable VCs affected the survivability of those investment firms positively.

There is a negative correlation between the debt to equity ratio and the survivability of a firm at the 10% significance level. This result is in accordance with finance theory, as more leverage can imply higher distress costs, which could result in the delisting of the firm. Furthermore, the only IPOs

which show a significant positive difference compared to the IPOs in the base year is 2014. This result suggests that the most recent three years were more stable compared to the years 2010 to 2013. The latter time period could be affected by the aftermath of the crisis, the US Financial Regulations Bill and uncertainty regarding the US debt obligations[1].

Table 5

Survivability performance measure on VC backing

Table 5 shows the logit model estimates of a sample of 250 US high-tech IPOs between 2010 and 2014 with the standard errors in parentheses. A logit model is employed to assess whether VC backed firms have a greater possibility to remain listed. The Y variable is SURVIVAL, which equals 1 if the firm is still publicly listed three years after their IPO. The X-variables are defined as follows: VCBACKED is a dummy variable, which equals 1 if the IPO is backed by a VC. LNOFFERSIZE is the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

	(1)
VARIABLES	Survival
VCBACKED	-0.547
	(0.385)
LNOFFERSIZE	-0.113
	(0.269)
LNAGE	0.0140
	(0.267)
MARKETCAP	0.00689
	(0.00880)
UREP	-0.00747
	(0.337)
UNDERPRICING	0.147
	(0.498)
DE	-0.134*
	(0.0762)
2011	0.0459
	(0.519)
2012	0.0514
	(0.471)
2013	0.737
	(0.468)
2014	1.426**
	(0.559)
Constant	1.433
	(1.344)

[1] Source: Annenberg Learner (https://www.learner.org/series/econusa/interactivelabs/economic-timeline/)

Observations	250

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

6.2.4 Abnormal buy and hold returns performance measure

I find that the majority of firms do not perform better than the average index, 94 versus 169. When I split these between VC-backed and non-VC-backed, I find that 33% of the VC-backed and 44% of the non-VC-backed firms perform better than the market. Yet, the VC-backed firms still possess a higher buy-and-hold abnormal return. This can be explained with the spread of the returns depicted in Figure 2. The VC-backed firms have more stocks which significantly outperform the index and therefore cause an inflation to the mean value. The VC-backed stocks have a mean of 9.86%, while the non-VC-backed firms merely hold an average abnormal return of 1.32%.

Figure 2. Abnormal Buy-and-hold return spread VC-backed and non-VC-backed.

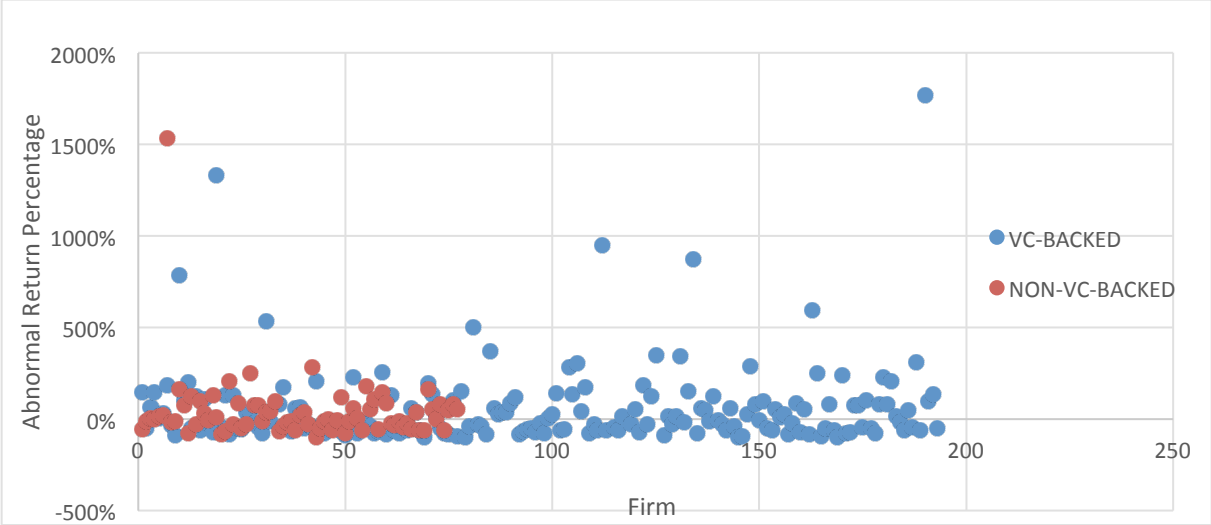

Figure 2 plots the individual firm abnormal returns of VC-backed (blue) and non-VC-backed (red) firms.

Nevertheless, the question remains whether investors are significantly more profitable when they would hold the VC-backed stock for 750 trading days after the IPO. The cross-sectional regression model is presented in Table 6. I find that almost none of the previously established explanatory variables are significantly correlated with the buy-and-hold abnormal returns. More noteworthy is the insignificant relationship between $VCBACKED$ and $BHAR$. This suggests that the involvement of VCs does not correlate with the abnormal stock returns. Thus, investors cannot acquire substantial profits by buying the VC-stock on the second trading day and holding it for 750 trading days before selling. This result is not in agreement with several previous studies, including Rindermann (2004)

and Bessler & Seim (2012). They attribute the significantly higher returns of VC-backed stocks to the contributions VC provides. In my sample, the insignificant abnormal returns are consistent with most of my previous tests, which showed that the involvement of VC did not significantly affect the long-run performance measure of the firms.

The only significant variable observed is the time fixed effect of 2012. We can interpret this as the IPOs in 2012 having a significant positive relation with the buy-and-hold abnormal returns. This implies that the abnormal returns of 750 trading days after the IPOs in 2012 significantly outperform the abnormal returns of those associated with the IPOs in 2010. Further research is required to find an explanation for this difference.

Table 6

Buy-and-Hold Abnormal Returns performance measure on VC backing

Table 6 shows the cross-sectional regression estimates of a sample of 257 high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable BHAR is defined as the difference between the firm stock returns and market index returns after 750 trading days. VCBACKED is a dummy variable, which equals 1 if the IPO is backed by a VC. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

	(1)
VARIABLES	BHAR
VCBACKED	0.111
	(0.288)
LNOFFERSIZE	-0.258
	(0.259)
LNAGE	-0.125
	(0.169)
MARKETCAP	0.00198
	(0.00206)
URANK	-0.0722
	(0.325)
UNDERPRICING	1.122
	(1.392)
D/E	-0.0563
	(0.0412)
2011	0.0737
	(0.413)
2012	0.816*
	(0.478)
2013	-0.423
	(0.448)
2014	-0.339
	(0.408)
Constant	1.247
	(1.243)

Observations	247
R-squared	0.081

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

6.2.5 Long-run performance measures on Venture Capital reputation

Since the significant differences and similarities between VC-backed and non-VC-backed IPOs have been analyzed, I will now further examine if there are significant associations within the VC-backed sample. Even though the VC backing variable might not show significance in most of the regressions, this does not inevitably imply that VC backing has no effect at all. In the VC-backed sample it is still possible to observe large differences between low- and high reputable firms, which would not lead to large variances in the mean. Therefore, the cross-sectional regressions on the dummy variables of VC ranks for the market-to-book ratio and the buy-and-hold abnormal returns are performed and presented in Table 7. The identical regression model for return on assets can be found in appendix E Table 8. The rankings are based on a weighted average of the measures: VC age, VC capital under management and VC IPO frequency. Remarkably, I find that, on average, the most reputable VCs do not significantly correlate with any of the performance measures. Instead, the VCs in the third ranking display a relationship with the market-to-book value in the second year. This third class of VCs contain the VCs with the highest IPO frequency scores. To examine whether this aspect of a VC is most essential, the long-run performances are regressed against the individual VC reputation measures. These results on the return on assets are displayed in Table 9. The regressions on the other long-run performance measures can be found in appendix E Table 10.

First $VCAGE$ and $IPOFREQ$ are significantly correlated with return on assets in the third year. This indicates that these two measures have a significant effect on the firm's performance in the long-run. For $VCAGE$, an increase in the age of the VC would correspond with a 0.289 gain in return on assets. Surprisingly, the IPO frequency of a VC is negatively correlated with the return on assets in the second and third year at the 10% and 5% significance level, respectively. This suggests that there is a relationship between the IPO frequency, and net income or total assets, which ultimately results in a decrease of the return on assets value. Only $VCCUM$ is significant in the first year and this carries onto the second year, while ceasing in the third year. This provides evidence for $VCCUM$ to be valuable in the short-run, but not in the long-run. Since the other reputation measures are not significant in the first year, it suggests that even reputable VCs have complications in positively affecting the return on assets shortly after the IPO. Furthermore, the same control variables as in the regressions of the whole sample remain significant, namely the firm age for all

three years and the offer size in the third year. Finally, the IPOs that occurred in 2014, show significantly lower return on assets compared to 2010 throughout the whole period.

Similar to the results from the between groups regressions, I observe that the influence of reputable VCs is not significantly associated with the market-to-book value. This is consistent with the results obtained by Krishnan et al. (2013), which followed Nahata (2008) and used VC age, VC capital and VC cumulative IPO market share as the reputation measures in their model. They also found no apparent relationship between these variables and the market-to-book value. Yet, my results deviate slightly to the outcomes generated by Krishnan et al. (2013) for the buy-and-hold abnormal returns. Whereas no significant correlation with any of the VC reputation variables is apparent in my model, they found a significant association between VC age and returns.

Table 7

Long-run Performance Measures on VC Rank

Table 7 shows the cross-sectional regression estimates of a sample of 189 high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable MTBV T+I is defined as the number of shares times the share price, divided by net asset value of the one, two and three years after the IPO. BHAR is defined as the difference between the firm stock returns and market index returns after 750 trading days. VCRANK stands for the level of reputation assigned. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

	(1)	(2)	(3)	(4)
VARIABLES	MTBV T+1	MTBV T+2	MTBV T+3	BHAR
VCRANK2	4.796	4.123	-3.713*	-0.0973
	(4.622)	(3.987)	(2.086)	(0.447)
VCRANK3	-0.115	6.577*	1.399	0.105
	(1.306)	(3.611)	(2.444)	(0.471)
VCRANK4	2.232	2.243	-0.311	0.0299
	(1.731)	(2.098)	(2.321)	(0.572)
LNOFFERSIZE	1.590	-3.390	-0.510	-1.157*
	(1.222)	(2.822)	(1.901)	(0.648)
LNAGE	2.852	-3.933	-0.218	-0.338
	(2.955)	(3.102)	(2.323)	(0.302)
MARKETCAP	-0.00264	0.0243	0.000278	0.00862*
	(0.0107)	(0.0232)	(0.0172)	(0.00499)
URANK	-2.873	-3.437	2.130	0.0645
	(2.332)	(2.747)	(1.932)	(0.392)
UNDERPRICING	1.272	5.086**	4.259*	1.731
	(1.366)	(2.341)	(2.516)	(1.541)
D/E	0.0218	-0.309	-0.00994	-0.0484
	(0.257)	(0.446)	(0.402)	(0.0615)
2011	6.573	-0.784	3.645	0.218
	(6.172)	(2.745)	(3.215)	(0.475)
2012	-1.651	1.025	3.554*	1.054*
	(1.267)	(2.164)	(1.903)	(0.609)
2013	-0.384	6.099	-2.196	-0.347

	(1.167)	(4.729)	(2.397)	(0.585)
2014	-1.263	2.044	3.478	-0.618
	(1.163)	(2.681)	(2.128)	(0.580)
Constant	-8.928	26.64*	5.013	5.649*
	(11.08)	(14.63)	(10.48)	(2.993)
Observations	189	189	188	186
R-squared	0.087	0.076	0.096	0.136

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

Table 9

Return on Assets and Individual VC Reputation Measures

Table 9 shows the cross-sectional regression estimates of a sample of 188 US high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the low- and high reputable VCs. The dependent variable ROA T+i is defined as the net income divided by the total assets for one, two and three years after the IPO. VCAGE is defined as the years between the VC found date and IPO date. VCCUM stands for the capital under management in millions of dollars and IPOFREQ is the ratio of public firms over all firms in a VC active portfolio over the last three years. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day.

	(1)	(2)	(3)
VARIABLES	ROA T+1	ROA T+2	ROA T+3
VCAGE	-0.445	0.887**	0.289**
	(0.768)	(0.375)	(0.116)
VCCUM	0.0860*	0.0685***	0.0128
	(0.0454)	(0.0203)	(0.0144)
IPOFREQ	-8.800	-29.93*	-16.85**
	(18.67)	(16.32)	(7.243)
LNOFFERSIZE	131.5	-26.63	14.69**
	(87.52)	(23.03)	(5.821)
LNAGE	70.24***	66.47**	18.13***
	(22.94)	(26.23)	(4.731)
MARKETCAP	-1.157	0.272	-0.0778
	(0.819)	(0.206)	(0.0522)
URANK	21.80	-1.733	1.531
	(16.34)	(13.00)	(4.615)
UNDERPRICING	10.17	48.94	2.147
	(21.65)	(32.30)	(4.392)
D/E	5.843*	18.30	0.0527
	(3.246)	(15.52)	(1.001)
2011	-56.56*	5.302	9.220
	(32.87)	(14.26)	(8.274)
2012	-19.82	-14.11	7.604
	(20.35)	(12.60)	(7.851)
2013	-52.61**	-14.52	-5.100
	(23.76)	(12.27)	(7.337)

2014	-147.2***	-37.55*	-23.60***
	(47.70)	(20.86)	(8.468)
Constant	-758.9**	-74.64	-138.7***
	(378.5)	(69.85)	(27.93)
Observations	188	188	185
R-squared	0.237	0.251	0.368

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

7. Robustness analysis

A robustness test is performed to investigate how the regression betas react to modifications in the model. This is typically performed by adding and subtracting variables from the model. When "core" coefficients are insensitive to the adding and dropping of the regressors, then the model can be claimed to be valid for causal inference (Lu & White, 2014).

In this research, the robustness test will be performed using Cook's distance, which identifies potential influential outliers using the F-distribution. Any observation with a Cook's distance greater than 1, will be dropped from the regression. Additionally, the Cook's distance measure will assign weights to the different variables. The larger the residual, the lower the weight will be. In other words, the variables with highest residuals will have the lowest weight. These weight assignments for the ten highest absolute standardized residuals are visible in table 12. I observe that several VCs are allocated a weight of 0 and are therefore dropped from the regression. In addition, the figure on buy-and-hold abnormal returns with leverage on the y-axis and normalized residual squared on the x-axis is displayed in appendix F.

Table 12

Cook's Distance Weights assignment per Venture Capital

Venture Capital name	Weight	Absolute Residual
1. Thomas Mcnerney and Partners LLC	0	2.129781
2. Alta Partners	0	2.92508
3. ProQuest Investments	0	1.928114
4. Balyasny Asset Management	0	3.524349
5. Walden International	0	5.311316
6. Venrock Inc	0	6.371092
7. Charter Venture Capital	.00608569	1.234533

8.	Highland Capital Partners LLC	.01962569	1.170329
9.	Versant Venture Management, LLC	.13186998	1.368192
10.	RRE Ventures LLC	.19781654	1.249613

The robust regression model of VC reputation measures on the long-run performance measures is displayed in table 13. Noticeable are that several regressions now contain fewer observations compared to the ordinary least squares regression. This indicates that indeed several observations have been dropped, due to these outliers being deemed too influential per the Cook's distance computation.

We observe that the coefficients of all the explanatory variables have changed, also for the significant ones. Still, the significant betas previously are largely the same, except for the coefficients of return on assets in the second year. There $IPOFREQ$ increased from -16.85 to -10.61 and $LNAGE$ from 18.13 to 23.47.

Table 13
Robust Regression of the Long-run Performance Measures

Table 13 shows the robust regression estimates of a sample of 179 US high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the low- and high reputable VCs. The dependent variable ROA T+i is defined as the net income divided by the total assets for one, two and three years after the IPO. MTBV T+i is defined as the number of shares times the share price, divided by net asset value of the one, two and three years after the IPO. BHAR is defined as the difference between the firm stock returns and market index returns after 750 trading days. VCAGE is defined as the years between the VC found date and IPO date. VCCUM stands for the capital under management in millions of dollars and IPOFREQ is the ratio of public firms over all firms in a VC active portfolio over the last three years. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day.

	(1)	(2)	(3)
VARIABLES	ROA T+3	MTBV T+3	BHAR
VCAGE	0.253**	0.00216	-0.00159
	(0.123)	(0.0193)	(0.00498)
VCCUM	0.0123	0.00485*	0.000128
	(0.0158)	(0.00249)	(0.000696)
IPOFREQ	-10.61**	-1.028	0.192
	(4.430)	(0.694)	(0.178)
LNOFFERSIZE	9.170**	0.466	-0.0844
	(4.241)	(0.661)	(0.183)
LNAGE	23.47***	0.366	0.0372
	(3.981)	(0.624)	(0.160)
MARKETCAP	-0.0326	-0.00326	0.00137
	(0.0504)	(0.00789)	(0.00208)
URANK	4.337	0.454	0.364**
	(3.753)	(0.585)	(0.150)
UNDERPRICING	1.763	1.256	-0.115
	(5.310)	(0.834)	(0.259)

D/E	0.889	0.138	-0.0199
	(0.869)	(0.137)	(0.0349)
2011	5.254	2.524**	0.471*
	(6.974)	(1.058)	(0.272)
2012	5.170	1.455	0.555**
	(6.459)	(0.976)	(0.250)
2013	-7.140	1.590*	-0.00102
	(6.226)	(0.942)	(0.242)
2014	-22.14***	1.747*	-0.0730
	(6.414)	(0.966)	(0.249)
Constant	-123.5***	-0.605	-0.438
	(21.20)	(3.251)	(0.879)
Observations	179	182	179
R-squared	0.391	0.112	0.117

8. Conclusion

8.1 Summary

This paper examines the long-run performances of VC-backed high-tech IPOs in the US between 2010 and 2014. Since VCs do not only provide net capital, but also monitoring, governing and signaling, it can be expected that those contributions also affect the firm's performance. Previous studies find that these contributions also continue after the IPO, but are ambiguous regarding the influence of VC on the firm's long-run performance. However, previous literature does find significant correlations between the reputation of the VC and the firm's performance after the IPO. Therefore, this paper compares two samples of VC-backed and non-VC-backed firms using multiple performance measures and regressions. Additionally, this study analyzes the effect of highly reputable VCs over conventional VCs.

While past research mostly find that VC-backed firms experience a lower degree of underpricing, I find the contrary, namely higher levels of underpricing. In addition, the results show a significant difference in the firm age before IPO between VC-backed and non-VC-backed firms. These outcomes provide some evidence in favor of Gompers' (1996) grandstanding theory in which VCs aspire to take the firm public as fast as possible and are willing to bear any negative consequences, such as a higher underpricing and a possible higher delisting likelihood.

Furthermore, I find that the involvement of VCs is not significantly correlated for three years after the IPO with the long-run performance measures: return on assets, market-to-book ratio and buy-and-hold abnormal returns. More surprising, I also find little evidence of VC-backing being significantly associated with the firm performances in the short-run. Nevertheless, the study does detect a limited amount of evidence in favor of highly reputable VCs, since the reputation measure

VCAGE shows a positive correlation with the return on assets in the long-run. Yet, only the return on assets performance measure exhibits any significance regarding the individual reputation measures.

8.2 Limitations and suggestions for further research

There are several limitations to which this paper is subject to. Firstly, the sample of non-VC-backed IPOs is rather small. Therefore, a wider period or the expansion towards various other industries with industry dummies should increase the data sample, and could possibly allow for more significant results. Secondly, a better quantifiable VC reputation measure could be employed as the main variable of interest. The VC dollar market share is an example of such a variable. Unfortunately, the necessary databases were inaccessible during the time of this research. Additionally, a time series regression could be added to the analysis, to predict the values of future performance measures and examine to what extent the predictions differ between VC-backed and non-VC-backed firms. At last, this research merely considers the firm performance post-IPO. Further research could investigate how these firms were performing before and after IPO, i.e. between -1 and +1. The analysis could provide additional insight to what extent the market recognizes the value of VC involvement.

8.3 Practical implications

Ultimately, this research could initiate some practical implications. First, the importance of the VC reputation is not as essential as previous research declared. Therefore, VCs should not be eager to take a firm public at all costs. Furthermore, it is obvious that firms are ecstatic when they receive VC funding, however, they should also be attentive, because this research cannot acknowledge the significant contributions VCs have on the long-run performances. Also, VCs might take the firm public, while it is not completely prepared, which could result in early delisting.

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10. Appendix

Appendix A.

Table 12

Overview of the SIC-codes to sample high-tech firms

Table 12 shows an overview of the SIC-codes and their description to sample high-tech firms.

283	Medicinal Chemicals and Botanical Products	**384**	Surgical and Medical Instruments and Apparatus
	Pharmaceutical Preparations		Orthopedic, Prosthetic, and Surgical Appliances and Supplies
	In Vitro and In Vivo Diagnostic Substances		Dental Equipment and Supplies
	Biological Products, Except Diagnostic Substances		X-Ray Apparatus and Tubes and Related Irradiation Apparatus
357	Electronic Computers		Electromedical and Electrotherapeutic Apparatus
	Computer Storage Devices	**481**	Radiotelephone Communications
	Computer Terminals		Telephone Communications, Except Radiotelephone
	Computer Peripheral Equipment	**482**	Telegraph and Other Message Communications
	Calculating and Accounting Machines, Except Electronic Computers	**737**	Computer Programming Services
	Office Machines, Not Elsewhere Classified		Prepackaged Software
366	Telephone and Telegraph Apparatus		Computer Integrated Systems Design
	Radio and Television Broadcasting and Communications Equipment		Computer Processing and Data Preparation and Processing Services
	Communications Equipment		Information Retrieval Services
367	Electron Tubes		Computer Facilities Management Services
	Printed Circuit Boards		Computer Rental and Leasing
	Semiconductors and Related Devices		Computer Maintenance and Repair
	Electronic Capacitors		Computer Related Services
	Electronic Resistors	**873**	Commercial Physical and Biological Research
	Electronic Coils, Transformers, and Other Inductors		Commercial Economic, Sociological, and Educational Research
	Electronic Connectors		Noncommercial Research Organizations
	Electronic Components		Testing Laboratories
382	Laboratory Apparatus and Furniture		
	Automatic Controls for Regulating Residential and Commercial Environments and Appliances		
	Industrial Instruments for Measurement, Display, and Control of Process Variables; and Related Products		
	Totalizing Fluid Meters and Counting Devices		
	Instruments for Measuring and Testing of Electricity and Electrical Signals		
	Laboratory Analytical Instruments		
	Optical Instruments and Lenses		
	Measuring and Controlling Devices		

Appendix B.

Figure 4a: Histogram of the variable OFFER SIZE

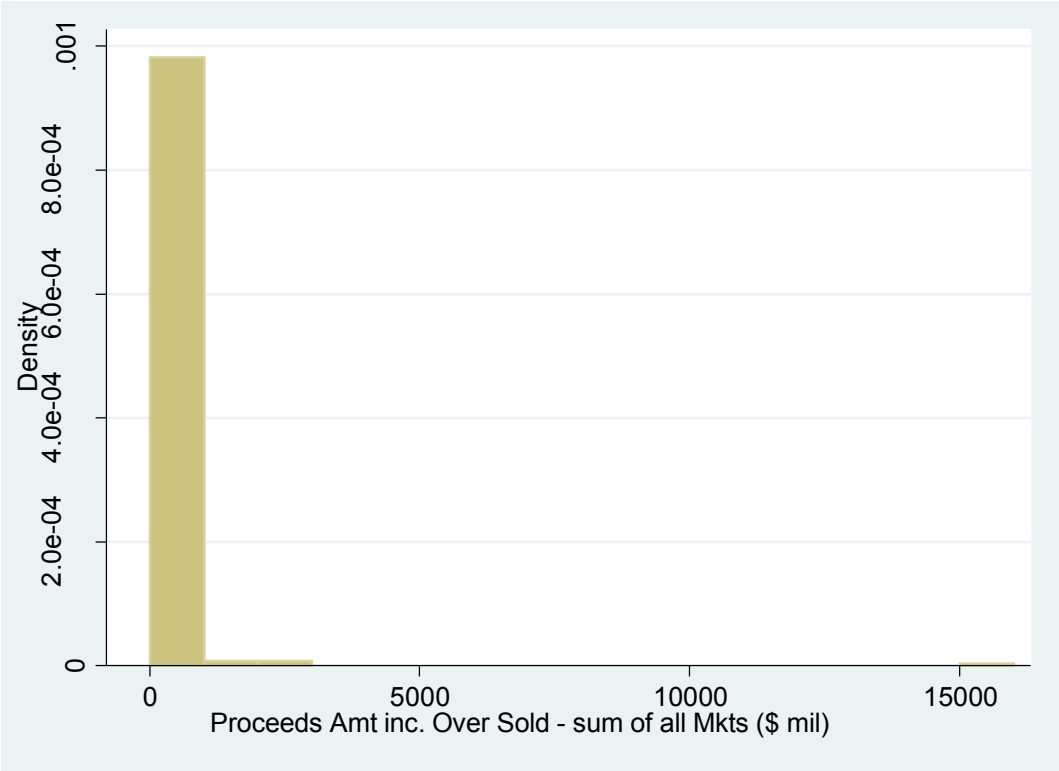


Figure 4b: histogram of the variable LN OFFER SIZE

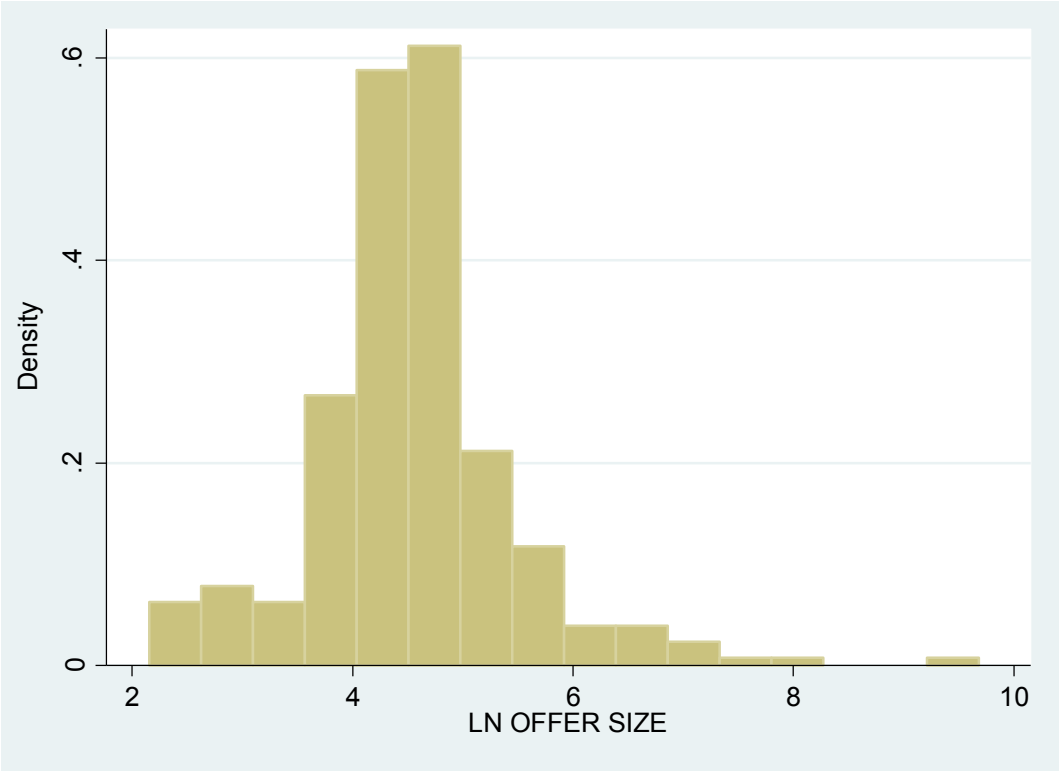


Figure 5a: Histogram of the variable AGE

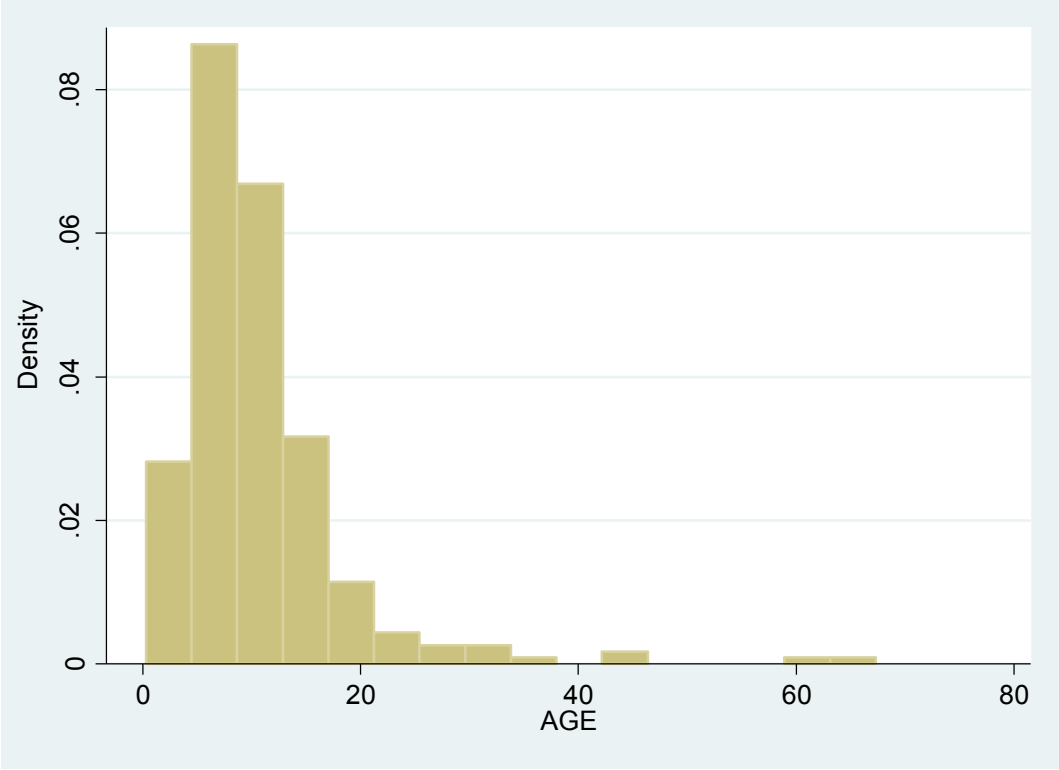
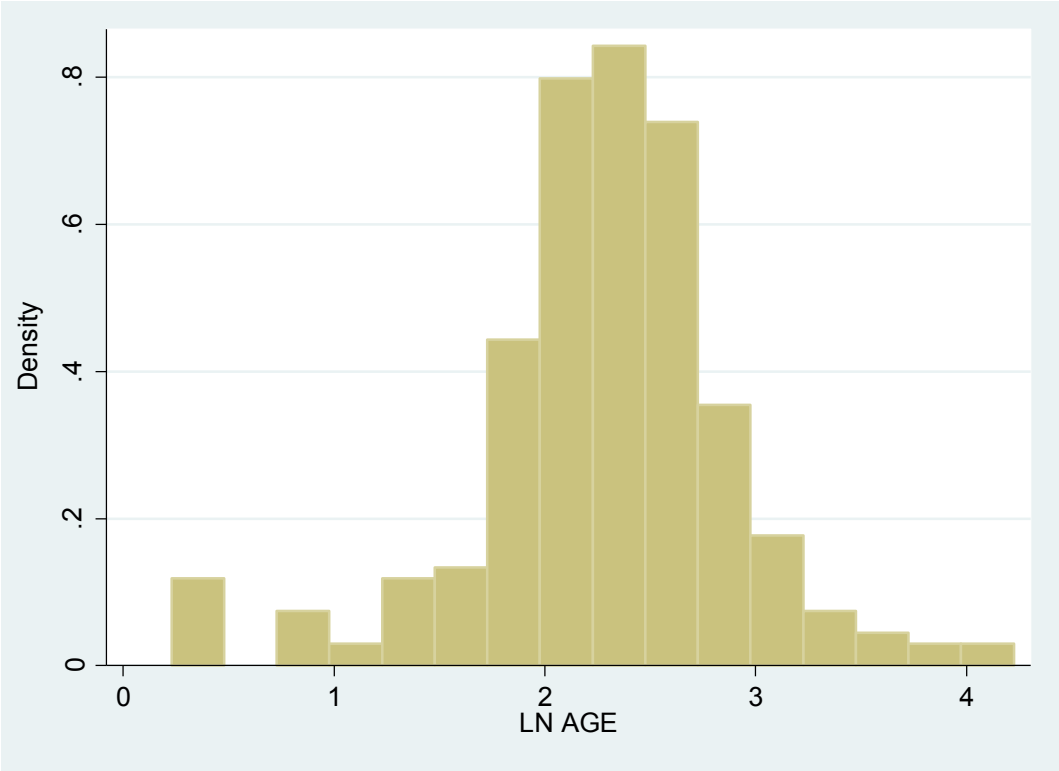


Figure 5b: Histogram of the variable LN AGE



Appendix C.

Table 14

Summary statistics on the variables (whole sample)

Table 14 shows the descriptive statistics of the explanatory variables. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO.

Variable	Number of observations	Mean	Median	Standard Deviation	Min	Max
LNOFFERSIZE	275	4.54	4.51	0.94	2.15	9.68
LNAGE	275	2.27	2.32	0.62	0.23	4.22
Market Capitalization in million $	262	12.85	4.28	47.45	0.00	631.42
Underwriter with high reputation %	275	0.46	0	.50	0	1
Debt to Equity ratio	260	-0.36	0	6.49	-98.62	16.43

Table 15

Summary statistics on performance measures (whole sample)

Table 15 shows the descriptive statistics of the dependent variables. The long-run performance measures are Return on Assets t+3, Market-to-Book value t+3, survivability and Buy-and-Hold abnormal returns.

Variable	Number of observations	Mean	Median	Standard Deviation	Min	Max
Return on Assets T+1	262	-61.31	-21.42	174.07	-2078.93	468.81
Return on Assets T+2	262	-34.62	-17.34	123.06	-976.60	1204.10
Return on Assets T+3	256	-43.02	-19.05	173.98	-2527.95	65.08
Market-To-Book value T+1	260	3.64	3.34	25.40	-356.9	172.27
Market-To-Book value T+2	260	5.95	3.65	16.43	-48.15	182.81
Market-To-Book value T+3	259	4.87	3.53	18.13	-84.99	219.33
Survivability %	273	0.75	1	0.43	0	1
Abnormal Return %	263	0.07	-0.54	2.17	-1.48	17.22

Figure 6: Market Capitalization in millions of dollars

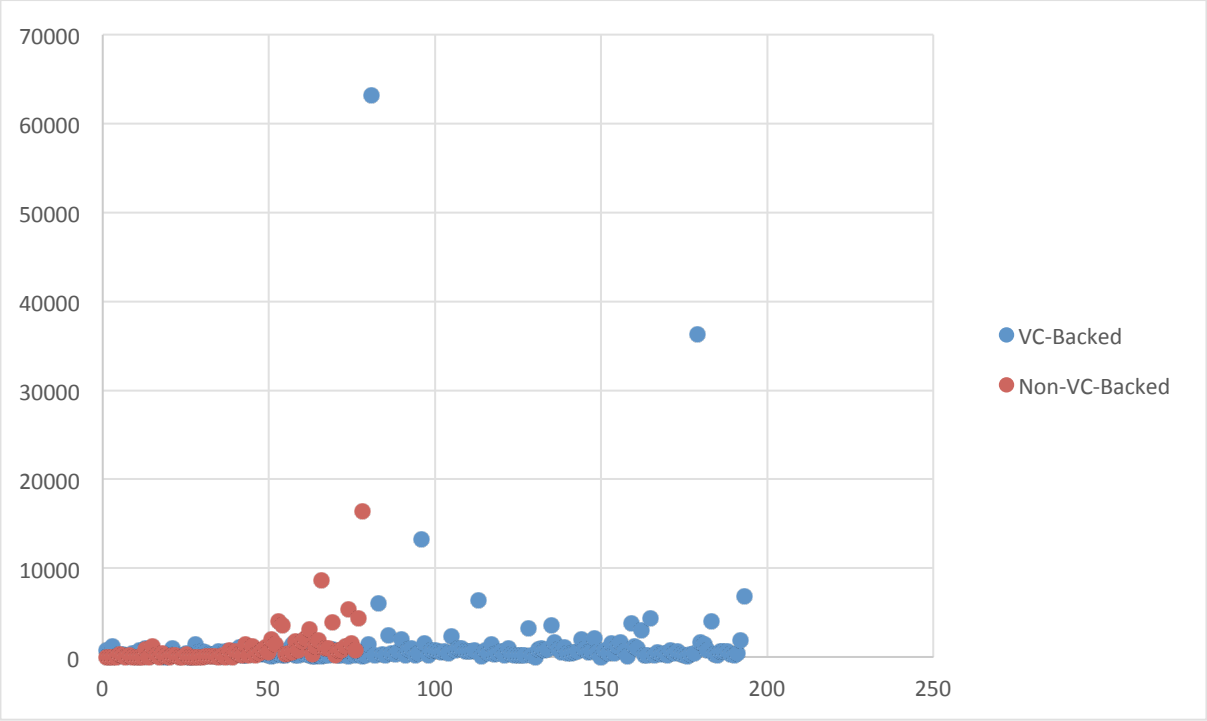


Figure 6 shows the market capitalization in millions of dollars

for VC-backed firms (blue) and non-VC-backed firms (red).

Table 11

Overview of correlations between variables

VCBACKED	Return~1	Return~2	Return~3	Market~1	Market~2	Market~3	LNOFFE~E	LNAGE	MARKET~P	URANKK	U~PRICING
VCBACKED	1										
ReturnOnAs~1	-0.0477	1									
ReturnOnAs~2	0.0867	0.2326	1								
ReturnOnAs~3	0.1327	0.2423	0.411	1							
MarketToBo~1	0.1411	-0.006	0.0157	0.0337	1						
MarketToBo~2	0.1412	-0.0145	0.015	0.0416	0.1912	1					
MarketToBo~3	0.011	0.0129	0.161	0.1213	0.1022	0.0494	1				
LNOFFERSIZE	-0.0137	0.2945	0.1558	0.1465	0.0401	-0.0323	-0.0429	1			
LNAGE	0.0704	0.0899	0.1928	0.1106	0.0238	-0.062	0.1156	-0.0415	1		
MARKETCAP	0.008	0.0683	0.0453	0.0568	0.0092	-0.0008	0.015	0.6033	0.0118	1	
UNDERWRANK	0.0266	0.209	0.1204	0.1225	-0.0903	-0.0991	0.0057	0.45	0.0131	0.1868	1
UNDERPRICING	0.1886	0.0982	0.1413	0.0667	0.0192	0.0731	0.0628	0.1983	-0.0065	0.0734	0.0651

Table 11 shows the correlation between the dependent variables as well as the independent variables.

Appendix D.

Table 16

Three-year average performance measure on VC backing

Table 16 shows the cross-sectional regression estimates of a sample of 259 high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable is the three-year average return on assets and the three-year average market-to-book value. VCBACKED is a dummy variable, which equals 1 if the IPO is backed by a VC. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day.

	(1)	(2)
VARIABLES	ROA 3yearaverage	MTBV 3yearaverage
VCBACKED	11.55	-3.376
	(15.45)	(2.339)
LNOFFERSIZE	41.43***	2.612
	(10.52)	(1.599)
LNAGE	29.06***	-1.332
	(10.88)	(1.662)
MARKETCAP	-0.324*	-0.0224
	(0.178)	(0.0268)

URANK	12.26	-0.114
	(15.21)	(2.270)
UNDERPRICING	21.79	0.636
	(21.16)	(3.166)
Constant	-316.0***	0.625
	(53.08)	(8.180)
Observations	259	257
R-squared	0.127	0.027

* Significance level is 10%.

**Significance level is 5%.

*** Significance level is 1%.

Appendix E.

Table 8

Return on assets and VC rank

Table 8 shows the cross-sectional regression estimates of a sample of 189 high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable ROA T+i is defined as the net income divided by the total assets for one, two and three years after the IPO. VCRANK stands for the level of reputation assigned. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

VARIABLES	(1) ROA T+1	(2) ROA T+2	(3) ROA T+3
VCRANK2	-6.105	-33.36	3.870
	(28.28)	(22.02)	(6.130)
VCRANK3	14.60	-16.43	-7.305
	(30.58)	(19.51)	(5.743)
VCRANK4	-24.23	-1.211	-0.597
	(55.71)	(15.90)	(6.275)
LNOFFERSIZE	133.3	-16.76	17.96***
	(84.91)	(20.58)	(5.698)

LNAGE	62.84**	63.17**	17.49***
	(24.29)	(25.11)	(4.638)
MARKETCAP	-1.197	0.173	-0.0957*
	(0.810)	(0.184)	(0.0501)
UREP	21.92	5.661	3.397
	(16.13)	(11.98)	(4.808)
UNDERPRICING	7.421	48.83	-2.528
	(23.32)	(32.53)	(4.379)
D/E	5.926*	18.63	0.281
	(3.311)	(15.63)	(0.912)
YEAR2	-55.64*	-3.691	9.056
	(31.58)	(13.76)	(8.442)
YEAR3	-16.20	-15.20	8.480
	(20.64)	(13.98)	(7.821)
YEAR4	-45.75*	-24.61*	-6.072
	(23.26)	(12.86)	(7.665)
YEAR5	-141.4***	-45.36**	-24.10***
	(42.63)	(22.08)	(8.815)
Constant	-759.5**	-75.38	-146.3***
	(363.7)	(73.37)	(27.74)
Observations	188	188	185
R-squared	0.239	0.234	0.324

Table 10

Return on assets and VC rank

Table 10 shows the cross-sectional regression estimates of a sample of 189 high-tech IPOs between 2010 and 2014 with the robust standard errors in parentheses. Student's t-tests are employed to identify if there is a significant difference between the means of the groups. The dependent variable MTBV T+I is defined as the number of shares times the share price, divided by net asset value of the one, two and three years after the IPO. BHAR is defined as the difference between the firm stock returns and market index returns after 750 trading days. VCAGE is defined as the years between the VC found date and IPO date. VCCUM stands for the capital under management in millions of dollars and IPOFREQ is the ratio of public firms over all firms in a VC active portfolio over the last three years. LNOFFERSIZE is defined as the natural logarithm of one plus the gross proceeds of the IPO, while LNAGE is defined as the natural logarithm of one plus the number of years between the firm was founded and date of IPO. The variable MARKETCAP stands for the market capitalization of the firm in the year of the IPO and URANK represents a dummy variable, which equals 1 if the underwriter achieved the perfect score. Underpricing is defined as the closing price minus the offer price, divided by the offer price, at the first trading day. D/E stands for the total debt divided by the total shareholder's equity. The years denote the year in which the IPO occurred.

	(1)	(2)	(3)	(4)
VARIABLES	MTBV T+1	MTBV T+2	MTBV T+3	BHAR
VCAGE	0.0206	0.115	0.0327	0.000526
	(0.0247)	(0.0777)	(0.0443)	(0.0139)
VCCUM	-0.000530	-0.00393	0.00442	-0.000477
	(0.00216)	(0.00475)	(0.00508)	(0.00118)
IPOFREQ	-0.758	7.530	1.724	0.205
	(1.905)	(7.506)	(4.638)	(0.297)
LNOFFERSIZE	1.677	-2.766	-0.732	-1.127*
	(1.236)	(2.127)	(2.067)	(0.647)

LNAGE	2.403	-4.766	-0.0253	-0.363
	(2.767)	(3.247)	(2.386)	(0.355)
MARKETCAP	-0.00769	0.0233	0.00703	0.00854*
	(0.0113)	(0.0204)	(0.0184)	(0.00501)
URANK	-2.598	-2.730	1.930	0.0792
	(2.104)	(2.619)	(1.758)	(0.372)
UNDERPRICING	2.318*	4.357	3.154	1.654
	(1.185)	(3.340)	(2.357)	(1.533)
D/E	-0.00543	-0.290	0.00885	-0.0468
	(0.205)	(0.356)	(0.383)	(0.0594)
2011	5.690	-1.254	4.432	0.253
	(5.538)	(2.367)	(2.933)	(0.489)
2012	-1.995	0.480	3.650*	1.072*
	(1.230)	(2.183)	(1.920)	(0.623)
2013	-0.691	6.515	-1.504	-0.315
	(1.132)	(4.395)	(2.391)	(0.660)
2014	-1.457	2.629	4.046*	-0.584
	(1.099)	(2.726)	(2.083)	(0.568)
Constant	-6.833	24.47*	3.308	5.524*
	(9.347)	(12.69)	(10.89)	(2.984)
Observations	189	189	188	186
R-squared	0.065	0.095	0.075	0.136

Appendix F.

Figure 7: Leverage and residuals spread of buy-and-hold abnormal returns

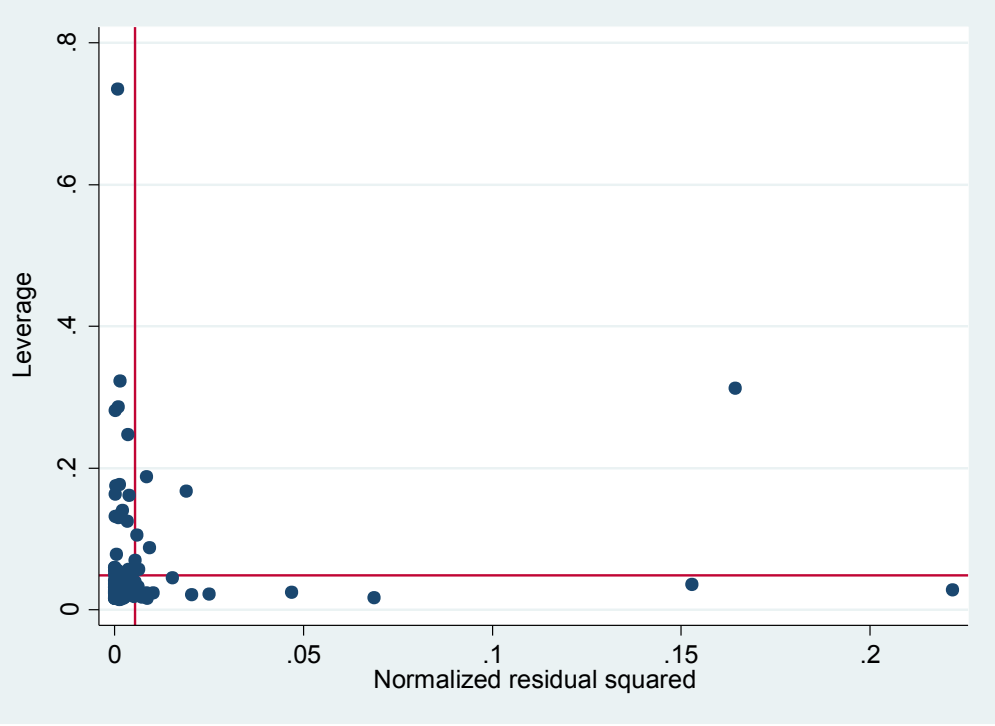


Figure 7 shows the residuals spread of the buy-and-hold abnormal returns. The x-axis presents the normalized residual squared and the y-axis the leverage.