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DO MORE REPUTABLE VENTURE CAPITALISTS ADD MORE VALUE?

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ABSTRACT

I examine the relationship between the reputation of venture capital (VC) firms and the performance of their portfolio companies when they go public. I find that VC reputation, measured with VC market share, has a significant and positive association with asset productivity at the initial public offering (IPO) and with corporate governance characteristics after the IPO. However, for the sample of VC-backed IPOs, I find a negative relationship between VC reputation and long-run performance, which is mainly driven by VCs with the highest reputation. VC reputation is inflated by IPOs with the highest proceeds, whereas other portfolio companies backed by the same VCs do not perform proportionally superior to their reputation. Additionally, more reputable VCs have better access to higher quality firms, but even after controlling for VC selectivity more reputable VCs are still connected to better asset productivity.

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1 INTRODUCTION

Most of the existing literature has shown that the reputation of VCs has a positive effect on their portfolio companies. However, the VC industry has undergone major changes, making it necessary to test if this positive relationship still holds true. In particular, as reputation is usually measured by market share of IPOs, many unicorns from the tech industry could bias the valuation as they have enormous amount of proceeds and thus boast VC reputation. Moreover, when making a purchase decision, a firm's reputation is by itself an important information and offers advantages to more reputable VCs. Reputation of VC firms is a crucial asset for VCs, to their investors and especially to potential portfolio firms. From the startup point of view, VCs bring important monitoring, advisory and network for the survival and growth of companies in the early stages. Also, startups are more likely to accept the offers from more reputable VCs even when offers form less reputable VCs bring higher funding to the firm. It seems that reputation is one of the crucial factors in the VC market. For this reason, my research question is if more reputable VCs indeed add incremental value to companies and provide better value-added services.

Over the past 30 years, VCs have enabled the USA to finance and support its entrepreneurs. The companies supported by VCs have greatly impacted the economy. Moreover, VC is generally believed to be crucial for new and innovative companies (Helmann & Puri, 2015). In the period between 1974 and 2016 more than 42% of public companies founded in the USA were backed by VCs. VC-backed firms also accounted for approximately 63% of market capitalization (Thornhill, 2016). Over the last years, VC industry has developed even further, and the trends have changed. While in 2017 average and median deal sizes reached a decade-high, fewer transactions were made and VC-backed companies stayed private longer (National Venture Capital Association, 2018). Apple, Google, Microsoft and Facebook are four of the five biggest American companies on July 2018. All four companies were funded by VC firms in early stage (data retrieved from Bloomberg).

The IPO market provides a peculiar environment for studying the role of VCs. First of all, VCs invest in private companies, which are not observable to public. Their position and activity become publicly recognizable at the IPO when the information is available in the offering prospectuses (Barry, Muscarella, Peavy & Vetsuypens, 1990). That is why I assess the influence of VC reputation on the IPO market. In order to infer on VCs influence of post-IPO performance on their portfolio companies, I use the data sample which consists of IPOs completed between 2007 and 2014 in the USA.

I apply a reputation measure defined as VC market share to my analysis, which is based on VC's past market share of completed IPOs. The measure is based on a 3-year moving window preceding the IPO date. It is important to examine the association between VC reputation (measured with VC market share) and post-IPO performance since younger VCs can have an incentive to grandstand and bring weaker firms to public. That is why it is not enough to simply correlate the measure to IPO frequency or IPO age (Krishnan, Ivanov, Masulis & Singh, 2011).

My primary goal is to examine if more reputable VCs indeed provide value-added services. I analyze whether VCs which specialize in financing promising early stage companies affect the long-run performance of IPOs. I further examine if companies backed by more reputable VCs have higher asset productivity at the time of IPO and outperform in the three years after the IPO. In addition, I investigate if more reputable VCs are connected to superior corporate governance characteristics.

First of all, I show that non-VC-backed IPOs significantly underperform VC-backed IPOs in the long run. This suggests that VCs provide value-added services to their portfolio companies that translates into better long-run performance. Second, I find that VC reputation has consistently a significant positive correlation with asset productivity of portfolio companies at the time of the IPO. The results demonstrate that within VC industry, more reputable VCs provide better value-added services which translate into superior operating efficiency in the short run. Third, the results from the study reject the positive relationship between VC reputation and long-run performance measures. What is more, there is a statistically significant negative relationship between VC reputation and long-run performance. These results are mainly driven by VCs that

backed unicorns, which are startups with a valuation of one billion dollars or more (Benner, 2015). Backing the IPOs with enormous amount of proceeds inflates the reputation of VCs, while other portfolio companies backed by the same VCs do not perform proportionally superior. The negative relationship between VC reputation and the long-run performance of their portfolio companies is an important indicator. Comparing the results with previous research, I show that the VC market indeed changed in recent years. However, when excluding the top 10th percentile of VCs with the highest reputation from the sample, I find that VC reputation has a positive relationship with the long-run performance measured by buy-and-hold abnormal return. Fourth, I show that more reputable VCs are associated with active monitoring as they hold shares and board seats longer than less reputable VCs.

The thesis contributes to the existing research on VC reputation in several ways. First and foremost, I show that VC market has changed as unicorns boast reputation through their enormous proceeds. That is why in the long run the relationship between VC reputation and the performance of portfolio companies turns negative. Second, the outperformance of VC-backed IPOs has been documented for the years prior to the internet bubble. However, Puri and Zarutskie (2012) show that after the year 2000 the difference in the performance between VC-backed IPOs and non-VC-backed IPOs narrows. Also, due to recent changes in the VC industry and growth of unicorns, I extend the analysis in the period after 2007 and connect it with the VC reputation measure to examine the influence of VC reputation after the Financial crisis. As far as I know, this thesis is the first to analyze the performance of VC-backed IPOs from the IPO event until three years after it. Last but not least, I provide the comparative evaluation of the two different VC reputation measures, VC market share and VC age.

The topic of VC reputation's influence on performance of their portfolio companies is relevant for the startup ecosystem, particularly for companies in the early stage and for VCs. Moreover, from the investor's point of view, the performance of portfolio companies is important as they expect high return on their high-risk investments. On the basis of my results, managers of early stage companies should seek VCs participation, as in the long run, the companies with VCs outperform their peers. Also, financing from more reputable VCs is associated with higher operating performance at the IPO and better monitoring after the firm goes public. However, the

link between VC reputation and superior long-run performance is not that clear. More reputable VCs are able to improve corporate performance up until some level. Therefore, it is important to note that VCs which backed unicorns with high amount of proceeds (those are VCs with high reputation) do not always provide proportionally superior value-added services.

2 LITERATURE OVERVIEW

The purpose of this section is to present the relevant literature and research connected to the influence of VCs on a performance of IPOs. In the first subsection, the general role of VC firms is described and connected to the IPO event. Second, the importance of VC reputation is assessed and widely used proxies are described. Third, the studies on the relation between VC and the performance of IPOs are presented.

2.1 VENTURE CAPITAL AND IPOs

Existing literature suggests that it is often difficult for newly established firms to access bank loans or issue stocks since they do not have a proven track record to signal their creditworthiness. In the case of young firms, informational asymmetries between borrowers and lenders are more pronounced. For this reason, capital suppliers and alternative financing mechanisms are particularly important factors for young companies (Scholtens, 1998). That is where VCs become significantly valuable as they tend to invest in early stage companies with insecure cash flows. They might help entrepreneurs to partly overcome informational asymmetries, providing them with access to top-tier investors and bankers. Additionally, VC firms are specialized to provide intensive monitoring to firms (Brav & Gompers, 1997).

VC firms raise money from individuals and institutions to invest in early stage companies with high potential but also high risk. They are normally active investors that try to add value to their portfolio companies and they often invest through syndicates with other VCs. Furthermore, VCs normally provide funding in periods of significant developments of their portfolio companies and assist with the creation of a business plan and first production (Lin & Smith, 1998). VCs usually play an important role in the management of their companies and serve on the board of directors. Besides, they often specialize in a specific industry and as a result of their expertise, they help companies with recruitment, production, suppliers and with the development of customer connections (Barry et al., 1990). There are four possible exit strategies for VC investments: sale of the firm's share in an IPO, the sale of share to another company, repurchase of the share by the firm or liquidation of the firm. Brav and Gompers (2003) emphasize that the IPO is often the first opportunity for a company's founders and investors to start the process of realizing their

ownership stake value. The IPO is also considered as the most profitable exist strategy for VCs. When the portfolio company of VCs offers their shares to public for the first time, VC firms usually retain their shares at the time of the IPO and sell them after the lock-up period or a few years later (Gompers, 1995).

2.2 INCENTIVES TO GRANDSTAND

More than 80% of VC funds are structured as limited partnerships with predetermined lifecycle, normally ten years with possible extensions. Thus, VCs must liquidate their investments in order to distribute proceeds to investors in this limited time. Moreover, to remain active in venture capital financing a specific fund must regularly raise follow-on partnerships (Gompers & Lerner, 1995). Considering the limited liability of outside investors in funds, it is difficult for investors to evaluate a VC's ability and expertise. Outside investors have limited access to operations of VC funds and that is why investors look for signals and information on the performance. Most of the existing literature examines the influence of a fund's performance and reputation on their fundraising ability (Sahlman, 1990; Nahata, 2008). The most effective mechanism through which VC funds can signal their knowledge and skills is bringing portfolio companies public with an IPO. This is when investors earn the highest of returns on VC amongst the possible exit strategies. Taking a firm public shows the skills of VC funds, it is a signal to investors which shows the high-ability of VCs. Consequently, a record of successful and profitable IPOs is essential for a VC firm to build up the reputational capital in the capital markets and improve the possibility of forthcoming fundraising (Gompers, 1996). Last but not least, Sahlman (1990) suggests that VCs with a good reputation are more attractive to potential investors and develop relationships easier with investment bankers, accounting firms, law firms and management recruiting firms.

Hence, the reputation and image of VC firms are important to their partners and investors. On the other side, it is also relevant to their potential portfolio companies, startups. In particular, companies in the early stage do not have a well-established reputation and that is why they need certification. Megginson and Weiss (1991) suggest that when the value of a startup cannot be observed directly, external parties rely on the value and quality of startups affiliates. Firms in early stage do not have continuous communication with investment bankers or acquiring firms

(Hsu, 2004). Hence, VCs help entrepreneurs by providing them with access to investors and bankers with the addition of value-added services, strategic and operational advice, developing suppliers and customer relationship. VC involvement can also decrease the risk of cash flows by informing the portfolio companies about possible causes of concern (Barry et al., 1990; Gompers, 1995). Regarding the VCs added values Sahlman (1997) suggests: "From whom you raise capital is often more important than the terms". This view is expanded by Hsu (2004) who finds that offers from more reputable VCs are three times more likely to be accepted. Moreover, entrepreneurs are willing to reject the offers with higher valuations with the aim of accepting offers from more reputable VCs. Overall, VCs have an incentive to grandstand because their reputation is not only positively correlated with the possibility of raising funds but also with the access to more promising startups (Sahlman ,1990).

2.3 HOW TO MEASURE VENTURE CAPITALISTS REPUTATION?

VC firms identify themselves by the reputational capital and the quality of business services that they offer to portfolio companies. They provide value-added services through monitoring, business referrals and financial assistance. Hsu (2004) suggests that startups usually differentiate between VC firms on the basis of their experienced people and the network that they have access to. Moreover, if VC firm gains skills in a specific industry, it is likely to obtain the expertise to help startups develop successfully in this sector, which altogether contributes to its reputation.

Widely used proxy for reputation and experience of VCs is their age, employed in studies by Lerner (1994), Gompers (1996), Lee and Wahal (2004) and Sørensen (2007). Usage of age as a proxy for reputation assumes that the longer a VC firm has operated the more expertise and experience it has gained and has better access to more promising business ventures. It is important to note that the age of leading VCs is an imperfect measure as experienced partners might decide to quit their jobs to start a new VC firm. As a consequence, the difference between new and old VC firms tends to disappear. Likewise, Sørensen (2007) examines that age is a less attractive measure as it does not differentiate between active and inactive investors.

Considering drawbacks of the age of VCs as a proxy for the reputation, economists have employed various other measures. Lee and Wahal (2004) use the number of previous IPOs that

VC firm has backed as a proxy for their reputation. In other words, the limited partners are interested in VC firms that are able to select superior companies and take them public. Nahata (2008) introduces the cumulative IPO market share, which is the aggregate of the market value of all companies taken public by the specific VCs until a given year normalized by the market value of all VC-backed firms that went public until the same year. Krishnan, Ivanov, Masulis and Singh (2011) further develop Nahata's measure and employ IPO market share based on a three-year moving window preceding the IPO date. Their measure avoids the bias against younger VCs with adjusting for the length of their active life.

2.4 VENTURE CAPITAL AND THE PERFORMANCE OF IPOs

Post-IPO performance of VC's portfolio companies is important to VCs that hold stock beyond the IPO date, to IPO investors, to VC investors and to entrepreneurs looking for VC funding. Most of the existing literature focuses on the relationship between VC and underpricing. For instance, Barry, Muscarella, Peavy and Vetsuypens (1990) examine that VC-backed IPOs are less underpriced since capital markets recognize superior monitoring by VCs. Gompers (1996) further shows that IPOs backed by younger VC firms are more underpriced. However, there is less empirical analysis on the association between VC and the performance of their portfolio companies.

According to Puri and Zarutskie (2012), an important characteristic for VC-backed companies is the scale of investment and production. The authors show that VC-backed companies have higher growth in employment and sales in comparison to non-VC-backed companies. Moreover, VC-backed companies also demonstrate higher levels of sales. However, they do not analyze the impact of VC reputation on the asset productivity. Nahata (2008) suggests that more reputable VCs are more likely to provide better value-added services. On the basis of this reasoning, the author finds that the portfolio companies backed by more reputable VCs are associated with higher asset productivity at the IPO.

Literature on the association between VC reputation and long-run performance is limited. First, Brav and Gomper (1997) treat all VCs as one class of investors, so they do not distinguish among VCs based on their reputation. The authors find that VC-backed IPOs have higher returns

than non-VC-backed IPOs. The outperformance is especially pronounced when returns are equally weighted. The outperformance is due to the fact that VCs may remain on the board of directors longer, continue to provide access to capital and promote management structures that help the company perform better. Krishnan, Ivanov, Masulis and Singh (2011) suggest that more reputable VCs have significant and positive association with the issuer long-run performance. Since younger VCs may have an incentive to bring the weaker firms to public too early in order to grandstand. Moreover, the authors find that more reputable VCs select better portfolio companies. Even after controlling for VCs self-selection effect the portfolio companies backed by more reputable VCs still outperform.

2.5 CORPOTATE GOVERNANCE OF VENTURE CAPITALISTS

Most of the existing literature argues that VCs retain their holdings in the portfolio companies even after the IPO (Barry et al., 1990; Megginson & Weiss, 1991; Gompers, 1996; Black & Gilson, 1998, Krishnan et al., 2011). VCs usually take significant equity positions in their portfolio companies and have an incentive to monitor them. As the IPO is an exit opportunity for VCs, they have a strong incentive to contribute to the portfolio companies' growth. They act as an active investor and usually exercise significant influence on management structure. Barry et al. (1990) find that VCs continue to hold their shares and board positions in the portfolio companies even after the IPO date. Jain and Kini (1995) suggest that one of the important reasons for continued monitoring is the reputational capital at stake. If VCs are associated with the successful portfolio companies, they are more likely to establish profitable follow-up funds. Last but not least, Krishnan et al. (2011) find that more reputable VCs (measured with VC market share) are more likely to retain their shares and board seats in the portfolio companies for even up to three years after the IPO. The authors also examine that continued shareholdings have a significant and positive association with the long-run performance of issuers.

3 HYPOTHESES DEVELOPMENT

In this section, I assess my hypotheses and link them to relevant literature. Moreover, I explain the motivation behind my assumptions. As indicated in the chapter 2, theories on the VCs investments predict that their portfolio companies that go public have better performance than companies that go public without VC backing. Furthermore, VC reputation is related to lower information asymmetry and better value-added services, in particular more reputable VCs seem to have superior expertise.

Hypothesis 1: IPOs backed by venture capital firms in the long-run outperform IPOs that are not backed by venture capital firms.

With my first hypothesis, I analyze if the portfolio companies of VCs are indeed related to better long-run performance. Brav and Gompers (1997) suggest that VCs may provide access to capital for their portfolio companies even after the IPO, while also maintaining their seats on the board of directors. In addition, VCs are likely to set up the management structure that provides the foundation for better performance in the long run. In line with this reasoning, there are two more possible explanations for the outperformance of VC-backed IPOs. First of all, they might influence who holds the shares of IPO companies even after the issue, considering that VCs have contacts with superior investment banks and institutional investors. Second, Gompers (1996) examines that VCs have concerns regarding their reputation because their failures in public market would affect their future ability to invest. For this reason, they are less willing to hype the stock and they have the incentive to be connected to the better performance of their portfolio companies.

The motivation for the first hypothesis is supported by results from Brav and Gompers (1997). They find that VC-backed IPOs outperform non-venture backed IPOs in the period from 1972 until 1992. While existing literature examines the long-run performance of VC-backed IPOs and non-VC-backed IPOs before the internet bubble, I analyze the relation between the two groups from the beginning of the Great Recession and the Financial Crisis of 2007.

Hypothesis 2: IPOs backed by more reputable venture capital firms have higher asset productivity at the offering than firms backed by less reputable venture capitalists.

The second hypothesis tests the relationship between the reputation of VCs and the efficiency of their portfolio companies in converting investments into sales (asset productivity). The scale of investment and production is an important measure for portfolio companies of VCs (Puri & Zarutskie, 2007). VCs have a considerable influence on the development of new firms, as they are related to the formulation of human resource policies, to the selection of stock option plans and to the hiring of leading personnel in marketing and sales (Hellman & Puri, 2002). For this reason, it is essential to determine the influence of the reputation of VCs on the asset productivity of their IPOs. I predict that more reputable VCs are connected to higher asset productivity at the time of the IPO because they are more likely to provide superior value-added services to their portfolio companies.

The motivation for the second hypothesis is backed by results from Nahata (2008). The author shows that portfolio companies of more reputable VCs have higher asset productivity at the IPO for the period between 1991 and 2001. However, Nahata (2008) employs a different proxy for VC reputation and I adjust his measure to the three-year moving window.

Hypothesis 3: The VC reputation has a positive association with the long-run performance of VC-backed IPOs.

Most of the existing literature analyzes the influence of more reputable VCs on the performance of their portfolio companies in the short run, mainly the influence on the underpricing. However, I hypothesize that if VCs continue to monitor and support the company, they may influence the IPO firms beyond the short run. First of all, Cronqvist and Fahlebrach (2009) find that large shareholders can have a significant influence on firm performance and corporate policies. Second, theoretical and empirical studies suggest that reputation has a positive effect on the ability to raise funds, while younger VCs may have motives to grandstand by taking weaker companies to public (Gompers, 1996: Krishnan et al., 2011). Overall, I combine their results and

predict that more reputable VCs have incentives and expertise to affect superior post-IPO performance.

For the period before 2004, Krishnan et al. (2011) suggest that more reputable VCs are connected to better performance in the long run. The authors suggest that the advice, support and monitoring of more reputable VC firms should have an influence on the superior post-IPO performance in the long run. Extending their research, I argue that the association continues to hold even for the period of Great Recession and thereafter.

Hypothesis 4: More reputable venture capital firms are more active in monitoring and supporting their portfolio companies even after the IPO date.

The existing literature suggests that VCs retain their holdings in the portfolio companies even after they go public (Barry et al., 1990; Megginson & Weiss, 1991). This is in line with the VCs monitoring role, after the IPO date they still participate actively in the corporate governance of the portfolio companies with serving on the board positions. Furthermore, Barry et al. (1990) conclude that VC firms specialize in their portfolio companies in order to offer intensive monitoring support. For this reason, VCs have an important role in governing and shaping new enterprises. Besides, Krishnan et al. (2011) examine that VCs influence better corporate governance structure through having a positive association with the separation of CEO and chairman roles (COE-COB). This separation strengthens the independence of the board and extends the board oversight of management roles. Overall, I predict that more reputable VCs continue to hold shares and board seats in the IPO issuers even after the IPO date and that they are connected to the separation of COE-COB at the IPO date.

4 DATA AND METHODOLOGY

The following section is intended to introduce the outline of the data sample. Moreover, I examine the construction of the set of variables used in the analysis and the general descriptive statistics. Finally, I explain the motivation of the technical choices that assure the testing of hypothesis. All the variables are described in Appendix 1.

4.1 SAMPLE CONSTRUCTION

The sample consists of IPOs issued from January 1, 2004 through December 31, 2014 in the USA. The first three years of the sample will be used exclusively for the calculation of the main variable VC market share. Thus, the analyzed period consists of IPOs between 2007 and 2014. I choose this time frame because VC activity experienced a strong slowdown after the Financial crisis in 2007 and 2008. Also, over the last years, VC industry has changed, deal sizes are larger and fewer transactions are made. The major changes include IPOs from unicorns with a high number of proceeds. That is why it is relevant to access VC industry in the recent period.

The primary data of IPOs and their characteristics are obtained from Thomson One Securities Data Corporation (SDC) New Issue database. More specifically, I limit my sample on the IPO issuers from the USA as per Thomson One. The information from Thomson One and the IPO prospectuses is used to distinguish between VC-backed IPOs and non-VC-backed IPOs and to identify the lead VC investors. Stock prices, returns and benchmark indexes are derived from the Center for Research in Security Prices (CRSP) database and DataStream. I retrieve the accounting data from Compustat. The missing data is manually obtained from Reuters and Bloomberg. Moreover, I manually assess the data on corporate governance from the IPO prospectuses and annual proxy statements from SEC's EDGAR database. I specifically focus on the Management and Shareholders sections.

Following previous research on IPOs, I restrict the data sample to the subsequent criteria. I exclude IPOs not listed on major U.S. exchanges (NYSE, AMEX and Nasdaq) or the ones which are not reported within 1 month of their IPO in the CRSP database (Krishnan et al., 2011). The small offerings under $5 million in global proceeds and with offering prices under $5 per share are excluded (Lee & Wahal, 2004). Moreover, I exclude IPOs of limited partnerships, spinoffs,

privatization, unit offerings and IPOs for which any important variable is unavailable (Brav & Gompers, 1997; Krishnan et al. 2011). To be consistent with other studies I further exclude IPOs of financial intermediaries (SIC codes 65), all offerings by investment companies and REITs (SIC codes 6726 and 6792) as well as by banks (SIC codes 6000 through 6081) (Schulz, 2003; Ritter, 2017). Last but not least, I review and compare my sample with the Jay R. Ritter IPOs Statistics.

4.2 VC REPUTATION MEASURES

My first reputation measure of VCs is called VC market share. I compute it by taking the VC's dollar market share of its venture-backed IPOs weighted to the total dollar size of all venture-backed IPOs in the preceding three calendar years. Suppose that I analyze the performance of an IPO issue in 2007, I first calculate the VC market share as the aggregation of the total dollar value of all IPOs backed by the specific VCs during 2004, 2005 and 2006. Second, the total dollar value is shown as a proportion of the total dollar size of all VC-backed IPOs in these three years (Krishnan et al., 2011). The total dollar value of an IPO is defined as the gross proceeds of the IPO, exclusive of the overallotment options (Ritter, 1984). When an IPO is backed by multiple VC investors, I concentrate on the impact of a lead VC's reputation with the largest venture investment in the portfolio company. If there are multiple leading VCs, the VC market share is equally weighted. I retrieve the data on VCs which invest in IPO issuers from Thomson One database. Furthermore, I manually analyze all the investment rounds from VCs and look for the VC firm with the highest sum of investment. As VC market share is founded on information which is known to investors before the IPO date, it does not include look-ahead bias.

The VC market share variable is similar to underwriter reputation from Megginson and Weiss (1991) and it shows the VC's success rate in comparison to other VCs. Because of the three-year moving window, the measure is present and it bypasses the bias against young VCs (Krishnan et al., 2011). First of all, my motivation to use the VC market share is that limited partners select the VC funds in which they are going to invest mostly based on the share of aggregate investment of VCs. Therefore, reputation is important for fund commitments. Second, existing literature shows that more reputable VCs have better investment opportunities because startups are willing to choose their offer even over higher valuation offers (Nahata, 2008). Last but not

least, IPO is one of the most profitable and visible VC outcomes which also explains why the VC market share measure is also robust.

The second measure of VC's reputation is VC age, which is used in previous studies from Gompers (1996), Lee and Wahal (2004) and Hochberg, Ljungqvis and Lu (2007). VC age measure is calculated as the difference between incorporation date of VCs and the date of the IPO of their portfolio company. For the incorporation date, I manually search through Thomson One database and cross-check the data with founding dates from Ritter (2015) website. Following Hellman, Lundsey and Puri (2008), I mark the year 1980 as a beginning of modern venture market. Therefore, the incorporation date of the VC firm is set to 1980, if the firm was established earlier. If IPO is backed by more VC firms, I examine the age of the leading VC firm with the largest investment. The age of the lead VC firms is a proxy for reputation because the existing literature suggests that the VCs which have operated longer gain more knowledge and have access to more valuable investment opportunity sets (Lee & Wahal, 2004).

The mean VC market share for my sample of VC-backed IPOs is 0.0303 and median is 0.0079. On the other side, the average and median VC age figures are 21.32 and 21, respectively. VCs with the highest reputation measured by VC market share are Kleiner Perkins, Accel Partners and New Enterprise Associates. All three VCs have an annual market share that exceeds 1%, averaged over my full sample period. It is important to note that VCs operate in the highly fragmented industry in comparison to IPO underwriters, where top 10 investment banks control a high amount of market share.

4.3 IPO PERFORMANCE MEASURES

First of all, I analyze the performance of firms at the time of the IPO. Therefore, I use asset productivity of issuing companies in order to measure their efficiency of converting investments in assets into sales. Asset productivity measure is calculated as the ratio of annual revenues to total book assets (both are reported prior to the IPO). Following Nahata (2008), I calculate the variable as the natural logarithm of one plus asset productivity ratio to decrease the skewness. Moreover, I retrieve the variables from Thomson One and Compustat. In addition, Nahata (2008) suggests that firms have higher asset productivity when they are backed by more reputable VCs.

By extension, VC firms have an important role in professionalizing their portfolio companies and more reputable VCs are likely related to better value-added services.

In this research study, I use three measures of post-IPO issuer performance; long-run abnormal returns, market-to-book ratio and listing survival. Post-IPO performance is measured in the time span from the IPO date until three years after that or until delisting, whichever comes first.

First of all, I follow previous literature on measuring post-IPO performance with long-run abnormal stock returns (Brav & Gompers, 1997; Carter, Frederick, Dark & Singh, 1998). The market-adjusted long-run return obtained with a buy-and-hold strategy (BHAR value-weighted) is calculated from the period of 6 days after the IPO date until 756 trading days after (approximately three years). Following Loughran and Ritter (1995), I define one year as twelve intervals per 21-trading days. In order to avoid causing survivorship bias, I estimate long-run abnormal returns using daily returns for the 756-days post-IPO period or until its delisting date, if it comes first. I match the performance of IPO firms to value-weighted CRSP (NYSE/AMEX/Nasdaq) index. The daily values of the CRSP index and stock returns of IPO firms are retrieved from CRSP. Moreover, the value-weighted BHAR is calculated as follows:

$$BHAR = \left[\left(\prod_{t=offer\ date+6}^{min[T,delist]} (1 + r_{it})\right) - \left(\prod_{t=offer\ date+6}^{min[T,delist]} (1 + r_{mt})\right)\right] \times 100,$$

where r_{it} = the return on the stock i on day t; T = the offer date + 756 trading days; r_{mt} = return on the NYSE/AMEX/Nasdaq value-weighted CRSP index on day t (Carter et al., 1998).

Also, I compare the performance of IPOs to equally-weighted CRSP (NYSE/AMEX/Nasdaq) index. This benchmark is used by, among others, Brav and Gompers (1997). The authors suggest that value-weighted returns considerably reduce the underperformance of non-VC-backed IPOs. Therefore, I use equally-weighted returns (BHAR equally-weighted) to obtain robust results. In order to limit the effect of outliers, I winsorize the BHAR variables at 1% and 99% levels. Accordingly, the values which are below the 1st percentile are replaced by the value at 1st percentile and the values greater than the 99th percentile are set to the value at 99th percentile.

Furthermore, I review the robustness of the main results performing the same regressions without winsorizing the BHAR.

Second, I use a market-to-book ratio (M/B 3) to measure the long-run post-IPO performance in the three years after the IPO. The market-book ratio is often used as a proxy for a firm's real options and Tobin's Q ratio (Moeller, Schlingemann & Stulz, 2004). Following Gompers, Ishii and Metrick (2003), I calculate market-to-book ratio as the ratio of the market value of common equity to book value of common equity. Whereas, the book value of common equity is the sum of deferred taxes and the book common equity. Moreover, I calculate the market value of common equity as the product of the number of shares outstanding and the share price. The required quarterly values are retrieved from Compustat North America. Market-to-book ratio for the long-run performance is measured for the time span of approximately three years after the IPO date. Therefore, the data is obtained for the end of the 12th quarter following the IPO or for the maximum numbers of quarters available in Compustat, if the issuer does not survive three calendar years. Once more, I perform winsorizing in Stata to minimize the effects of outliers.

Third, I use aftermarket survivorship measure (Survival), which is a proxy for the long-run financial strength of IPO issuer. Krishnan et al. (2011) examine that the listing survival captures the consequences of accounting window dressing prior to IPO. For instance, companies with more window dressing (earnings management) at the IPO are more likely to delist. Survival is an indicator variable which equals one when the IPO firms remain in the CRSP database for three years after the IPO date or when they are acquired or merged by other listed firms. Contrary, it is equal to zero if the IPO firm becomes bankrupt, liquidated or goes private. The data on survival of IPO issuers is obtained from Datastream and the CRSP database.

4.4 CORPORATE GOVERNANCE MEASURES

The existing literature supports the view that VCs generally continue to hold their investment and board positions in the portfolio companies even after the IPO (Barry et al., 1990; Krishnan et al., 2011). I analyze the effects of their monitoring services and support with the data on VC shareholdings and VC directorships. The data is manually gathered from SEC's EDGAR website. Furthermore, I examine these two measures from the time of the IPO date until three

years after. The governance measures are available for 302 IPO issuers backed by VCs for the data at IPO. In addition, for one, two and three years thereafter I gather the data for 287, 281 and 236 IPO issuers, respectively.

As a further matter, I include the indicator variable CEO-COB, which equals one if CEO of IPO issuer is also chairman of the board and zero otherwise. The variable is manually retrieved from IPO prospectuses. Krishnan et al. (2011) suggest that the separation of the roles of CEO and chairman of the board improves board independence and their oversight of senior management. Therefore, it is used as a proxy for superior governance structure.

4.5 CONTROL VARIABLES

In order to control for the determinants that may have been of influence of IPO issuers performance, I use the following independent variables: venture-backed, offer size, issuer age, underwriter reputation, underpricing, issuer M/B, VC syndicate size, asset and TOP auditor. With control variables related to selected issuer characteristics and other issues, I ensure that VC market share or VC age are not just a proxy for noticeable sample heterogeneity.

First of all, I include an indicator variable for VC backing (Venture-Backed) to test the difference in performance of VC-backed and non-VC-backed IPOs. The variable is equal to one when a VC firm backed the IPO issuer and it is equal to zero otherwise. As the existing literature suggests that VC-backed IPO firms have rather superior post-IPO performance (Megginson et al., 1990), I include an indicator variable to capture the difference in comparison to non-VC-backed IPOs.

Second, the common characteristic used in the IPO literature is the offer size, which is measured by the natural logarithm of gross proceeds from the IPO. IPO gross proceeds do not consist of overallotment options which are exercised. The mean offer size for non-VC-backed IPOs is $323.02 million and for VC-backed IPOs is $169.86 million. Moreover, I include the offer size to control for systematic effects due to offering size of the issue and for the reason that larger offerings are usually made by more established and financially stronger firms. Therefore, well-

established companies should reduce the risk (Carter et al., 1998). I obtain the data on gross proceeds from Thomson One database.

Third, I control for the age of the issuing firm (issuer age), which is suggested as a proxy for risk. The issuer age is computed as the difference between the issuer incorporation date and the date of the IPO. According to Ritter (1984), older and more established firms have the following characteristics: more tangible assets, stronger customer connections and competent management of the organization. Hence, all these aspects imply lower issuer growth and risk profile. Additionally, I retrieve the incorporation date from Thomson One database and if not available, I collect it from the issuer's official website or Bloomberg. In order to decrease the skewness, the issuer age is calculated as the natural logarithm of one plus issuer age (Krishnan et al., 2011).

Forth, existing literature supports the view that more prestigious underwriters are associated with lower short-run underperformance, as well as with better long-run performance (Carter et al., 1991). For this reason, I use the measure of underwriter reputation to bypass any false attribution of its effect on the reputation of VCs. The underwriter reputation is measured with the Carter-Manaster scale[1].

Fifth, I include two more control variables which account as a proxy for differences between the issuer quality and IPO demand. Begin with unadjusted first-day return (underpricing), which I calculate with the traditional underpricing formula from Dawson (1987) and Loughran and Ritter (2004):

$$Underpricing = ((P_C - P_O)/ P_O) \times 100,$$

where P_C is the closing price on the first day of IPO and P_O is the offer price. I obtain the closing price of the IPO issuers from Datastream while the offer price is retrieved from Thomson One. Next, the market-to-book ratio of the issuer company at the IPO is included, as it is frequently

[1] I retrieve Carter and Manaster ranking from the updated Jay Ritter's website (https://site.warrington.ufl.edu/ritter/ipo-data/). Moreover, Carter and Manaster scale is a prestige ranking for the IPO market in the USA, which measures the reputation of underwriters on the scale from one to nine, where nine denotes the most reputable underwriters.

used as a proxy for company growth opportunities (Nahata, 2008). Moreover, I calculate the variable with the same procedure employed with the calculation of the market-to-book ratio in the long run (M/B 3).

In addition, I control for the size of the VC syndicate (VC syndicate size). Syndication appears when VC firm jointly invests in the portfolio companies. I measure VC syndicate size by the number of VC members which are invested in the specific IPO issuer. Brander, Amit and Antweiler (2004) find that syndicated investments are associated with higher returns. That is why I employ VC syndicate size to control for its effect on performance. Last but not least, to perform a standard Heckman 2-step model, I include two additional variables. First, the variable asset is calculated as the natural logarithm of an IPO issuer asset size at the time of the IPO. It is a proxy for an unattractive investment opportunity for VCs as it captures more developed and lower growth companies. Second, I use the variable TOP auditor to account for the reputation of a big 4 accounting firms. The indicator variable TOP auditor equals one if the firm is one of the big 4 companies and zero otherwise. Both variables should be related to VC reputation but not to the long-run performance of the issuer.

Since a wide variety of variables is used in the regressions, Appendix 1 examines their descriptions to further clarify the variables.

4.6 DESCRIPTIVE STATISTICS

The final sample consists of 511 VC-backed and non-VC-backed IPOs. Panel A of Table 1 shows the distribution of IPOs from 2007 until 2014. The highest number of IPOs was completed in 2007 and 2014, while 2008 was the year with the least IPOs completed. For the period between 2007 and 2014, I obtain the complete data for 511 IPOs, amongst which 59% are backed by VCs.

Table 1

Descriptive statistics of IPOs

The table reports the frequency, characteristics and performance of VC-backed and non-VC-backed IPOs between 2007 and 2014. The sample consists of 209 non-VC-backed IPOs and 302 VC-backed IPOs. Panel A presents the frequency of IPOs per specific year. Panel B reports the mean of an issue and issuer characteristic. Also, the mean of

long-term performance measures is presented. **p**-values related to a *t*-test for equality of means are reported. The variable offer size is measured as gross proceeds from the IPO, exclusive of overallotment options. Issuer age is defined as the difference between the issuer incorporation date and the IPO date. Issuer M/B is a market-to-book ratio of an issuer at the IPO calculated as the market value of common equity divided by book value of common equity. The variable underpricing presents the percentage change between the offer price and the closing price on the first IPO day. BHAR value-weighted (BHAR VW) and BHAR equally-weighted (BHAR EW) are market-adjusted long-run returns obtained with buy-and-hold strategy (the calculation procedure is explained in section 4.1). Market-to-book ratio in the three years after the IPO (M/B 3) is calculated as issuer M/B. The data for M/B 3 is obtained for the end of the 12th quarter following the IPO or for the maximum numbers of quarters available if the issuer does not survive three calendar years.

Panel A. IPO Frequency per Year	Number of IPOs		
Year	**All IPOs**	**VC-backed IPOs**	
		No.	%
2007	103	58	56%
2008	12	5	42%
2009	31	10	32%
2010	63	31	49%
2011	53	33	62%
2012	60	39	65%
2013	85	54	64%
2014	104	72	62%
Total	511	302	59%

Panel B. IPO Characteristics and Performance	Mean		
	Non-VC-backed IPOs	**VC-backed IPOs**	**Test of equality (*p*-values)**
Offer Size (million dollars)	323.02	169.86	0.046
Issuer Age (years)	19.21	9.58	0.00
Issuer M/B	2.38	5.08	0.00
Underpricing (%)	23.17	34.09	0.19
BHAR VW	-0.15	0.098	0.02
BHAR EW	-0.28	0.0030	0.01
M/B 3	1.92	3.61	0.00

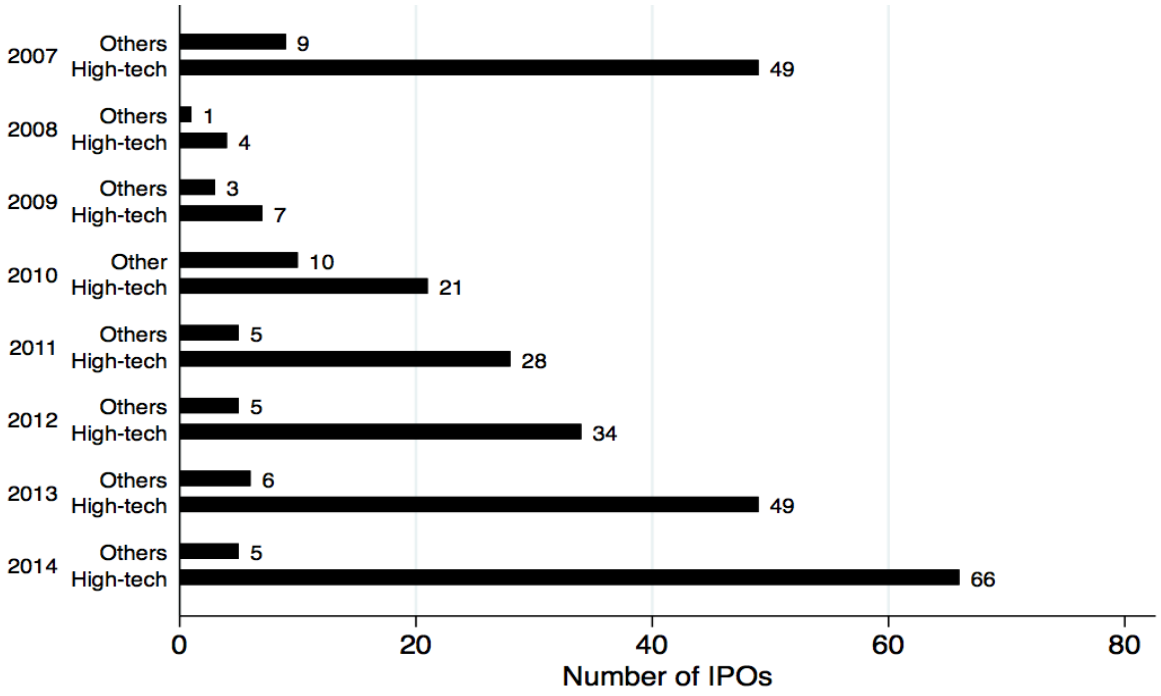
Panel B of Table 1 above displays the mean of issue characteristics, IPO characteristics and the IPO long-run performance. Consistent with Lee and Wahal (2004), VC-backed IPO issuers are younger than non-VC-backed IPOs. Moreover, VC-backed IPOs are also more underpriced than non-VC-backed IPOs, but the difference between means is not significant. In line with analysis from Brav and Gompers (1997), all three measures of long-run performance (BHAR value-weighted, BHAR equally-weighted and M/B 3) are significantly higher for VC-backed IPOs.

When specifying the industry groups of VC-backed IPOs, an important part is the proportion of high-tech companies represented in the subsample. Amit, Brander and Zott (1998) suggest that VCs are more likely to invest in industries with higher asymmetric information, namely high-tech industry. Graph 1 shows that the number of VC-backed IPOs operating in the high-tech industry is undoubtedly higher than the number of VC-backed IPOs in other industries (non-high-tech). Moreover, graph 1 demonstrates that after the Financial Crisis in 2007 and 2008, the number of VC-backed IPOs starts increasing or recovering, especially due to the growth of high-tech VC-backed IPOs. It is important to note that the number of VC-backed IPOs in other industries is mostly consistent through the years after the crisis.

Graph 1

Frequency of VC-backed IPOs in high-tech and non-high-tech

The graph presents the frequency of VC-backed between 2007 and 2014. It differentiates between high-tech IPOs and others. High-tech industry indicators are retrieved from Thomson One.



4.7 REGRESSION MODELS

In this section, I explain how the hypotheses are tested. Specifically, to assess the predicted relations, I employ several regressions with diverse independent and dependent variables.

The first hypothesis suggests that VC-backed IPOs outperform non-VC-backed IPOs in the long run. I assess the performance with the following cross-sectional regression:

(i) $$P = \beta_Y + \beta_I + \beta_1 VC\ Backed + \beta_2 Offer\ Size + \beta_3 Issuer\ Age + \beta_4 \frac{M}{B} + \beta_5 Underpricing + \varepsilon,$$

where P is one of the performance measures for the issuing company (BHAR value-weighted, BHAR equally-weighted, M/B 3). Furthermore, I use year fixed effects (β_Y) and industry fixed

effects (β_I)[2]. The year fixed effects are employed to control for the inconstant economic environment and the industry fixed effects are used to assess the divergence in industries where VC investments are concentrated. Based on the existing literature, I predict that VC-backed IPOs firms are connected to better long-run performance than non-VC-backed IPO firms. Hence, I foresee the positive coefficient for VC-backed IPOs. I perform the regression on the basis of standard errors robust to heteroscedasticity.

The second hypothesis is assessing the performance within the VC-backed firms at the time of the IPO. Moreover, it predicts a positive relationship between VC reputation (VC market share or VC age) and asset productivity. This is tested with the following cross-sectional regression:

(ii) $$Asset\ Productivity = \beta_Y + \beta_I + \beta_1 VC\ Reputation + \beta_2 Offer\ Size + \beta_3 Issuer\ Age + \beta_4 \frac{M}{B} + \beta_5 VC\ Syndicate\ Size + \beta_6 Underwriter\ Reputation + \varepsilon,$$

where VC reputation is VC market share or VC age. The second hypothesis predicts that coefficient β_1 is positive due to VCs significant influence on the development of new firms and since more reputable VCs are likely to provide better value-added services. Once again, I employ the regression on the basis of standard errors robust to heteroscedasticity.

After assessing VC reputation influence on the performance in the short run, I analyze the influence on the long-run performance. The third hypothesis which suggests that VC reputation has a positive association with the long-run performance is tested with the subsequent cross-sectional regression:

(iii) $$P = \beta_Y + \beta_I + \beta_1 VC\ Market\ Share + \beta_2 Offer\ Size + \beta_3 Issuer\ Age + \beta_4 \frac{M}{B} + \beta_5 VC\ Underpricing + \beta_6 Underwriter\ Reputation + \varepsilon,$$

[2] Following Krishnan et al. (2001), I allocate the IPO firms in nine different industries: internet and computers, communications and electronics, business and industrial, consumer products, energy, biotech and healthcare, financial services and business services.

where P is one of the performance measures for the IPO issuer (BHAR value-weighted, BHAR equally-weighted, M/B 3 or survival). Following Krishnan et al. (2011), I include underwriter reputation as a control variable to bypass assigning effects of underwriter reputation to VC reputation. As in the previous two hypotheses, I use robust standard errors. In addition, I adjust the standard errors for clustering within industries.

To further analyze the influence of VC reputation on their portfolio companies, I examine the monitoring role of VCs firms. The third hypothesis predicts that more reputable VCs hold issuer shares and board seats longer, even up to three years after the IPO date. Thus, I utilize the subsequent probit regression:

$$\text{(iv)}\ G = \beta_Y + \beta_I + \beta_1 VC\ Reputation + \beta_2 Offer\ Size + \beta_3 Issuer\ Age + \beta_4 \frac{M}{B} + \beta_5 VC\ Underpricing + \varepsilon,$$

where G is one of the indicator variables for VC shareholdings, VC directorship or CEO-COB. VC shareholdings and VC directorship are measured at the time of the IPO and also for the three following years. I use a probit model to assess the likelihood of corporate governance characteristics in relation to VC reputation. Moreover, the VC reputation (reputation above median) is an indicator variable that equals one if VC market share is above median and zero if it is below median.

5 EMPIRICAL RESULTS

In this section, I present the results of the regressions which I perform in order to test the four hypotheses. First of all, I test if VC-backed firms perform better in the long run than non-VC-backed firms. Second, I continue with analyzing the subsample of IPOs which are backed by VC firms. Moreover, the difference in reputation of VCs is considered to explain the better performance of their portfolio companies in the short and long run.

5.1 PERFORMANCE OF IPOs

The results for the differences between VC-backed and non-VC-backed IPOs are presented in Table 2 below. I use three long-run performance measures as dependent variables in cross-sectional regression analysis. The reported standard errors are adjusted for industry clustering and robust to heteroscedasticity. Table 2 shows that the indicator variable for VC-backed IPOs is significant at 1% level for all the performance measures. This suggests that, after controlling for characteristics of issuer firm and other issues, VC-backed firms are still connected to better long-run performance. For instance, the indicator variable in regression (1) is 0.286 for long-run performance measured by BHAR value-weighted (BHAR VW), significant at the 1% level. Everything else constant, VC-backed IPOs have 28.6% higher long-run performance than non-VC-backed IPOs. Moreover, controlling variables do not explain the difference in the long-run performance in the regression (1). Likewise, the coefficient of the indicator variable (venture-backed) is 0.297 for the regression (2). In addition, the regression (3) uses the M/B 3 ratio of issuers in the three years after the IPO date as a proxy for a firm's real options. Table 2 displays that indicator variable is 1.017, significant at 1% level. It follows that, everything else constant, VC-backed IPOs have 101.7% higher market-to-book ratio in long-run than non-VC-backed IPOs. Furthermore, the variable for M/B at the IPO date positive and significant in the regression (3). On the other side, underpricing is negative and significant.

Table 2

Cross-sectional regression analysis of VC-backed and non-VC-backed IPOs and their long-run performance

The sample in the regressions consists of VC-backed and non-VC-backed IPOs between 2007 and 2014. The dependent variables in all the regression models are the long-run performance measures, BHAR value-weighted (BHAR VW), BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3). The performance is measured until three years after IPO or until delisting, whichever happens first. Each of long-run performance measures is

regressed on the indicator variable venture-backed, which equals one if the IPO issuer is backed by VC firms and equals zero otherwise. Other control variables are offer size, issuer age, issuer M/B (at the time of IPO) and underpricing. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity. As OLS regression is performed, the adjusted R^2 is reported. Year and industry fixed effects are included in regressions, but their coefficients are not reported. *** and * indicate statistical significance at the 1% and 10%, respectively.

	Dependent Variable		
	BHAR VW (1)	**BHAR EW (2)**	**M/B 3 (3)**
Venture-Backed	0.286***	0.279***	1.017***
	(2.87)	(2.75)	(5.15)
Offer Size	0.0556	0.0516	-0.0749
	(1.33)	(1.21)	(-0.86)
Issuer Age	0.0101	0.00858	-0.00773
	(0.22)	(0.19)	(-0.10)
Issuer M/B	-0.0121	-0.0126	0.149***
	(-0.68)	(-0.70)	(3.09)
Underpricing	-0.0632	-0.0655	-0.312***
	(-1.37)	(-1.43)	(-2.86)
_cons	-0.615*	-0.972***	1.119
	(-1.73)	(-2.70)	(1.43)
Observations	511	511	511
Adj. R^2	0.0618	0.0653	0.216

Based on the results from Table 2, I confirm the first hypothesis that IPOs backed by venture capital firms in the long-run outperform IPOs that are not backed by VC firms. The conclusion is in line with Brav and Gompers (1997), who find the same results for their sample.

5.2 RELATIONSHIP BETWEEN REPUTATION AND PERFORMANCE IN THE SHORT RUN

The results from the analysis of the second hypothesis are presented in Table 3 below. I use a multivariate regression for the purpose of analyzing the relationship between the reputation of VCs and the asset productivity of their portfolio companies at the IPO. In contrast with the analysis carried out for the first hypothesis, here I consider only IPOs which are backed by VCs. The dependent variable used is the natural logarithm of one plus the asset productivity ratio.

Moreover, I observe a significantly positive coefficient on VC reputation (measured by either VC market share of VC age).

Table 3

Cross-sectional regression analysis of VC reputation and asset productivity

The sample in the regressions consists of VC-backed IPOs between 2007 and 2014. The dependent variable in both regression models is asset productivity ratio, calculated as the ratio of annual revenues to total book assets at the IPO. The ratio is further adjusted for skewness and therefore the natural logarithm of one plus asset productivity is used. The reputation of VCs is assessed by two measures. The first measure used is VC market share, calculated as a VC's dollar market share of all VC-backed IPOs in the prior three calendar years. The second measure employed is VC age. Other control variables are offer size, issuer age, underwriter reputation and VC syndicate size. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported. Year and industry fixed effects are included in the regressions, but their coefficients are not reported. ***, ** and * indicate statistical significance at the 1%, 5% and 10%, respectively.

	Dependent Variable	
	Asset Productivity (1)	**Asset Productivity (2)**
VC Market Share	0.471***	
	(3.58)	
VC Age		0.00402***
		(5.17)
Offer Size	-0.0768**	-0.0737**
	(-3.67)	(-2.25)
Issuer Age	0.0375	0.0314
	(0.37)	(0.31)
Underwriter Reputation	-0.00168	-0.00158
	(-0.17)	(-0.15)
VC Syndicate Size	-0.0182	-0.0182
	(-1.34)	(-1.33)
_cons	0.592*	0.487
	(2.18)	(1.75)
Observations	280	280
Adj. R^2	0.230	0.234

In accordance with Regression (1) in Table 3, one standard deviation increase in the VC market share is related to approximately 2% increase in asset productivity of VC-backed IPOs. Additionally, the VC market share in Regression (1) is statistically significant at the 10% level. Moreover, regarding economic significance, one standard deviation increase in the VC age is correlated to nearly 4% increase in asset productivity of VC-backed IPOs. An additional significant predictor which emerges from Table 3 is offer size. It follows that larger offerings have lower asset productivity.

In line with the results from Table 3 above, I confirm that IPOs backed by more reputable VCs have higher asset productivity. In order to obtain robust results, I use two different proxies for VC reputation, both have positive and significant coefficients.

5.3 RELATIONSHIP BETWEEN REPUTATION AND PERFORMANCE IN THE LONG RUN

After the analysis of the relationship between VC reputation and the short-run performance of IPOs, I determine the effect of VC reputation on the long-run performance. Table 4 shows the results of my analysis. The coefficient estimates and t-statistics are reported based upon standard errors which are adjusted for the industry clustering and are robust to heteroscedasticity. It is important to note that VC market share has a negative association with all four long-run performance measures. Moreover, it has a statistically significant negative association with BHAR value-weighted and BHAR equally-weighted with statistical significance at 5% level for both coefficients. In terms of economic significance, a change equal to one standard deviation in VC market share is associated with 7.9% change in BHAR VW and with 7.4% change in BHAR EW, after controlling for other issue characteristics. There is also a negative relationship between reputation and market-to-book ratio in the long-run with a significance at 10% level. The coefficient of VC market share correlation with survival is not significant.

To test the robustness of the results presented in Table 4, I also use VC age as a proxy for VC reputation. The report on coefficient estimates and t-statistics is presented in Appendix 2. Even after using VC age, the correlation between the VC reputation measure and long-run

performance is still negative. Furthermore, the coefficients are negative and statistically significant for BHAR VW, BHAR EW and M/B 3. While for the Survival variable, the coefficient is negative but not statistically significant.

Table 4

Cross-sectional regression analysis of VC market share and issuer long-run performance

The sample in the regression consists of VC-backed IPOs between 2007 and 2014. The dependent variables are BHAR value-weighted (BHAR VW), BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3) and listening survival (Survival). Dependent variables are measuring the long-run performance. OLS regression is used together with BHAR VW, BHAR EW and M/B3, while a probit model is employed in the case of Survival. The post-IPO performance is regressed on VC market share, which measures VC reputation. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable			
	BHAR VW (1)	**BHAR EW (2)**	**M/B 3 (3)**	**Survival (4)**
VC Market Share	-1.635**	-1.536**	-0.365*	-0.262
	(-2.57)	(-2.33)	(-0.22)	(-0.13)
Offer Size	-0.0887	-0.105	-0.0427	0.152
	(-1.30)	(-1.49)	(-0.27)	(1.37)
Issuer Age	-0.101	-0.0994	-0.159	0.111
	(-0.60)	(-0.56)	(-0.89)	(0.73)
Issuer M/B	0.00194	0.00238	0.135**	-0.0143
	(0.10)	(0.11)	(3.15)	(-0.86)
Underpricing	-0.0799***	-0.0867***	-0.336**	0.104*
	(-6.34)	(-6.78)	(-2.62)	(1.69)
Underwriter Reputation	-0.0134	-0.0118	-0.0224	-0.0290
	(-0.37)	(-0.33)	(-0.49)	(-0.96)
_cons	1.315***	1.028**	1.362**	0.704
	(4.49)	(2.87)	(2.88)	(1.01)
Observations	302	302	302	285
Adj./Pseudo R^2	0.0878	0.0914	0.1025	0.0908

Overall, the results in Table 4 above and Appendix 2 reject my third hypothesis that VC reputation has a positive connection with the long-run performance measures. This is surprising considering the results from Krishnan et al. (2011), which found the opposite results. Also, most of the existing literature suggest that reputation of VCs indeed has a positive effect on their portfolio companies. However, my results are reversed as the analysis demonstrates that more reputable VCs are actually related to the underperformance of their portfolio companies that went public.

When interpreting the results from Table 4, it is important to note that Krishnan et al. (2011) find the opposite relationship, but their sample consists of IPOs completed between 1993 and 2004. Moreover, Puri and Zarutskie (2012) examine that performance of VC-backed firms narrow in the period after the internet bubble. That is why I further analyze my dataset, especially focusing on the association between VC reputation and the long-run performance for the portfolio companies of VCs within the top 10th percentile of VC market share and the lowest 10th percentile of VC market share. On the basis of my dataset, I suggest that on the one hand, VCs which backed the IPOs with the highest proceeds gained a high level in terms of reputation, but all their portfolio companies do not outperform in the long run proportionally to their reputation. On the other hand, some companies outperform because of the combination of their own expertise and resources, despite the fact that they are not backed by more reputable VCs.

These arguments are valuable as the trends in the VC industry are changing. National Venture Capital Association (2018) suggests that the average and median deal sizes are higher, fewer transactions are made and VC-backed companies stay private longer. Moreover, an important shift in VC market started in 2003 with the introduction of unicorns, which were defined as tech startups in the USA that are valued at one billion dollars or more. After 2010 unicorns started surging in number and worth, for example, the total value of these companies reached 28$ billion in the fourth quarter of 2014. Following this growth, investors spending has increased significantly. Moreover, VCs and other investment firms are doubling down on startups (Howe, 2015).

On the basis of this reasoning, I perform the regression within the group of VC-backed IPOs, which exclude IPOs backed by VCs with the VC market share in the top 10th percentile. As VC reputation might be overestimated when VCs back unicorns with high amount of proceeds and other portfolio companies of these high reputational VCs might not perform proportionally superior to their VC market share. The cross-sectional regression model is equal to the one used to test the third hypothesis explained in section 4.6. The results are summarized in Table 5 below. VC market share has a statistically significant and positive association with BHAR value-weighted as well as with BHAR equally-weighted (as presented in Appendix 3). This illustrates that long-run underperformance is mainly driven by VC firms in the top 10th percentile. Nevertheless, the results are not significant when using VC age as a proxy for the reputation or when using M/B 3 or Survival. The additional results are reported in Appendix 3. Overall, it seems that the results for the third hypothesis are mostly driven by VCs that backed IPOs with the highest proceeds or unicorns. It appears that backing the IPOs with an enormous amount of proceeds inflates the reputation of VCs, while all the portfolio companies backed by the same VCs do not perform proportionally superior to their high reputation.

According to result from the third hypothesis, I conclude that VC industry indeed changed in last years and that the relationship between VC reputation and the long-run performance is not that straightforward anymore. It is important to note that unicorns might be an influential driver of the changes in VC market.

Table 5

Cross-sectional regression analysis of VC reputation and issuer long-run performance within a subsample

The sample in the regressions consists of VC-backed IPOs subsample between 2007 and 2014. The IPOs backed by VCs with VC market share in the top 10th percentile are excluded. The dependent variable is BHAR value-weighted (BHAR VW), which measure the long-run performance. The post-IPO performance is regressed on VC market share and VC age, both variables measure VC reputation. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions. Year and industry fixed effects are included in regressions. *** and * indicate statistical significance at the 1% and 10% levels, respectively.

	Dependent Variable	
	BHAR VW (1)	**BHAR VW (2)**
VC Market Share	9.452* (2.29)	
VC Age		-0.00384 (-1.01)
Offer Size	-0.0996 (-1.24)	-0.104 (-1.30)
Issuer Age	-0.171 (-1.03)	-0.163 (-0.91)
Issuer M/B	-0.0109 (-0.55)	-0.00645 (-0.33)
Underpricing	-0.0609*** (-4.12)	-0.0676*** (-4.52)
Underwriter Reputation	-0.0169 (-0.50)	-0.0163 (-0.48)
_cons	1.307*** (3.54)	1.488*** (4.27)
Observations	272	272
Adj. R^2	0.0724	0.0678

In addition, regarding the comparisons between VC market share and VC age both measures have statistically significant relation with BHAR value-weighted, BHAR equally-weighted and market-to-book ratio. However, VC market share has also significant relation to BHAR measures in regressions based on the subsample of VC-backed IPOs.

5.4 MONITORING OF VCs

Table 6 contains the results of the univariate and multivariate analysis which test the fourth hypothesis. I examine if there is a connection between VC reputation and their portfolio companies' governance characteristics. First of all, I divide the whole sample of VCs in two groups with the VC market share above median (reputation above median) and below median

(reputation below median). The VC shareholdings, VC directorships and CEO-COB are indicator variables that equal one when VCs hold shares, board seats or the CEO of the portfolio company is also the COB, respectively and equal to zero otherwise.

The proportion of the IPO firms which have each of corporate governance characteristics at the IPO and also three years after is presented in Panel A of Table 6. First, it is important to note that VCs with lower reputation do not always hold shares until the IPO, while more reputable VCs consistently hold shares at the IPO. One year after the IPO date, VCs with the reputation above median hold shares in 89.3% of their portfolio companies. Whereas, VCs with the reputation below median hold shares in 80.7% of firms. The difference between both is statistically significant at 10% level. The pattern of holding a higher proportion of shares by the group with the reputation above median continues to hold for two and three years after the IPO date, with the difference being statistically significant. The same holds true for VC directorships. It should be noted that also VCs with reputation above median hold board seat in less than 100% of their portfolio companies at the IPO date. For instance, VCs in the group with the reputation above median hold and issuer board seat at the IPO in 95.9% of their portfolio companies, while VCs with reputation below median hold seats in only 88.1% of their portfolio companies at the IPO. The difference is statistically significant at 1% level. Moreover, more reputable VCs are also associated with a lower proportion of CEO-COB at the IPO, but the difference is not significant. Overall, Panel A of Table 6 displays that VCs with reputation above median hold shares and board seats in a higher proportion of their portfolio companies at the IPO also one, two and three years after the IPO date.

Panel B of Table 6 shows the results of a probit regression which test the likelihood of observing the corporate governance measures with VCs whose reputation is above median. Other coefficients of this regression are reported in Appendix 5. More reputable VCs have statistically significant and positive association with VC shareholdings and VC directorships, apart from VC shareholdings in two years after the IPO date, which has a positive relationship with the VCs with reputation above median, although with a non-significant coefficient. With regards to economic significance, Regression (3) shows that being in a group of VCs with reputation above median increases the probability of still holding shares one year after the IPO by 0.0931.

Similarly, Regression (4) displays that being in a group of VCs with reputation above median increases the probability of holding board seats in the IPO issuer one year after the IPO by 0.114. In addition, I find that more reputable VCs are negatively related to issuers having CEO-COB at the IPO date, results are significant at 10% level (as reported in Appendix 4).

Regarding the data presented in Panel A and Panel B in Appendix 5, I find that the issuer age has a significant negative association with VC shareholding and VC directorships after the IPO. This suggests that VC shareholdings are more diluted in older IPO companies. The same relation holds for offer size in connection to VC shareholding.

To analyze the robustness of these results, I perform a multivariate analysis presented in Panel B in Table 6 using VC age instead of VC market share (as reported in Appendix 6). Following Puri and Zarutski (2012), I create a variable defined as the top quartile of VC age, which equals one if the VCs are in the top quartile of the age distribution and equals zero otherwise. As presented in Panel A and Panel B in Appendix 6, corporate governance characteristics continue to have a significantly positive association with reputation. Beyond this, with top quartile of VC age, the positive and significant coefficient also holds for VC shareholding in the two years after the IPO.

Table 6

Corporate governance characteristics and VC market share

The sample in the regressions consists of VC-backed IPOs between 2007 and 2014. Panel A of Table 5 presents the proportion of IPO issuer with each of 3 corporate governance measures, VC shareholdings, VC directorships and CEO-COB. I examine these characteristics at the IPO date and one, two, three years after that. The governance measures are available for 302 IPO issuers backed by VCs for the data at IPO. For one, two and three years the data is available for 287, 281 and 236 IPO issuers, respectively. Significant difference from the other cohort at the 10%, 5% and 1% levels is indicated by [a], [b] and [c]. Panel B reports a probit regression coefficients based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The dependent variables are VC Shareholdings and VC Directorships. Each dependent variable is regressed on the variable named reputation above median, which is based on VC market share being above the median in VC-backed IPOs. Other control variables are offer size, issuer age, issuer M/B and underpricing. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Panel A. Univariate Analysis

	Date of measure	Reputation above median (1)	Reputation below median (2)
VC Shareholdings	IPO	100%	93%[a]
	1 year after IPO	89.3%	80.7%[b]
	2 years after IPO	70%	59.9%[a]
	3 years after IPO	55.9%	42.9%[b]
VC Directorships	IPO	95.9%	88.1%[c]
	1 year after IPO	94%	81.3%[c]
	2 years after IPO	90.1%	73.2%[c]
	3 years after IPO	78.7%	61.1%[c]
CEO-COB	IPO	37.3%	42%

Panel B. Multivariate analysis

		Dependent Variable	
		VC Shareholdings (3)	**VC Directorships (4)**
Reputation above median (VC Market Share)	1 year after IPO	0.446***	0.641**
		(3.44)	(2.19)
	2 years after IPO	0.202	0.468**
		(0.98)	(2.49)
	3 years after IPO	0.321***	0.423***
		(3.01)	(3.09)

To conclude, the results in Table 6 indicate that VC reputation is associated with VC shareholdings and VC directorships at the IPO date and one, two and three years after that. Thus, I confirm my fourth hypothesis that more reputable VCs are more actively involved in the monitoring of their portfolio companies even after the IPO date. Moreover, Cronqvist and Fahlenbrach (2008) suggest that large shareholders can have a significant effect on corporate policies and firm performance through effective monitoring. However, on the basis of the results of the third hypothesis, I cannot confirm that VCs' active monitoring is indeed translating into a superior performance of their portfolio companies.

5.5 ROBUSTNESS TESTS

First, I perform a Breusch-Pagan test to assess the heteroscedasticity. The null hypothesis which assumes homoscedasticity (the error variances are all equal) is rejected for all the regressions. As a result, I use regression models with standard errors which are robust to heteroscedasticity.

Second, I examine if VC market share maintains the significant association with the performance measures that are not winsorized. The results are presented in Appendix 7, Appendix 8 and Appendix 9. First, to test the robustness of the results from the first hypothesis (section 5.1), I perform analysis with the same performance measures which are not winsorized (as presented in Appendix 7). The significant and positive relationship between performance measures and an indicator variable venture-backed continues to hold. That is why, I conclude that winsorizing the performance measures does not change the results qualitatively. Second, Appendix 8 and Appendix 9 present the analysis of the third hypothesis (section 5.3). Using the same regression models and the performance measures which are not winsorized, the results continue to have statistically significant coefficients. On the basis of these results, I conclude that mitigating the effect of outliers with winsorizing the performance measures does not change the relations in regression models qualitatively.

Third, to obtain robust results, regressions from second, third and fourth hypotheses are performed with two different reputation measures. After using both VC market share and VC age, I suggest that results are not only driven by a specific proxy of the VC reputation.

Fourth, to further examine the robustness of the VC market share variable in particular, I perform additional sensitivity analyses. The results that show the association between VC market share and IPO performance could be biased on the account of more reputable VCs having access to better portfolio companies (Hsu, 2004). The VC self-selection effect of more reputable VCs having access to better investment opportunity set is documented also by Lee and Wahl (2004) and Sørensen (2007). As a consequence of the self-selection effect, the performance of IPO issuers may be due to the quality of the companies themselves rather than due to VCs expertise, value-added service and reputation. Even though the effect of VC self-selection is reduced with the control variables which capture the quality of VCs portfolio companies, it is likely that

influence of selection is not eliminated (Nahata, 2008; Krishnan et al., 2011). To control for the potential endogeneity and to separate the VCs selection effect from their value-added services, I employ a standard Heckman's (1979) correction method.

In the first step of the Heckman procedure, I use the subsequent probit regression to estimate the likelihood of an investment by more reputable VCs:

(v) $Top\ quartile = \beta_Y + \beta_I + \beta_1 Offer\ Size + \beta_2 Issuer\ Age + \beta_3 VC\ Syndicate\ size + \beta_4 Underwriter\ Reputation + \beta_5 Assets + \beta_6 TOP\ Auditor + \varepsilon.$

Following Nahata (2008), I utilize the top quartile variable, which is an indicator variable that equals one for VCs with VC market share in the top quartile. The additional variables used are asset, VC syndicate size and TOP auditor. Krishnan et al. (2011) suggest that the natural logarithm of issuer assets (asset) at the IPO is a proxy for lower growth companies which are unattractive to VCs. Furthermore, VC syndicate size is a proxy for the characteristics of more reputable VCs that are able to attract other VC firms. TOP auditor is a proxy of the accounting firm's reputation which is likely to be positively associated with VC reputation. Additionally, I calculate an inverse Mills ratio from the first step regression, which is included in the second step regression as an explanatory variable. The regression model from the second step of the procedure is explained in the section 4.6 under the second hypothesis (ii). Regression (2) also includes inverse Mills ratio. The results from a standard Heckman selection procedure are presented in Table 7. Among the independent variables in Regression (1), solely TOP auditor coefficient is statistically significant. Thus, more reputable VCs are related to more reputable auditors. Notably, the inverse Mills ratio in the Regression (2) is statistically significant which indicates the relevance of VC selectivity. Nevertheless, VC market share has a positive and statistically significant association with asset productivity, even after considering the self-selection effect of VCs.

Table 7

Analysis of asset productivity with controlling for endogeneity of reputable VCs

The sample in the tables consists of VC-backed IPOs between 2007 and 2014. In thefirst step, a probit regression models the likelihood of a company receiving funding from reputable VCs. Top quartile is an indicator variable that

equals one if the VCs has a VC market share in the top quartile and zero otherwise. The instrumental variables are VC syndicate size, asset, TOP auditor, offer size, issuer age and underwriter reputation. The inverse Mills ratio is calculated from the first step regression and used in the second step regression. The dependent variable in OLS regression (2) is asset productivity, defined as the natural logarithm of one plus asset productivity. The reputation is measured with VC market share. Other independent variables are offer size, issuer age, underwriter reputation and inverse Mills ratio. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and in the OLS regression adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable	
	Top quartile (VC Market Share) (1)	**Asset Productivity (2)**
VC Market Share		0.549***
		(4.27)
VC Syndicate Size	-0.0496	
	(-0.94)	
Asset	-0.0214	
	(-0.26)	
TOP Auditor	0.321*	
	(1.05)	
Offer Size	0.163	-0.0929**
	(0.92)	(-3.41)
Issuer Age	-0.122	0.0736
	(-0.61)	(0.84)
Underwriter Reputation	0.00759	-0.00184
	(0.17)	(-0.19)
Inverse Mills Ratio		-0.179*
		(-2.25)
_cons	-1.429	0.832**
	(-1.19)	(2.64)
Observations	275	275
Adj./Pseudo R^2	0.112	0.226

In addition, I also consider a VC selectivity effect in the analysis of the third hypothesis. I perform Heckman selection procedure within the VC-backed IPOs which exclude IPOs backed by VCs in the top 10th percentile of VC market share. Moreover, I do not implement Heckman

procedure on the complete sample of VC-backed IPOs because the positive relation between VC reputation and the long-run performance is rejected. Therefore, the correction for the likelihood of more reputable VC being associated with better quality firms on the basis of whole VC-backed IPOs sample is not meaningful. In the first step, I employ a probit model (v) explained above. This model differs in the dependent variable that is reputation above median, as an indicator variable if VCs have VC market share higher than the median (Krishnan et al., 2011). Furthermore, in the second step of the Heckman procedure I use the regression model (iii) with an additional control variable, the inverse Mills ratio derived from the probit regression in the first step. Table 8 above shows the results from the first and second step models. From the second regression (2), I conclude that even after considering the selectivity of VCs, more reputable VCs are still associated with statistically significant better long-run performance. It is important to note that the sample excludes IPO firms backed by VCs in the top 10th percentile of VC market share.

Table 8

Analysis of the long-run performance with controlling for endogeneity of reputable VCs

The sample in the tables consists of VC-backed IPOs between 2007 and 2014. In a first step, a probit regression models the likelihood of a company receiving funding from reputable VCs. Reputation above median is an indicator variable that equals one if the VCs has an VC market share above median and zero otherwise. VC market share is estimated as dollar market share of all IPOs backed by a specific VC firm. The instrumental variables are VC syndicate size, asset, TOP auditor, offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The inverse Mills ratio is calculated from the first step regression and used in the second step regression. The dependent variable in OLS regression (2) is BHAR value-weighted (BHAR VW). The reputation is measured with VC market share. Other independent variables are offer size, issuer age, issuer M/B, underpricing, underwriter reputation and inverse Mills ratio. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and in the OLS regression adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable	
	Reputation above median (VC Market Share) (1)	**BHAR VW (2)**
VC Market Share		12.71*
		(2.33)
VC Syndicate Size	0.0590	
	(1.14)	
Asset	-0.212	
	(-1.02)	
TOP Auditor	0.857***	
	(3.08)	
Offer Size	0.0343	-0.159
	(0.14)	(-1.39)
Issuer Age	-0.0810	-0.187
	(-0.45)	(-1.23)
Issuer M/B	0.0126	0.0123
	(0.50)	(0.65)
Underpricing	-0.0602	-0.128**
	(-0.82)	(-2.91)
Underwriter Reputation	0.0346	0.0235
	(0.87)	(0.81)
Inverse Mills Ratio		0.816*
		(1.84)
_cons	3.668	0.917
	(1.07)	(1.51)
Observations	272	272
Adj./Pseudo R^2	0.0773	0.102

Fifth, as it seems that unicorns with an enormous amount of proceeds from the IPO boast the reputation of VCs, I perform winsorizing of VC market shares to mitigate the effect of outliers. However, winsorizing VC market share does not change the relations in regression models qualitatively.

6 CONCLUSION

The extensive literature on VC firms and the importance of their reputation generally suggests that there is a positive relationship between VC reputation and the performance of their portfolio companies. This study provides an empirical analysis of VC market for recent years.

I analyze if VC reputation brings benefits to their portfolio companies and to investors which are invested in the VC industry. After controlling for portfolio companies' characteristics and other issues, I find that VC-backed IPOs outperform non-VC-backed IPOs. Moreover, more reputable VCs are indeed associated with better performance at the IPO event and more involved monitoring after the company goes public. However, the value-added services provided by more reputable VCs do not translate into better long-run performance. Contrary, I find that more reputable VCs are connected to underperformance in the long run. This indicates that trends in the VC industry are changing. It is important to note that the number of high-valued IPOs is rising and that these kinds of exists may inflate VC reputation (NVCA, 2018). Last but not least, I show that the negative relationship between the long-run performance and VC reputation is mainly driven by VC firms in the top 10th percentile of VC market share (VCs that backed IPOs with the highest proceeds).

Based on the results, I suggest that the reputation of VCs is still important when managers of early stage companies are seeking funding and value-added services. However, the association between high VC reputation and corporate performance, in the long run, is not proportional. That means that reputable VCs that backed IPOs with the highest proceeds do not necessarily add superior value to their portfolio companies. One of the possible explanations could be that they focus more on their biggest exits and provide less added-value services to other portfolio companies. Another possible reason is that in the long run, the potential of VCs to influence the portfolio companies is reduced.

6.1 LIMITATIONS AND FUTURE RESEARCH

As the study incorporates a relatively large number of variables from different data sources, I merge various databases and files. Moreover, the databases are not entirely complementary. As a result of merging and missing data, many observations are dropped. Without the loss of data, the

analysis could be more robust. Although I perform a 2-step Heckman model, the connection between VCs' selection effect and VCs' value-added service might still hold because of insufficient controlling variables. Several studies control for the endogeneity with additional variables which could improve the model; for example, lead VC connectedness, total VC funding, early stage investor variables, top law firm or hot IPO market (Nahata, 2008).

The limitation of the data sample consists in the inclusion of only a seven years long period. In order to examine the development of the VC industry, a longer time period would be needed. However, considering that a great amount of data is obtained manually and because of the time constraints, this was not possible. Another limitation of the sample is that more non-VC-backed IPOs are excluded from the sample as the data is not available in addition to the fact that the sample is also biased towards IPOs with lower proceeds which are more likely to be excluded for the same reason. Last but not least, when considering portfolio companies' performance in the long-run, the study could be improved with employing return on assets (ROA) as a performance measure. The match-adjusted ROA is used as a proxy for operating performance by Krishnan, Ivanov, Masulis and Singh (2011) and in other existing research.

For future research, it would be useful to examine the influence of VC reputation on their portfolio companies starting during the private years up until a few years after the IPOs in order to understand the effect of VC reputation on the development of the portfolio company. Moreover, in line with Hellman, Lundsey and Puri (2008), who put the upper limit to VC age as the reputation measure, future studies could mark the upper maximum for VC market share. For instance, all VCs with the VC market share higher than 5% could be replaced by the value of 5%, due to unicorns which boast VC reputation up to the level where VC firms' influence on the reputation cannot be proportionally superior.

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8 APPENDIX

Appendix 1

Summary table of key variables

Appendix 1 examines all the relevant variables used in regressions and their definition.

Variable	Description
VC Market Share	VC's dollar market share of all venture-backed IPOs in the previous three calendar years
VC Age	The difference between the IPO date and VC firm's incorporation date
Venture-Backed	An indicator variable for whether VC firm backed the IPO issuer
Asset Productivity	The natural logarithm of one plus the ratio of annual revenues to total book assets at the IPO
BHAR VW	Buy-and-hold abnormal return value-weighted of IPO issuer in the 3 years after the IPO
BHAR EW	Buy-and-hold abnormal return equally-weighted in the 3 years after the IPO
M/B 3	The market-to-book ratio of the IPO issuer in the 3 years after the IPO
Survival	An indicator variable for whether the IPO issuer remain listed on the stock exchange
Offer size	The natural logarithm of gross proceeds from the offering
Issuer Age	The natural logarithm of one plus the age of the IPO issuer at the time of the IPO
Issuer M/B	The market-to-book ratio of the IPO issuer at the time of the IPO
Underpricing	The percentage change between the offer price and the closing price on the first day
Underwriter Reputation	The lead underwriter reputation measured by Carter and Manaster scale
VC Syndicate Size	Number of VCs invested in the firm at the time of the IPO
VC Shareholdings	An indicator variable for whether lead VC has shareholdings in the IPO issuer
VC Directorships	An indicator variable for whether lead VC has directors on board in the IPO issuer
CEO-COB	An indicator variable for whether lead VC has CEO who also hold COB position
Assets	The natural logarithm of the total assets of the IPO issuer
TOP Auditor	An indicator variable for whether the IPO issuer is connected to top 4 accounting firm

Appendix 2

Cross-sectional regression analysis of VC age and the long-run performance of IPO issuer

The sample in the regression consists of VC-backed IPOs between 2007 and 2014. The dependent variables are BHAR value-weighted (BHAR VW), BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3) and listening survival (Survival). Dependent variables are measuring the long-run performance. OLS regression is used together with BHAR VW, BHAR EW and M/B3, while probit model is employed in the case of Survival. The post-IPO performance is regressed on VC age, which is defined as the difference between incorporation date of VCs and the date of the IPO of their portfolio company. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

	Dependent Variable			
	BHAR VW (1)	**BHAR EW (2)**	**M/B 3 (3)**	**Survival (4)**
VC Age	-0.0207***	-0.0199***	-0.0357**	-0.0311
	(-6.20)	(-5.78)	(-2.93)	(-1.54)
Offer Size	-0.0965	-0.112	-0.0467	0.170
	(-1.45)	(-1.61)	(-0.31)	(1.14)
Issuer Age	-0.0529	-0.0535	-0.0816	0.169
	(-0.33)	(-0.32)	(-0.49)	(1.07)
M/B	0.00459	0.00493	0.139***	-0.00862
	(0.25)	(0.26)	(3.51)	(-0.52)
Underpricing	-0.0804***	-0.0872***	-0.335**	0.0977
	(-7.95)	(-8.90)	(-2.77)	(1.57)
Underwriter Reputation	-0.0148	-0.0133	-0.0257	-0.0345
	(-0.47)	(-0.42)	(-0.67)	(-0.98)
_cons	1.843***	1.534**	2.257**	4.737***
	(4.74)	(3.34)	(3.47)	(6.43)
Observations	302	302	302	285
Adj./Pseudo R^2	0.103	0.100	0.0712	0.119

Appendix 3

Cross-sectional regression analysis of VC market share and issuer long-run performance within a subsample

The sample in the regressions consists of VC-backed IPOs subsample between 2007 and 2014. The IPOs backed by VCs with VC market share in the top 10th percentile are excluded. The dependent variables are BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3) and listening survival (Survival). OLS regression is used together with BHAR EW and M/B3, while probit model is employed in the case of Survival. The post-IPO performance is regressed on VC market share, which measures VC reputation. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable		
	BHAR EW	**MB3**	**Survival**
VC Market Share	9.602**	-11.91	10.01
	(2.40)	(-0.95)	(0.95)
Offer Size	-0.120	-0.000117	0.400
	(-1.40)	(-0.00)	(1.55)
Issuer Age	-0.169	-0.224	-0.0569
	(-0.97)	(-1.39)	(-0.37)
M/B	-0.0104	0.132**	-0.0226
	(-0.52)	(2.73)	(-0.89)
Underpricing	-0.0676***	-0.337**	0.0955**
	(-4.72)	(-2.80)	(2.22)
Underwriter Reputation	-0.0148	-0.000659	-0.0136
	(-0.45)	(-0.02)	(-0.39)
_cons	1.045*	1.102	3.190***
	(2.29)	(1.80)	(3.36)
Observations	272	272	230
Adj./Pseudo R^2	0.0813	0.0504	0.0926

Appendix 4

Corporate governance characteristics (CEO-COB) and VC market share

The sample in the regressions consists of VC-backed IPOs between 2007 and 2014. Table reports a probit regression coefficients based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The dependent variable is CEO-COB, which indicates if CEO of IPO issuer is also COB. The independent variable that measures VC reputation is reputation above median, which is based on VC market share being above the median in VC-backed IPOs. Other control variables are offer size, issuer age, issuer M/B and underpricing. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable
	CEO-COB (1)
Reputation above median (VC Market Share)	-0.256**
	(-2.03)
Offer Size	0.289***
	(4.14)
Issuer Age	-0.351**
	(-2.51)
M/B	-0.00661
	(-0.60)
Underpricing	-0.0725
	(-1.57)
_cons	-1.044*
	(-1.96)
Observations	302
Pseudo R^2	0.132

Appendix 5

Corporate governance characteristics and an indicator variable for above median of VC market share

The sample in the regressions consists of VC-backed IPOs between 2007 and 2014. Panel A and Panel B of Appendix 4 reports a probit regression coefficients based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The dependent variable in Panel A is VC Shareholdings which is regressed on the variable named reputation above median, which is based on VC market share being above the median in VC-backed IPOs. Other control variables are offer size, issuer age, issuer M/B and underpricing. The dependent variable in Panel B is VC Directorships which is regressed on the variable named reputation above median, which is based on VC market share being above the median in VC-backed IPOs. Other control variables are offer size, issuer age, issuer M/B and underpricing. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. VC Shareholdings	Dependent Variable (VC Shareholdings)		
	1 year after IPO (1)	**2 years after IPO (2)**	**3 years after IPO (3)**
Reputation above median (VC Market Share)	0.446***	0.202	0.321***
	(3.51)	(0.99)	(3.01)
Offer Size	-0.343***	-0.376***	-0.295***
	(-3.31)	(-5.55)	(-4.82)
Issuer Age	-0.438**	-0.908***	-0.394*
	(-2.40)	(-6.25)	(-1.76)
M/B	-0.0102	-0.0158	0.00460
	(-0.69)	(-1.37)	(0.53)
Underpricing	0.598**	0.251*	-0.00181
	(2.06)	(1.81)	(-0.05)
_cons	6.802***	8.473***	2.203***
	(8.94)	(18.27)	(4.28)
Observations	287	281	253
Pseudo R^2	0.140	0.152	0.107

Panel B. VC Directorship	Dependent Variable (VC Directorships)		
	1 year after IPO (4)	**2 years after IPO (5)**	**3 years after IPO (6)**
Reputation above median (VC Market Share)-	0.641** (2.26)	0.468** (2.53)	0.423*** (3.19)
Offer Size	-0.283 (-1.14)	-0.144 (-0.78)	-0.0824 (-0.58)
Issuer Age	-0.341* (-1.76)	-0.562** (-2.51)	-0.441*** (-2.66)
M/B	0.153*** (13.82)	0.0478 (1.63)	0.0191 (1.17)
Underpricing	-0.384*** (-5.52)	-0.144** (-2.24)	-0.0296 (-0.32)
_cons	6.089*** (6.50)	6.064*** (5.77)	5.862*** (5.34)
Observations	287	281	236
Pseudo R^2	0.184	0.127	0.114

Appendix 6

Corporate governance characteristics and an indicator variable for top quartile of VC age

The sample in the regressions consists of VC-backed IPOs between 2007 and 2014. Panel A and Panel B of Appendix 5 reports a probit regression coefficients based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The dependent variable in Panel A is VC Shareholdings which is regressed on the variable named top quartile of VC age, which is based on VC age being in top quartile of the age distribution in VC-backed IPOs. Other control variables are offer size, issuer age, issuer M/B and underpricing. The dependent variable in Panel B is VC Directorships which is regressed on the variable top quartile of VC age. Other control variables are offer size, issuer age, issuer M/B and underpricing. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Panel A. VC Shareholdings	Dependent Variable (VC Shareholdings)		
	1 year after IPO (1)	**2 years after IPO (2)**	**3 years after IPO (3)**
Top quartile of VC Age	1.279***	1.049***	1.077***
	(4.97)	(5.34)	(6.53)
Offer Size	-0.368***	-0.502***	-0.398***
	(-4.42)	(-6.08)	(-5.22)
Issuer Age	-0.508**	-1.075***	-0.517**
	(-2.56)	(-13.04)	(-2.36)
M/B	-0.0144	-0.0122	0.0138
	(-0.94)	(-1.07)	(1.14)
Underpricing	0.681***	0.281**	-0.0238
	(3.83)	(2.17)	(-0.63)
_cons	7.530***	9.832***	2.841***
	(8.78)	(18.08)	(4.41)
Observations	287	281	253
Pseudo R^2	0.191	0.210	0.168

Panel B.
VC Directorship

	Dependent Variable (VC Directorships)		
	1 year after IPO (4)	**2 years after IPO (5)**	**3 years after IPO (6)**
Top quartile of VC Age	0.722**	0.965***	0.889***
	(2.39)	(9.46)	(2.61)
Offer Size	-0.298	-0.167	-0.0858
	(-1.26)	(-0.92)	(-0.56)
Issuer Age	-0.389*	-0.694***	-0.526**
	(-1.90)	(-3.07)	(-2.57)
M/B	0.165***	0.0525*	0.0232
	(31.00)	(1.91)	(1.13)
Underpricing	-0.420***	-0.157***	-0.0447
	(-8.36)	(-2.88)	(-0.46)
_cons	7.973***	7.012***	6.282***
	(6.78)	(6.31)	(5.73)
Observations	287	281	236
Pseudo R^2	0.173	0.152	0.140

Appendix 7

Cross-sectional regression analysis of IPOs and their long-run performance (without winsorizing)

The sample in the regressions consists of VC-backed and non-VC-backed IPOs between 2007 and 2014. The dependent variables in all the regression models are the long-run performance measures, BHAR value-weighted (BHAR VW), BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3). The performance is measured until three years after IPO or until delisting, whichever happens first. Each of long-run performance measures is regressed on the indicator variable venture-backed, which equals one if the IPO issuer is backed by VC firms and equals zero otherwise. Other control variables are offer size, issuer age, issuer M/B (at the time of IPO) and underpricing. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity. As OLS regression is performed, the adjusted R^2 is reported. Year and industry fixed effects are included in regressions, but their coefficients are not reported. *** and ** indicate statistical significance at the 1% and 10%, respectively.

	Dependent Variable		
	BHAR VW (1)	**BHAR EW (2)**	**M/B 3 (3)**
Venture-Backed	0.335***	0.327***	1.038***
	(3.02)	(2.91)	(5.21)
Offer Size	0.0556	0.0516	-0.0749
	(1.33)	(1.21)	(-0.86)
Issuer Age	-0.00168	-0.00232	-0.00833
	(-0.04)	(-0.05)	(-0.10)
Issuer M/B	-0.0168	-0.0169	0.147***
	(-0.89)	(-0.88)	(3.06)
Underpricing	-0.0608	-0.0635	-0.312***
	(-1.24)	(-1.31)	(-2.86)
_cons	-0.491	-0.843**	1.173
	(-1.25)	(-2.13)	(1.45)
Observations	511	511	511
Adj. R^2	0.0472	0.0540	0.205

Appendix 8

Cross-sectional regression analysis of VC market share and issuer long-run performance (without winsorizing)

The sample in the regression consists of VC-backed IPOs between 2007 and 2014. The dependent variables are BHAR value-weighted (BHAR VW), BHAR equally-weighted (BHAR EW), market-to-book ratio (M/B 3) and listening survival (Survival). Dependent variables are measuring the long-run performance. OLS regression is used together with BHAR VW, BHAR EW and M/B3, while probit model is employed in the case of Survival. The post-IPO performance is regressed on VC market share, which measures VC reputation. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions and a pseudo R^2 for the probit regression. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable		
	BHAR VW (1)	**BHAR EW (2)**	**M/B 3 (3)**
VC Market Share	-1.766**	-1.668*	-0.457*
	(-2.47)	(-2.25)	(-0.28)
Offer Size	-0.144	-0.160	-0.0768
	(-1.59)	(-1.71)	(-0.48)
Issuer Age	-0.197	-0.194	-0.166
	(-0.92)	(-0.87)	(-0.93)
Issuer M/B	-0.00382	-0.00326	0.134**
	(-0.18)	(-0.15)	(3.20)
Underpricing	-0.0724***	-0.0789***	-0.336**
	(-4.39)	(-4.99)	(-2.64)
Underwriter Reputation	-0.0160	-0.0144	-0.0322
	(-0.44)	(-0.40)	(-0.78)
_cons	1.700***	1.409**	1.573***
	(3.60)	(2.60)	(3.60)
Observations	302	302	302
Adj./Pseudo R^2	0.0634	0.0707	0.1135

Appendix 9

Cross-sectional regression analysis of VC reputation and issuer long-run performance (without winsorizing) within a subsample

The sample in the regressions consists of VC-backed IPOs subsample between 2007 and 2014. The IPOs backed by VCs with VC market share in the top 10th percentile are excluded. The dependent variable is BHAR value-weighted (BHAR VW), which measure the long-run performance. The post-IPO performance is regressed on VC market share and VC age, both variables measure VC reputation. Other control variables are offer size, issuer age, issuer M/B, underpricing and underwriter reputation. The coefficients and associated t-statistics (in brackets) are based on standard errors which are robust to heteroscedasticity and adjusted for industry clustering. The adjusted R^2 is reported for OLS regressions. Year and industry fixed effects are included in regressions. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Dependent Variable	
	BHAR VW (1)	**BHAR VW (2)**
VC Market Share	8.663*	
	(2.11)	
VC Age		0.000217
		(0.03)
Offer Size	-0.106	-0.109
	(-1.34)	(-1.40)
Issuer Age	-0.217	-0.219
	(-1.11)	(-1.01)
Issuer M/B	-0.0121	-0.00857
	(-0.57)	(-0.39)
Underpricing	-0.0605**	-0.0667***
	(-3.33)	(-3.54)
Underwriter Reputation	-0.0163	-0.0152
	(-0.47)	(-0.42)
_cons	1.420**	1.487***
	(3.43)	(4.60)
Observations	272	272
Adj. R^2	0.0590	0.0557