Journal of Corporate Finance 37 (2016) 356–374

Contents lists available at ScienceDirect

Journal of Corporate Finance

journal homepage: www.elsevier.com/locate/jcorpfin

Are VC-backed IPOs delayed trade sales?☆

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ARTICLE INFO

Article history:
Received 3 April 2015
Received in revised form 11 January 2016
Accepted 14 January 2016
Available online 26 January 2016

JEL classification:
G24
G30
G34

Keywords:
Delisting
Takeovers
VC-backed IPOs
Corporate governance

ABSTRACT

We investigate the role of venture-backing at the time of the initial public offering for the decision to subsequently be taken over and leave the exchange. We show, controlling for firm characteristics as well as the endogeneity of the involvement of VC, that VC-backed firms are significantly more likely to leave the exchange in the course of a take over. Our analysis sheds new light on decisions to go private, and even more so on the process of going public for VC-backed firms. Our findings suggest that, in a significant number of cases, VC-backed IPOs can be interpreted as delayed trade sales.

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1. Introduction

Going public is one of the most important corporate governance decisions in a firm's lifetime. However, in a significant number of cases this process reverses because firms go from private to public and then back to private (see, e.g., Bharath and Dittmar, 2010; Mehran and Peristiani, 2010). Using a sample of initial public offerings (IPOs) covering most of the US IPO market between 1980 and 2010, we show that the involvement of venture capital (VC) in young firms at the time of the IPO significantly increases the likelihood of the firm being delisted later by means of a takeover (i.e., an acquisition, merger, or leveraged buy out (LBO)). In our data sample, 69% of all firms that had VC-backing at the time of their IPO were taken over and delisted, compared to 22% of all non-VC-backed IPOs. Hence, public ownership after a VC-backed IPO is very often of a temporary nature. Since we show that VCs select quite different firms and bring them to the exchange, this might be either due to a selection effect or because of the VC-backing that the firms received. Taking the endogeneity of VC-investment into account via an instrumental variable

☆ We are thankful for participants of the MOVE workshop on Venture Capital in Barcelona, the Special Session on Entrepreneurial Finance, Venture Capital and Private Equity at the EFMA meeting in Braga, the Law and Economics Workshop at the University of Bonn, the Multinational Society Meeting in Krakow, the INFINITI Conference in Dublin, the EFA Annual Meeting in Copenhagen, the finance seminar at WU Vienna as well as the Annual Meeting of the French Finance Association in Lyon for providing very helpful comments and suggestions. In particular, we would like to thank Douglas Cumming, Daniel Metzger, Antoinette Schoar, Armin Schwienbacher, and Jay Ritter for their very helpful comments on an earlier version of the paper. We gratefully acknowledge the very helpful comments and suggestions of an anonymous referee. We also would like to thank the LOEWE center SAFE for providing support for our research.

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http://dx.doi.org/10.1016/j.jcorpfin.2016.01.007
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approach, and controlling for firm characteristics, we carve out the average effect of VC-treatment. We find a significant causal effect of VC-investment on the subsequent decision to be taken over and leave the exchange again.

Given this causal effect, the often emphasized diametrical contrast between the two main exit channels of VCs from their investment in young entrepreneurial firms trade sales and IPOs (cf. Bayar and Chemmanur, 2011) becomes somewhat blurred from the point of view of the firm. What looks like a firm ending up on the exchange and with dispersed ownership (via the IPO) is in essence, in a significant number of cases, a delayed trade sale: afterwards, the firm is no longer listed itself and has a concentrated ownership. This finding sheds new and detailed light on the exit decisions of VCs as well as the governance of their portfolio firms.

We investigate in the next step the drivers behind this phenomenon, focusing on the role of the evolution of the firms' characteristics and corporate governance structure, as well as the role of the VCs. We pose two main research questions: First, how does the evolution of VC-backed public firms' characteristics effects the likelihood of a takeover? Second, what circumstances cause and allow VCs to lead their portfolio firms to the exchange, even if the firms will likely end up back in concentrated private ownership again?

To answer the first question, we explore various arguments for and against being listed on an exchange as well as the evolution of firms' corporate governance which we conjecture have different effects on VC-backed as compared to non-VC backed firms to be taken over. In our empirical analysis, we provide support for the hypothesis that corporate governance problems become more pressing after the VC as the monitor of the firm has left. We show that adverse effects on the benefit–cost relation to stay public affect the VC-backed firms more pronouncedly making them more likely to become a takeover target compared to their non VC-backed counterparts.

With regard to the second research question, we explore a number of potential hypotheses on the role of VCs in this process. Our tests of these hypotheses show no support for either the timing (firms which are taken public by their VCs in a hot-issue market are more likely to be taken over) or the grandstanding hypothesis (young VCs grandstand leading their IPOs to be taken over later). Our analysis, however, does indicate that a VC's experience and reputation have positive and significant effects on the probability that the firm gets delisted in the course of a takeover. This finding supports our certification hypothesis that more experienced and reputable VCs bring portfolio firms temporarily to the exchange.

In a further step, we check the robustness of our findings by controlling for financial performance. This turns out to partially influence the decision to leave the exchange via a takeover, but does not change our main results qualitatively. Furthermore, we check whether the year of the IPO plays a crucial role by including IPO-year fixed effects as well as splitting the sample into different time periods. Finally, we explore the question of whether the ownership structure of the firms matters. We show that taking the company's ownership structure into account leaves our main results unchanged.

Our paper is closely related to two branches of the literature. First, our paper contributes to the literature on the delisting process and indirectly on corporate governance discussions concerning the decision to go public. We focus on the corporate governance issues of the interaction between going public and the process of leaving the exchange in the course of a takeover; a process akin to a decision to go private. A number of recent papers have addressed in detail the determinants of the decision to go private (see in particular Bharath and Dittmar, 2010; Mehran and Peristiani, 2010). However, none of these papers investigate the role of VCs and VC-backing in this decision-making process. Furthermore, our paper is related to the theoretical literature on the determinants of the choice between going public or private (see e.g. Zingales, 1995) as well as to the empirical analysis of this choice (see e.g., Ritter and Welch, 2002; Chemmanur et al., 2010). The role of VC-backing in determining the optimal corporate governance scheme (i.e., being a public or private firm) has not played an important role in the literature to date. The main aim of this paper is to address this issue in more detail and link the role of VC-backing in the decision to go public, with the decision-making process to subsequently go private.

Second, our paper is also closely related to the literature on the exit choice of VCs. Starting with Black and Gilson (1998), a substantial number of papers have addressed the VC's choice of exit mode via acquisitions or IPOs (see e.g. Giot and Schwienbacher, 2007; Bayar and Chemmanur, 2011), as well as the issue of exit timing (see e.g. Giot and Schwienbacher, 2007; Neus and Walz, 2005). The literature on VC's exit decisions via IPOs has also examined the implications of this decisive decision on the contractual relation between the VC and the entrepreneur (see, e.g., Cumming, 2008; Cumming and Johan, 2008). However, most of these papers only address the time during or prior to the IPO, with the only exceptions being those papers which investigate the post-IPO financial performance of VC-backed firms (see, e.g., Brav and Gompers, 1997). The dynamics of the corporate governance of VC-backed firms in the aftermath of an IPO has not yet been analyzed, a gap which we aim to partially close.

The paper is organized as follows. The next section derives hypotheses that might explain the high likelihood of VC-backed firms eventually leaving the exchange during a takeover. In the third section, we introduce our data set and provide some descriptive statistics on the delisting via takeover process. The fourth section expands on our hypothesis that VC-backed firms are much more likely to be delisted during a takeover, even if we control for firm and market characteristics as well as the endogeneity of the VC selection effect. In the fifth section we test our hypotheses. The sixth section contains extensions and robustness checks of our basic analysis. The last section concludes.

2. Hypotheses on why VC-backed firms are more likely to be taken over

Before carefully carving out the causal effect of VC-backing on the takeover decision in the next session we explore the potential drivers behind this effect. We focus on two potential sources that might help us to explain this phenomenon. The first

potential source stems from the evolution of the firm, its characteristics as well as its corporate governance, in the aftermath of the IPO, most notably after the VC has exited the firm. Specifically, we look into the evolution of the trade-off between the costs and benefits of staying public which might develop differently for initially VC-backed firms relative to non VC-backed IPOs. We thereby address different agency problems that can arise for firms with initial VC-backing after the VCs have left the firms.

The second potential source is the role of the VCs themselves (and their characteristics) in the firms at the time of the IPO. First, we conjecture that VCs are particularly able to time the market properly to bring firms to the exchange. Furthermore, we investigate the possibility that VCs have an incentive to grandstand; that is, young VC firms have an incentive to exit their portfolio firms to an excessive degree via IPOs. Thereby, the VCs aim to signal their quality and ability to select and nurture promising firms to attract subsequent funding for future investments. Finally, we explore the certification hypothesis that states that experienced and reputable VCs are more willing and able to bring young and entrepreneurial firms to the exchange that have a higher likelihood to eventually leave the exchange. We derive these hypotheses in detail in the subsection 2.2 and provide exemplary cases.

2.1. Costs and benefits of staying public and the role of corporate governance

First we consider whether the evolution of the firm structure and the corporate governance after the IPO are potential candidates for explaining the phenomenon that VC-backed firms are being taken over much more often than their counterparts. These considerations differ from the analysis of the selection effect where we focus on firm characteristics at the time of the IPO. The main idea is that for VC-backed firms both the cost–benefit trade-off of staying on the exchange and corporate governance issues are affected by the circumstance that the VC gradually exits from the portfolio firm after the IPO. Hence, those effects become more important relative to those firms which are not financed by VCs at the time of the IPO.

For VC-backed firms, the IPO is part of the exit strategy of the VC (see e.g. Cumming, 2008). Hence, other gains of being a public company are less pronounced for VC-backed firms. After the task of the IPO namely to provide an exit channel for the VC has been fulfilled, the firm is confronted with the conventional costs of being on the exchange and being a public company. The more pressing these costs are, the more likely it becomes that the incentive to leave the exchange becomes more pronounced. We conjecture, that, due to our above arguments, this effect is more important for VC-backed firms relative to non VC-backed firms.

In a similar manner, we consider how the evolution of the firms' corporate governance may affect VC-backed firms differently as compared to their non-VC backed counterparts. The underlying idea is that for the VC-backed firms the initial agency problems are solved by the VC especially when approaching the IPO. In a recent paper Arthurs (2014) show that indeed VCs increase their advice effort for portfolio companies they perceive as IPO exits in the future. However, in a certain time period after the IPO, the VC has to exit because of its closed-end structure. With the gradual exit of the VC, the main mechanism to resolve corporate governance problems becomes less and less important. This implies, to the contrary, that corporate governance problems become more pressing after a while on the exchange for VC-backed firms as compared to non VC-backed firms. This circumstance, in turn, makes some VC-backed firms more attractive candidates for a takeover. A seemingly similar argument is the one by Barry et al. (1990) who argue that lower underpricing in VC-backed IPOs is driven by the capability of VCs to monitor the portfolio firms properly. Better monitoring makes VC-backed firms more mature, allowing them to do better on the exchange as compared to their counterparts as long as the VC exercises that monitoring role. As soon as the VC leaves the firm, the monitoring problem arises acting in a similar fashion as the certification argument.

Hence, our first hypothesis is:

Hypothesis 1. Corporate governance and the cost–benefit trade-off of staying public: *Takeovers of VC-backed firms become more likely relative to non VC-backed firms if the evolution of the firm structure reduces the benefits relative to the costs of being public. The same is true for a deterioration of the firm's corporate governance.*

The potential determinants of the cost–benefit trade-off of staying public as well as the corporate governance determinants are – together with the associated literature – summarized in Table 1.

2.2. The active role of the VCs

Next, we develop hypotheses on the active role of the VC in this process. We start out with the observation that there are considerable differences among VCs with respect to their approach to the governance of their portfolio firms (see Cumming et al., 2010) and with respect to their exit decisions of VCs from their portfolio firms. Exit decisions are decisive in the investment cycle of the VC (see, e.g., Black and Gilson, 1998), and there is a significant body of literature dealing with the many aspects of exit decisions. However, we focus on the studies that address the potential determinants behind the decision to go public. For successful investments, VCs face two exit-related decisions: the choice of the exit mode and the choice of the exit timing. We identify three main arguments regarding these two facets.

Lerner (1994), using a sample of 350 biotechnology firms, suggests that VCs indeed time the market, that is, taking an overproportion of portfolio firms public, relative to a non-VC-backed control group, in times when equity valuations are high. Furthermore, he finds in his data set that more experienced VCs are the most capable at timing capital markets. Because VCs hold exit rights, they have a crucial say not only on the exit mode but also on the exit timing in most of their ventures

Table 1
Control variables of the takeover decision.
This table provides an overview of potential drivers of the takeover decision. Together with the underlying economic mechanisms, we provide the proxy variable to control for this effect, and cite the associated literature.

Economic mechanism	Variable; (effect on takeover)	Literature
Cost and benefit of being a publicly listed firm		
Higher liquidity of the share leads to more information generation	TRADVOL (−): Trading volume: Common shares traded annual	Bharath and Dittmar (2010)
More mature firms require less monitoring (costs) on the exchange	AGE-AT-IPO (−): Fiscal year of IPO minus founding year	Pagano and Röell (1998)
The more financially constrained a firm is the more attractive it is to tap public capital markets via being a listed company	KAPLAN–ZINGALES-DUMMY (+) Index calculated on the basis of Lamont et al. (2001) for all firms and years	Röell (1996)
Existence of value-increasing investment opportunities creates demand for funds from public markets	MARKET-TO-BOOK (−) (Market value of equity plus (book value of) total assets − common equity)/total assets	Morck et al. (1990)
Benefit of being public: gathering of serendipitous information	R&D INTENSITY (−): R&D expenses/sales	Subrahmanyam and Titman (1999)
Independent firms on the exchange forego economies of scale less profitable firms are more likely to be taken over	NI/EQUITY (−): net income/total equity	Gao et al. (2013)
Corporate governance		
Corporate governance problems become		
More pronounced with higher levels of free cash flows	FCFAT (+): free cash flow over total assets	Jensen (1986)
Less pronounced if free cash is paid out in dividends	DIVIDEND-DUMMY (−): dummy = 1 if dividend is paid	
Less pronounced with high leverage	LEVERAGE (−): Long-term debt/total assets	Stulz (1988)
More pronounced with higher propensity to waste resources	CAPEX/SALES (+): Capex/sales	Mehran and Peristiani (2010)

(see, e.g., Aghion et al., 2004; Bienz and Walz, 2010). Furthermore, VCs have an interest in timing the capital markets despite the fact that they are selling only a small proportion of their share holdings at the time of the IPO (see Lin and Smith, 1998). This is due to two circumstances. On the one hand, taking portfolio firms public in hot-issue markets leads to less dilution of the VC because a given sum of capital is collected with the issuance of a smaller number of shares (see Barry et al., 1990). On the other hand, cheaper underpricing in hot-issue markets, allows for less costly build-up of the VC's reputation vis-a-vis investors in the capital markets (see, Grinblatt and Hwang, 1989 for evidence).

A prominent example which is particularly fitting to this reasoning is the case of Hotjobs.com an internet job portal. Hotjobs.com received a first round of financing (series A financing) by Bessemer Ventures and General Capital Partners, two venture capital firms. On August 9th, 1999, almost at the peak of the IPO cycle and of NASDAQ valuation, Hotjobs.com went public at an issue price of 8USD. At the time of the IPO Hotjobs.com had a negative net income level. The first-day of closing price was USD 7.625, implying that there were no underpricing costs. In January 2002, Yahoo acquired Hotjobs.com at a price of USD 10.50 per share.

Hence, we derive our second hypothesis:

Hypothesis 2. Market timing: *The VCs are able to time capital markets. This ability allows them to take firms public in hot-issue markets. These firms have a significantly higher probability of ending up in concentrated ownership (after the takeover). We should therefore expect that VC-backed firms that go public in such a market environment are the most likely to be taken over later on.*

Second, Gompers (1996) stresses that VCs have an incentive to grandstand. New and inexperienced VCs have an incentive to signal their ability to their potential investors. Given that VCs are typically organized as limited partnerships and closed-end funds, they need to raise new capital when the lifetime of a fund ends. The main decision variable for investors (limited partners) is the quality of the fund managers (general partners) to select and nurture promising ventures. Hence, general partners have a strong incentive to convince potential limited partners by building a reputation of being a capable VC investor. One of the most obvious signals general partners can send is to take one of their portfolio firms public. Because reputation is decisive for fund raising, VCs are even willing to incur costs to build such a reputation (e.g., a higher degree of underpricing). Gompers (1996) argues that younger VCs especially have an incentive to incur the costs of investing in their reputations. These younger firms have an incentive to grandstand by taking their portfolio firms public more often and earlier compared to established VCs. This concept of grandstanding – and the associated willingness of less established VCs to incur its costs – is also supported by Lee and Wahal (2004). Indeed, they find that the degree of underpricing negatively depends on the VC's reputation, measured by the VC's age and its number of previously conducted IPOs.

Therefore, the less established VCs are more likely to bring firms with a higher takeover probability to the exchange. These firms are less mature and less likely to benefit from the exchange while at the same time are less able to bear the costs of being public (e.g., lacking a big shareholder). Hence, we expect these firms to have a higher probability of leaving the exchange as an independent entity later on.

This notion is consistent with industry experience. For example, Hummer-Winblad was founded as a VC firm in 1989. In 1992, Hummer-Winblad found it very difficult to raise a second fund. They could not rely on a proven track record with respect to have taken portfolio firms public. This changed drastically with the successful IPO of the software company

Powersoft, one of Hummer-Winblad's portfolio firms, on February 3rd, 1993. After the IPO of Powersoft, Hummer-Winblad raised a 60 million USD second fund (HWVPII) in just a couple of months (see Gompers, 1996). The life of Powersoft on the exchange, however, was rather short. In November 1994, the company was taken over by Sybase and left the exchange.

Thus, our third hypothesis is:

Hypothesis 3. Grandstanding: *The VCs with a lower level of reputational capital are more likely to bring firms to the exchange. Firms backed by these VCs have a higher likelihood of being delisted during a takeover in the future.*

The third line of argument goes back to Megginson and Weiss (1991). They argue that VC-backed IPOs are less underpriced than their non-VC-backed counterparts and that VCs certify the quality of their portfolio firms and hence might overcome informational asymmetries, one of the main tasks of VCs (cf. Amit et al., 1998). This certification ability of VCs (for a general discussion of the certification hypothesis, see, e.g., Xu and Masulis, 2006; Lee and Wahal, 2004) allows them to take firms to the exchange that might not have been able to go public otherwise. Consequently, experienced VCs should be the most able to exercise this certification role. This is in line with a recent study by Nahata (2008) who shows that portfolio firms that are backed by a more reputable VC are more likely to go public and access the exchange faster. In addition, his findings imply that experienced and reputable VCs back firms that are more successful as measured by their asset productivity. These firms are the ones with more pronounced informational asymmetries and are hence more prone to corporate governance problems. They are therefore also less suitable for dispersed ownership on the exchange. Hence, we conjecture that these firms are then among the first to leave the exchange as an independent entity. For the group of VC-backed firms, this argument implies that firms backed by experienced and reputable VCs are the ones that are the most likely to leave the exchange via a takeover.

A prominent example very much in line with this argument is Zymogenetics, a US-based biotechnology firm which was backed by two experienced and reputable VCs: Warburg Pincus Equity Partners and Apax. Together these two VC firms owned 37% of Zymogenetics just prior to the IPO. Zymogenetics went public in a quite problematic phase of the market. The IPO took place in February 2002 (there were only 31 IPOs in 2002 in our data) with a share price of USD 12. The degree of underpricing was rather low: On the first day of trading, Zymogenetics' shares closed 0.4% above the IPO price pointing to the certification role of the VCs. In 2010 Zymogenetics was acquired by Bristol-Myers Squibb at a price of USD 9.75 at a stage at which the VCs had already divested their shares in Zymogenetics.

We can therefore state for our fourth hypothesis:

Hypothesis 4. Certification: *The VCs are able to certify the quality of their firms, thereby enabling them to take firms public that might not have been able to go public otherwise. Because established VCs are best suited to certify the quality of their firms, firms backed by these VCs are the most prone to leave the exchange later on.*

3. The data set

3.1. Data sources and construction of the sample

The key innovation of our data set is that we merge IPO data and information on takeovers with data on VC-backed IPOs and data on the underlying VC characteristics (sources: Compustat, Center for Research in Security Prices (CRSP) and SDC Platinum database). We start by using the available companies in Compustat that had their IPO in the U.S. between 1980 and 2010. We want to focus on companies that had their IPO between 1980 and 2010 because of data availability in the other datasets. This yields a total of 6286 companies, of which 3111 are classified as VC-backed IPOs according to the SDC Platinum database. To gather information on reasons for delisting, we rely on information from the CRSP database. We focus only on delisting codes between 200 and 300, thereby focusing exclusively on delistings classified as mergers, since we want to explicitly exclude all companies that left the exchange for other reasons (may it be bankruptcy, liquidations or unknown reasons). We complement the CRSP data with the Compustat information on the delisting process. That is, whenever we find missing information in the CRSP database we use information from Compustat for that particular case. With respect to the delisting decision, we code the following Compustat reasons as takeovers: acquisitions, mergers, and LBOs. Information on the IPOs (date of IPO plus IPO price) are derived from all three databases. As we require a known IPO date and information on the delisting in all our estimations, the sample size drops to a total of 4484 companies, which is the maximum number of observations at the IPO. Out of these 4484 companies, 2402 are VC-backed at the time of the IPO while 2082 firms had no VC-backing. Out of those companies classified as VC-backed (non VC-backed) at the time of their IPO, 1654 (489) companies were involved in a takeover. We extract the firms' balance sheet information from the Compustat database. All of the information on market prices are from the CRSP database. The information on VC characteristics comes from SDC Platinum database, in particular from Thomson's Venture Expert database. The raw data for calculating the measures of the VC's market power and experience are also taken from the SDC Platinum database. Data on the firm age at the time of the IPO are provided by Jay Ritter on his website. Data on the IPO gross proceeds and the number of IPOs also comes from Jay Ritter's website.

The following Table 2 provides an overview of the distributions of IPOs and takeovers over the sample period:

Table 2
Distributions of IPOs and percentage of subsequent takeovers.
This table provides an overview of the distribution of IPOs across time and the percentage of these IPOs that are taken over subsequently.

	VC backed		Non-VC backed	
IPO year	Number IPOs	% M&A	Number IPOs	% M&A
1980	7	71%	11	9%
1981	28	79%	15	20%
1982	15	87%	11	36%
1983	69	87%	34	21%
1984	26	69%	25	4%
1985	33	88%	28	7%
1986	66	68%	58	26%
1987	68	82%	69	19%
1988	34	79%	46	30%
1989	34	94%	30	27%
1990	48	77%	38	34%
1991	81	74%	51	16%
1992	125	74%	96	23%
1993	114	74%	130	15%
1994	108	82%	122	25%
1995	129	79%	94	19%
1996	187	81%	145	25%
1997	121	73%	130	26%
1998	76	72%	123	24%
1999	189	75%	115	24%
2000	217	69%	96	22%
2001	56	55%	68	16%
2002	31	52%	56	27%
2003	37	43%	42	19%
2004	127	61%	85	19%
2005	93	43%	98	29%
2006	112	45%	114	19%
2007	114	44%	111	21%
2008	19	26%	41	20%
2009	29	24%	0	0%
2010	9	33%	0	0%
All periods	2402	69%	2082	22%

3.2. Variable descriptions

We explore two sets of variables that might potentially have effects on whether takeovers occur or not: firm and market characteristics at the time of the IPO, and variables that divulge changes in the firm characteristics during the time in which the firms are public. Furthermore, we collect information on the characteristics of the VC that we use later in our analysis of the takeover probability.

Table 3 provides an overview of these variables in our data set.

3.3. Descriptive statistics

We split the descriptive analysis into two steps. First, we provide a comparison of the takeover sample with the control group of all other firms. This comparison provides initial insights into the potential determinants of the takeover process. We also compare the evolution of the main firm characteristics between the subsamples to investigate the potential role of these dynamics in the delisting decision. Second, we distinguish variables for the VC-backed and the non-VC-backed firms, which allows us to investigate the potential selection effects underlying the VC investments.

3.3.1. Takeover versus control sample

Table 4 provides the descriptive statistics for the comparison between the takeover sample and the control group. The table illustrates that a number of firm characteristics at the time of the IPO differ significantly between the takeover sample and the control group. For both groups, we conduct mean-comparisons and Wilcoxon signed-rank tests to detect for statistically significant differences in the respective variables. The main findings are as follows. Firms that are taken over after the IPO are significantly younger at the time of the IPO (mean: 12.57 years; median: 7 years) as compared to their counterparts in the control group (mean: 19.03 years; median: 9 years). In addition, our further comparisons indicate that the firms that are delisted during the course of a takeover are also smaller on average at the time of the IPO in a number of dimensions. The differences between the two subsamples are significant at the 1% level for these two size variables. Furthermore, our univariate comparisons suggest that the firms in the takeover sample have significantly lower leverage, significantly higher relative cash holdings, and pay

Table 3
Data description.
This table provides an overview of the main variables used in the descriptives and regressions. Number of observations, means and standard deviations are at the time of the IPO.

Variable	Variable description	Source	No of obs.	Median	Std. deviation
Firm characteristic					
Sales	Gross sales minus discounts and allowances	Compustat	4349	46.94 mil.	1792.36
Market value	Common shares outstanding times share price (end-of-year)	Compustat	3900	180.18 mil.	2927.98
Market-to-book	(Market value of equity plus (book value of) total assets - common equity)/total assets	Compustat	3876	2.34	172.01
FCF/total assets	Operating income before depreciation after taxes, interests, dividends/total assets	Compustat	3698	0.048	0.504
Age-at-IPO	Fiscal year of IPO minus founding year	Compustat	3264	8	21.29
R&D intensity	R&D expenses/sales	Compustat	2539	0.118	40.59
Capex/sales	Capex divided by sales	Compustat	4061	0.060	46.97
Kaplan Zingales index	Index calculated on the basis of Lamont et al. (2001) for all firms and years	Compustat	3344	0.573	51.22
Leverage	Long-term debt/total assets	Compustat	4344	0.022	0.24
Dividend dummy	Dummy equal to 1 if positive dividends are paid	Compustat	4484	0	0.475
Cash-to-assets	(Cash and short-term investments)/total assets	Compustat	4355	0.278	0.356
VC characteristics					
VC-backed	Dummy equal to 1 if firm is VC-backed at the IPO	Thomson VentureExpert	4484	0.536 (mean)	0.49
Market-share-mcap-VC	Sum of the share of a specific VC over the total VCs market share over time	Thomson VentureExpert	1581	0.0003	0.03
Num-IPO-VC	Number of companies a specific VC brought public over time	Thomson VentureExpert	1614	3	11.54
Market characteristics					
Number of IPO	Aggregate number of IPOs in fiscal year	Jay Ritter's Website			
IPO gross proceeds	Total proceeds of all IPOs in fiscal year	Jay Ritter's Website			
Shares of directors	Shares held by the directors (proxy for the VC's fraction of shares)	RiskMetrics			

dividends less often. Overall, these findings suggest that, at the time of the IPO, there are already differences between the takeover subsample and the control group.

Table 5 shows that we also observe differences between the two subsamples with respect to the five-year growth rates of the key firm characteristics after the IPO.

The most remarkable differences exist with respect to sales growths, changes in market valuations, and market-to-book ratios. These differences suggest that changes over time (i.e., after the IPO), and hence the development of the firms, differ across the VC- and non-VC-backed firms. We thereby see indications that the firm dynamics have an effect on the delisting and takeover processes.

Table 4
Comparison — takeover subsample; date of IPO.
In this table we display the main firm characteristics for our two subsamples: the takeover subsample as well as the control group at the time of the IPO of the respective firm. The takeover subsample thereby consists of all firms that later on are taken over due to a merger, LBO or acquisition. The control group consists of all firms that are still public end of fiscal year 2010. Since we do not always have information on all variables, the number of observations may differ. We present means as well as medians and report potential significance levels of the comparison between the two groups for main firm characteristics. +++, ++, + (***, **, *) represent significance levels for differences in means (medians) at the 1, 5, and 10% level, respectively.

	Takeover subsample					Still public		
Variable	Obs	Mean	Median	Sig.	Sig	Obs	Mean	Median
Age at IPO	1765	12.57	7	+++	***	1499	19.03	9
FCF/total assets	1789	−0.043	0.41		***	1909	−0.055	0.053
Market value	1909	542.9	1661.4	+++	*	1991	1019.5	3746.9
Sales	2077	197.5	36.8	+++	***	2272	561.1	61.87
Total assets	2078	312.9	63.9	+++	***	2285	1462.8	113.65
Market-to-book value	1901	4.26	2.58		***	1975	9.03	2.08
Kaplan–Zingales index	1645	0.312	0.595		**	1699	1.601	0.545
R&D intensity	1383	3.36	0.149		***	1156	4.03	0.068
Leverage	2070	0.109	0.015	+++	***	2274	0.149	0.033
Capex/sales	1994	0.708	0.064		***	2067	2.418	0.054
Cash/total assets	2076	0.411	0.403	+++	***	2276	0.305	0.184
Dividend dummy	2113	0.315	0	+++	***	2371	0.371	0
Net income/equity	2075	−0.176	0.034		***	2267	−0.036	0.079

Table 5
Comparison — takeover subsample; 5 years after IPO.
In this table we display the development of main firm characteristics for our two subsamples for the 5 years following the IPO: the takeover subsample as well as the control group. The takeover subsample thereby consists of all firms that later on are taken over due to a merger, LBO or acquisition. The control group consists of all firms that are still public end of fiscal year 2010. We present means as well as medians and report potential significance levels of the comparison between the two groups. +++, ++, + (***, **, *) represent significance levels for differences in means (medians) at the 1, 5, and 10% level, respectively.

	Takeover subsample					Still public		
Variable	Obs	Mean	Median	Sig.	Sig.	Obs	Mean	Median
Sales growth	1093	20.75	1.629		**	1732	210.34	1.371
Asset growth	1117	8.89	1.083		***	1801	22.41	1.305
Leverage growth	832	11.84	−0.189		***	1315	16.66	0.027
Change in market value	988	4.803	0.228		***	1518	4.858	0.526
Change in Capex/sales	1041	0.748	−0.358		***	1523	2.626	−0.258
Change in market-to-book	983	−0.063	−0.298		***	1501	0.434	−0.175
Change in FCF/total assets	895	−0.686	0.036			1383	−1.103	−0.023
Change in cash/total assets	1106	2.459	−0.257			1774	5.195	−0.247
Change in NI/equity	1118	2.078	−0.214			1784	−0.588	−0.171

3.3.2. VC-backed versus non-VC-backed firms

Our observation of a very high proportion of VC-backed takeover firms leads us to conjecture that VCs are more able and willing to bring such firms to the exchange. However, an alternative interpretation is that VCs are more likely to have invested in special firms: those with a higher takeover probability per se. We aim to disentangle the role of the VC on the takeover probability from this selection effect. The selection effect emerges if VCs are invested at the time of the IPO in significantly different firms as compared to the non-VC-backed subsample. To get an impression of the extent to which VC-backed firms differ from non-VC-backed firms, we compare the firm characteristics for the VC-backed firms with the characteristics of non-VC-backed firms at the time of the IPO. Table 6 delineates the potential differences in the firm characteristics.

The table shows that the VC-backed firms are significantly different from non-VC-backed firms in a number of dimensions. First and foremost, we observe that the VC-backed firms are significantly younger at the time of the IPO than their non-VC-backed counterparts. The difference in age amounts to four years with respect to the median and eight years in the mean. Furthermore, the VC-backed firms are significantly smaller than the non-VC-backed firms (with respect both to sales and total assets). In addition, the VC-backed firms disclose less of a need for capital (higher cash/total asset ratio) and are less leveraged (indicating their lower debt capacity). Overall, these findings strongly suggest that VCs invest in young firms with fewer tangible assets. This suggests that VCs do indeed select particular firms which differ from their IPO counterparts. An obvious strategy to take this selection effect into account is to control for firm characteristics. This may, however, only partially cover the selection mechanism. If there exists any unobservable variable (such as the particular abilities of the founding team) which jointly influences both the selection decision of the VC and the subsequent take-over decision, then any estimate of the effect of the VC-backing variable on the take over decision would be biased. One of the main aims of our analysis is to address this endogeneity problem with a proper econometric approach in the next step.

Table 6
Comparison — VC-backed versus non-VC-backed firms; date of IPO.
In this table we display the main firm characteristics for our two subsamples: the VC-backed and the non-VC-backed companies. We present means as well as medians and report potential significance levels of the comparison between the two groups. The VC-backed subsample thereby consists of all firms that were VC-backed at the time of the IPO. The control group consists of all firms that were not VC-backed at time of their IPO. +++, ++, + (***, **, *) represent significance levels for differences in means (medians) at the 1, 5, and 10% level, respectively.

	VC-backed					Non-VC-backed		
Variable	Obs	Mean	Median	Sig.	Sig	Obs	Mean	Median
Age at IPO	2166	12.85	7	+++	***	1098	20.86	11
FCF/total assets	2082	−0.039	0.46		**	1616	−0.062	0.049
Market value	2238	684.2	199.29	+++	***	1662	923.48	147.91
Sales	2385	204.83	42.43	+++	***	1964	609.23	55.38
Total assets	2387	318.68	73.63	+++	***	1976	1635.64	106.23
Market-to-book value	2234	4.400	2.685		***	1642	9.807	1.828
Kaplan–Zingales index	1975	0.382	0.625		***	1387	1.793	0.477
R&D intensity	1686	3.802	0.154		***	853	3.403	0.039
Leverage	2378	0.111	0.014	+++	***	1966	0.152	0.043
Capex/sales	2305	0.706	0.066		***	1756	2.723	0.049
Cash/total assets	2385	0.441	0.453	+++	***	1970	0.253	0.128
Dividend dummy	2402	0.317	0	+++	***	2082	0.376	0
Net income/equity	2384	−0.154	0.033		***	1958	−0.041	0.085

4. The (causal) effect of VC-backing on the takeover decision

In order to address the effect of VC-backing on the takeover decision, we have to take care of three different issues. First, we must take the selection effect into account by addressing the endogeneity of the VC-backing variable. Second, we are facing a right-censoring problem which needs to be tackled. At the end of our observation period some candidates for being taken-over simply have not yet begun that process but will do so only in the future. In our data sample, however, they are only captured as still being listed on the exchange. Third, we need to account for the possibility that firm characteristics as well as other variables affect the take over decision. We address all three issues below.

4.1. Non-parametric local average treatment effect regressions

Typically, in applied work, selection effects are addressed in a conventional instrumental variable approach using e.g. two-stage least square estimations. These approaches rely on a number of restrictive assumptions on the underlying functional relationship such as additive-separability in the error terms and linearity of the underlying functional relationship. These assumptions are often not fulfilled, and they are definitively not fulfilled in our highly non-linear set-up which employs a duration model (see below). In order to overcome this problem and to avoid biased estimators, we rely on the non-parametric instrumental variable estimation of local average treatment effects (LATE) developed by Imbens and Angrist (1994). Further to incorporate additional covariates, and hence, address our third issue, we make use of the non-parametric LATE extension proposed by Frölich (2007). Frölich (2007) shows his non-parametric estimator is $\sqrt{n}$-consistent and efficient. We implement Frölich's approach using the NPLATE package in STATA. We are thereby not only able to provide efficient local average treatment effects of our VC-backed variable but also to include further covariates in our regression even when using our highly-nonlinear duration model (see below and the Appendix for a more detailed description of the approach used).

Following Lee and Wahal (2004) we take into account the geographical proximity of the firm to VC-clusters. We thereby make use of the fact that the VC industry is particularly concentrated around Boston as well as in California by using a dummy which is one if the respective firm is located in California or Massachusetts and zero otherwise. We argue that the proximity of the firm to potential VCs influences the likelihood of VC-financing and backing but has no effect on the likelihood of being taken over later on.

4.2. Right-censoring and duration models

In our next step, we address the right-censoring problem. We start with our analysis of the delisting decision after the takeover in a multivariate setting by making use of the panel structure of our data set. The aim of this analysis is to check whether our observation of VC-backed firms having a significantly higher probability of being taken over remains a robust finding after we control for the other main drivers of the takeover process. Our dependent variable is time since the IPO. We use one of the most widely used duration models, the Cox proportional hazard model. This duration model is particularly helpful when the exact timing of each "exit" is known, as in our data set, but when the data suffers a right-censoring problem.

The Cox model describes the (instantaneous) hazard function $h(t)$ as a vector of explanatory variables x with unknown variables and h_0 as the baseline hazard rate: $h(t) = h_0 e^{x'\beta}$. In our context, the hazard rate depicts for each firm the instantaneous probability of being taken over and delisted. The Cox model can be used to estimate β without specifying the form of the baseline hazard function h_0 (see Kiefer, 1988, p. 667). Thus, the hazard rates ($\exp(x'\beta)$) are computable from the reported coefficients, which measure the economic significance of the coefficient estimates. The right-censoring problem can be addressed by using the appropriate corrections in STATA for the Cox model.

4.3. Potential drivers of the takeover decision

In this third step, we aim to include potential drivers for the takeover decision of firms in order to investigate whether we still observe a significant impact of the VC-backing of firms after we control for the factors potentially explaining the takeover decision.

The takeover decision has two aspects. First, the firm leaves the exchange and becomes either a private firm or part of a publicly-listed company, but loses its status as an independent publicly-listed firm. The second aspect is that the firm is acquired by another firm which has to extract some extra value from the target firm in order to justify the buying price. We rely in our analysis on arguments addressing both these aspects. We should note at this point, however, that we do not aim to explain the takeover decision per se. Rather, our main goal is twofold. First, we want to investigate whether the inclusion of other potential determinants of the takeover decision leaves the VC-dummy still with a statistical and economically significant impact on the takeover probability. Second, later on, we will argue that the cost–benefit trade off of staying on the exchange, along with the evolution of corporate governance problems, may affect VC-backed firms differently in the aftermath of the IPO.

The details of the potential drivers of the takeover decision as well as the underlying economic mechanism and the associated literature have already been discussed in Section 2 (see Table 1). We use these arguments and the related proxy variables to investigate the likelihood of the takeover process. Most notably we ask whether the VC-dummy survives as a significant factor in explaining the takeover decision even if we control for these potential other determinants of the takeover decision.

4.4. Multivariate regressions

The first two columns of Table 7 present the results of the Cox regressions. These columns denote the conditional probability of being delisted in the course of a takeover. A positive (negative) coefficient implies a higher (lower) probability of a takeover the larger the value of the respective independent variable is, as a consequence of the increase in the independent variable by one unit. We employ the non-parametric local average treatment effect approach to tackle the endogeneity of the fact that a firm receives VC-financing. The VC-backing variable denotes the standardized fitted value of the propensity score from the first-stage regression of receiving VC-financing in which we use the proximity of VC clusters to the respective firm as instrument.

For example, the coefficient of 1.152 in the first column of the table denotes that the differences in the probability of being acquired, merged, or being part of an LBO between VC-backed and non-VC-backed firms is 115% after taking the endogeneity effect into account. This percentage implies that if, on average, the takeover probability of a non-VC-backed firm is 20%, then the respective probability of the VC-backed firm is 46%.

A number of significant effects emerges. The dividend dummy variable as well as the market-to-book ratio and the age-at-IPO variable are statistically significant and have the predicted sign (see Tables 1 and 7). However, for our purpose, the most important result is that the VC-backed variable remains highly significant. This is true for both of our Cox models where we in the second model add the R&D intensity of the firm as the control variable, which we use as a further potentially firm characteristic. However, this variable – which also leads to a rather sharp drop in the number of observations – has no significant effect on the takeover decision (see Table 7) and leaves all the other factors, most notably the VC variable, unchanged. Therefore, we find a very pronounced statistical significance (at the one percent level) but also a very pronounced significance for the economic effect of the VC variable.

To gain a better understanding of the takeover determinants accruing from factors that are already present at the time of the IPO, we run a probit regression. We report the results of the second stage of a standard two-stage instrumental variable approach. These results rest on the findings of a OLS regression in the first stage with geographical proximity between the firm's headquarters and a VC cluster as an instrument. The firms that are VC-backed also have a statistically significant influence on the takeover decision in the probit regression. In order to check robustness, we also run the NPLATE approach in our probit estimation. It reveals that due to the linearity of the probit regression the difference between the standard approach and the findings with the NPLATE approach are rather small. We find for the local average treatment effect a coefficient of 0.702 with a z-value of 3.84 thereby indicating an almost identical economic effect which is, statistically, a bit less pronounced.

In this regression, a number of variables from the time of the IPO have predictive power for a takeover to occur years later. The sales variable satisfies this condition. It has a negative and statistically significant coefficient. In addition, we find a negative and statistically significant Kaplan–Zingales index. This finding indicates that the firms that are financially constrained seek access to public markets and hence stay on the exchange while those with a low Kaplan–Zingales index are more likely to be taken over. Taken together, these findings show that the firm characteristics at the time of the IPO matter.

Table 7
Probability of being part of a takeover.
In this table we present our multivariate estimations. The first two models display Cox regressions with the left hand side representing the time since IPO. In the first regression the explanatory variables are the main firm characteristics for which we provided descriptives in the previous tables. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing. In the second model we include R&D intensity (R&D expenditures over sales) to capture possible selection effects of companies by VCs. Since the R&D variable is often missing in the Compustat database we face a drop in the number of observations. The third model displays a probit regression wherein once gain we have instrumented the VC-backed variable. We use a standard two-stage least squares approach and report the second stage only. The left hand side is the takeover dummy which is one if the firm has left the exchange at a certain point in time and zero if the firm is still public. All explanatory variables are collected at the time of the IPO.

	Cox regression		Cox regression		Probit	
	Coefficients	z	Coefficient	z	Coefficient	z
VC-backed	1.152	5.23	1.206	4.70	0.686	6.05
Log sales	−0.033	−1.41	−0.029	−1.00	−0.029	−4.32
Capex/sales	−0.295	−2.44	−0.463	−2.33	−0.001	−0.89
Dividend dummy	−0.521	−5.38	−0.483	−3.73	0.028	1.31
Market-to-book	−0.142	−6.19	−0.137	−5.49	0.001	0.57
Total assets	−0.000	−0.94	−0.000	−0.55	0.000	0.84
Market value	0.000	0.12	0.000	0.32	−0.000	−1.34
FCF/total assets	−0.425	−5.93	−0.399	−4.98	0.022	0.49
Leverage	0.133	0.87	0.182	1.04	0.018	0.32
Age-at-IPO	−0.004	−2.07	−0.006	−1.79	−0.000	−0.29
Kaplan–Zingales dummy	−0.103	−1.14	−0.088	−0.80	−0.048	−1.88
Trading-volume	−0.000	−1.07	−0.000	−1.81	−0.000	−0.92
Net income/equity	−0.000	−0.28	0.001	0.36	0.003	0.64
R&D intensity			−0.007	−0.76		
Industry dummies	Yes		Yes		Yes	
No of observ	20,381		13,178		2599	

From all these observations, two important questions arise. First, what role do the evolution of firm structure and characteristics play in this process? Second, why do VCs have the ability but also the willingness to take these firms public? We address these questions by testing our hypotheses in the next section.

5. Hypotheses tests

5.1. The evolution of the firm's structure and corporate governance

First, we address the roles of the evolution of the firm structure, and also of its corporate governance, that is, Hypothesis 1. In order to test this hypotheses, as well as Hypothesis 2, we use the full sample (see Table 8). For testing Hypotheses 3 and 4, we limit our analysis to all VC-backed IPOs only, since we have only variation across these firms. These hypotheses rest on the idea that the VC has already left the firm. Because we are not able to observe this directly, we use firms that have already been on the exchange for four years as a proxy. This is based on empirical findings suggesting that the large majority of VCs have divested the shares within four years after the IPO (cf. Fürth and Rauch, 2015). This suggests that after this time period the formerly VC-backed firms have lost their main shareholder and monitor and, therefore, may be more likely to encounter corporate governance problems.

In addition to the variables of our base regression, we interact the variables with the VC-dummy thereby gaining a measure for their effects on the evolution of both the firm's structure and corporate governance for the VC-backed firms relative to non-VC-backed firms. Once again, since we apply the non-parametric local average treatment effects approach, the VC-dummy is the standardized value (on the 0–1 domain) of the propensity score resulting from the first-stage regression.

To test the corporate governance part of Hypothesis 1 we rely on the free-cash-flow-over-assets variable and on the leverage variable. The propensity to waste financial resources is approximated by the CAPEX/SALES variable. We expect that larger free-cash-flows over assets and higher capex over sales in VC-backed firms make takeovers more likely, while higher leverage (mitigating the governance problem) makes takeovers less likely. Furthermore we expect a negative sign for the interaction with the dividend dummy since it reduces the free-cash-flow problem. For the cost–benefit trade off of being on the exchange-part of Hypothesis 1 we employ our other interaction terms. Therefore, we expect that the interactions of the AGE-AT-IPO, MARKET-TO-BOOK, TRADVOL, and the NI/EQUITY variables with the VC-backed dummy to each have a negative impact on the probability of being taken over. Our variables measuring the degree of capital constraints associated with the firm should indicate

Table 8
Testing the firm structure and corporate governance hypotheses.
In this table we address Hypotheses 1 and 2. All models display Cox regressions with the left hand side representing the time since IPO. Besides the variables used in our standard Cox regression we use the proxies for the role of firm characteristics and of corporate governance. All observations start not before four years after the IPO, when the likelihood that the VC has exited the firm is sufficiently high. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Coefficient	z
VC-backed	0.895	1.97
Log sales	−0.036	−1.31
Capex/sales	−3.678	−2.98
Dividend dummy	−0.185	0.29
Market value	0 .000	0.90
Total assets	−.0000	−1.21
Market-to-book	−0.342	−2.23
FCF/total asset	−1.317	−2.11
Leverage	0.553	0.65
Age-at-IPO	−0.000	−0.01
Kaplan–Zingales dummy	0.004	0.01
Trading volume	0.000	1.33
Net income/equity	−0.004	−0.39
Capex/sales * VCdummy	3.648	2.77
Dividend dummy * VCdummy	−0.593	−0.88
Market-to-book * VCdummy	0.224	1.24
FCF/total asset * VCdummy	0.990	1.42
Leverage * VCdummy	−0.533	−0.47
Age-at-IPO * VCdummy	−0.016	−1.27
Kaplan–Zingales dummy * VCdummy	−0.101	−0.16
Trading volume * VCdummy	−0.000	−1.82
Net income/equity * VCdummy	0.006	0.38
Industry + year dummies	Yes	
No of observ	15,903	

that more capital constrained VC-backed firms should stay on the exchange, implying that we expect a positive sign for the interaction term with the Kaplan–Zingales dummy.

We find evidence for our corporate governance hypothesis. The interaction term with capex over sales is positive and statistically significant, thereby supporting Hypothesis 1. If corporate governance issues become more pressing after the VC has left the firm, this makes the VC-backed firms more prone to leaving the exchange relative to non VC-backed firms.

The interaction term with the trading volume has the predicted negative sign and is statistically significant. The benefit–cost relationship of staying on the exchange becomes relatively less positive for VC-backed firms leading to a significantly higher probability of takeovers for VC-backed firms. This finding also provides support for our Hypothesis 1.

5.2. The role of the VCs in the takeover process

In this subsection, we address our hypotheses on the role of the VC. Thereby, we look into the impact of different types of VCs on the takeover decision. In contrast to taking VC firm fixed effects into account, with this procedure we are able to potentially carve out the economic mechanisms involved. At the same time we are overcoming the problem that some VC firms are only represented once in our sample. We begin with empirically introducing the proper proxies for our hypotheses in the standard Cox regression. We start with Hypothesis 2 (see Table 9). We use two different proxies for hot-issue markets. First, we control for the sizes of IPOs by using the aggregate IPO proceeds in the fiscal year in which the firm goes public. Our second proxy variable measures the index levels in the Nasdaq for the fiscal year in which the firm goes public. In all of our regressions, we rely on the standard Cox regression described earlier. We find a rather clear-cut picture that does not support Hypothesis 2. While firms that go public in a hot-issue market are significantly more likely to leave the exchange via a takeover after a couple of years, the same is not true for VC-backed IPOs. These findings are very strong for the Nasdaq variable. The coefficient of the variable itself is positive and highly significant. However, the interaction term of the variable with the VC dummy is negative and also significant. Our findings for the IPO proceeds variable point in the same direction but are not statistically significant.

Our interpretation of this finding is that firms with a higher likelihood of leaving the exchange via a takeover go public during hot-issue markets. However, this general finding does not apply to VC-backed firms. This finding is reinforced by the fact that the VCs, rather than contributing to hot-issue markets, do almost exactly the opposite. The higher the number of IPOs in a particular year, the lower is the share of VC-backed IPOs in particular and vice versa.

We address the grandstanding and certification hypotheses jointly. Since we investigate the variation across VCs, we restrict the analysis to the subsample of VC-backed firms. To test the two hypotheses we need to establish proxies for the VC's experience and reputation. A direct variable that measures the experience and reputation of the VC is the number of previous IPOs of the VC. Since the VCs exit their most successful firms via an IPO (see Giot and Schwienbacher, 2007; Cochrane, 2005), the number of previous IPOs is not only an indicator of the VC's experience but also of its reputation. We refer to this variable as NUMBER-IPO-VC. Second, we use a variable that was

Table 9
Testing the hot-issue market hypothesis.
In this table we test our hot-issue market hypothesis. All models display Cox regressions with the left hand side representing the time since IPO and the main firm characteristics as explanatory variables. We use two proxies for hot-issue markets. First, we use the IPO proceeds which are calculated as IPO price times issued shares in the year of the IPO of the particular firm (IPO proceeds). Second, we use the total annual returns in the NASDAQ as a proxy for a hot-issue market. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Model (1)		Model (2)	
	Coefficient	z	Coefficient	z
VC-backed	1.58	3.86	1.99	5.96
Log sales	−0.028	−1.19	−0.028	−1.19
Capex/sales	−0.292	−2.42	−0.293	−2.42
Dividend dummy	−0.505	−5.21	−0.507	−5.24
Market value	0.000	0.11	0.000	0.07
Total assets	−0.000	−0.95	−0.000	−1.05
Market-to-book	−0.140	−6.12	−0.140	−6.12
FCF/total asset	−0.423	−5.90	−0.427	−5.91
Leverage	0.126	0.84	0.114	0.77
Age-at-IPO	−0.004	−2.06	−0.004	−2.07
Kaplan–Zingales dummy	−0.099	−1.10	−0.093	−1.04
Trading volume	−0.000	−1.14	−0.000	−1.11
Net income/equity	−0.000	−0.28	−0.000	−0.29
IPO proceeds	0.00001	2.03		
IPO proceeds * VC dummy	−0.00001	−1.41		
Nasdaq			0.001	4.20
Nasdaq * VC dummy			−0.001	−3.48
Industry + year dummies	Yes		Yes	
No of observ	20,381		20,381	

proposed recently by Nahata (2008) in his study of VC performance. He constructs a variable that measures each VC's share in the accumulated market capitalization up to the year of the VC-backed IPOs. He divides the capitalization by the accumulated market share to determine the relative share. We refer to this variable as MARKET-SHARE-MCAP-VC.

To test our grandstanding and certification hypothesis, we use the standard Cox regression and add these proxies for the VC's experience and reputation to different regressions. While the grandstanding hypothesis might suggest negative and statistically significant coefficients for both proxy variables, the opposite holds true for the certification hypothesis. Table 10 displays our results. Model (1) in Table 10 indicates that the number of firms brought to the exchange via an IPO by their respective VC has a statistically significant and positive effect on the takeover variable. The variable measuring the accumulated role of the VC in the IPO market turns out to have an insignificant effect on the take over probability (see model 2 in Table 10). If we use both proxy variables at the same time (see model 3 in Table 10) our results are reinforced. The NUMBER-IPO-VC variable remains positive and statistically significant at the one percent level, the MARKET-SHARE- MCAP-VC variable has no significant effect on the takeover probability. Taking these findings, we can interpret them as support for the certification hypothesis. More experienced and reputable VCs are better equipped to take firms public that then delist during a takeover. Our results also indicate a clear rejection of the grandstanding hypothesis. We find no support for the conjecture that young and inexperienced VCs in particular have the ability and incentive to take these firms public.

It is interesting to view our results against the background of the findings in Nahata (2008). Nahata (2008) shows that experienced and reputable VCs are more likely to exit their successful ventures. He also finds that more reputable VCs exit their ventures faster. Our findings suggest that this success, at least from a corporate governance point of view, is only a temporary one. Firms backed by more reputable and experienced VCs seem to be more likely to be successful – with respect to the exit per se – but also as suggested by Nahata (2008) with respect to their asset productivity. But of those firms that end up on the exchange via an IPO, the ones with the backing of a more reputable VC are also significantly more likely to be taken over later on. Hence, we can stress that for many VC-backed firms in general, the IPO is not the final step in the firm's corporate governance, but rather a temporary one. This in particular is true for firms backed by reputable and experienced VCs. All of these findings shed very strong doubts on the view that at least implicitly exists in the literature on venture capital: the IPO as the silver bullet for the portfolio firms. Rather, it seems to be the case that being listed is only a temporary part of the lifetime of the formerly VC-backed firms; or to put it more bluntly, a delayed trade sale. The certification ability of the VCs allows firms to become public but after the VC has left being public obviously prove to not be optimal anymore, that is, the firms end up in concentrated ownerships once again.

In a next step, we address the question of whether VCs pay for their willingness to take firms with a higher ex-post takeover probability to the exchange via underpricing (i.e., leaving sufficient money on the table in the course of an IPO). We thereby start from the conjecture, based on Barry et al. (1990), that underpricing is lower in VC-backed IPOs (especially for reputable and experienced VCs). We interpret any deviation from this hypothesis of lower underpricing in VC-backed IPOs as indication that VCs pay for taking firms with a higher ex-post takeover probability to the exchange by giving up the opportunity not to underprice their IPOs.

We regress the level of underpricing on the firm as well as the VC characteristics (see Table 11). Once again, we rely on the NPLATE approach and use the standardized propensity score merging from the first-stage instrumental-variable regression as our

Table 10
Testing the grandstanding and the certification hypotheses.
In this table we test the grandstanding as well as the certification hypothesis with the subsample of VC-backed firms. All models display Cox regressions with the left hand side representing the time since IPO. Besides the variables used in our standard Cox regression we use four proxies with which we test the grandstanding as well as the certification hypotheses. These variables are: the number of IPOs the VC who backs the particular company has undertaken (Number-IPO-VC), the age of the VC firm at the time of the IPO (Age-VC), the cumulative market share of the VC in total market capitalizations of IPOs up to the year of the IPO (Market-share-mcap-VC), as well as a dummy taking a value of one if the VC is an independent VC or zero if the VC is a captive VC (Dummy-independent). We only consider companies that are or were listed for at least four years. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Model (1)		Model (2)		Model (3)	
	Coefficient	z	Coefficient	z	Coefficient	z
Log sales	−0.064	−1.73	−0.049	−1.32	−0.052	−1.38
Capex/sales	−0.218	−1.23	−0.249	−1.33	−0.236	−1.26
Dividend dummy	−0.218	−1.53	−0.235	−1.64	−0.235	−1.61
Market value	0.000	0.25	0.000	0.15	0.000	0.21
Total assets	−0.000	−0.68	−0.000	−0.25	−0.000	−0.73
Market-to-book	−0.202	−5.63	−0.196	−5.48	−0.200	−5.52
FCF/total asset	−0.437	−3.34	−0.476	−3.64	−0.432	−3.27
Leverage	−0.049	−0.18	−0.083	−0.30	−0.042	−0.15
Age-at-IPO	−0.006	−1.87	−0.006	−1.91	−0.007	−1.91
Kaplan–Zingales dummy	−0.052	−0.37	−0.049	−0.35	−0.051	−0.36
Trading volume	−0.000	−1.51	−0.000	−1.84	−0.000	−1.54
Net income/equity	0.013	1.65	0.012	1.60	0.013	1.66
Number-IPO-VC	0.007	2.09			0.008	2.18
Market-share-mcap-VC			−0.234	−0.12	−0.388	−0.19
Industry + year dummies	Yes		Yes		Yes	
No of observ	8168		8189		8101	

Table 11
Underpricing.
In this table we explore determinants of underpricing in a simple OLS regression. We regress the level of underpricing (market price at the end of the first day of trading relative to the issue price) on firm as well as VC characteristics. The level of underpricing of the firm's IPO is the left hand side variable. The usual set of firm characteristics is taken as explanatory variables. We amend the regression by a set of VC characteristics and market characteristics — Number of IPOs at the time of the IPO, a dummy variable that indicates whether the VC is independent, the age of the VC at the time of the portfolio firm's IPO and the cumulative market share of the VC in total market capitalizations of IPOs up to the year of the IPO. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Model (1)		Model (2)		Model (3)	
	Coefficient	t	Coefficient	t	Coefficient	t
VC-backed	0.269	0.46	−0.929	−1.10		
Log sales	0.032	0.55	0.028	0.48	0.017	1.38
Capex/sales	−0.002	−0.22	−0.002	−0.21	0.001	0.81
Dividend dummy	−0.166	−0.94	−0.183	−1.04	−0.049	−1.60
Market value	0.000	0.57	0.000	0.57	0.000	5.30
Total assets	−0.000	−0.54	−0.000	−0.15	−0.000	−0.77
Market-to-book	0.013	1.24	0.011	1.04	0.018	7.73
FCF/total asset	0.183	0.48	0.227	0.59	−0.064	−0.93
Leverage	−0.697	−1.53	−0.640	−1.41	−0.270	−3.23
Age-at-IPO	−0.000	−0.08	−0.000	−0.02	−0.000	−0.09
Kaplan–Zingales dummy	−0.044	−0.21	−0.064	−0.30	0.055	1.56
Trading volume	0.000	0.17	0.000	0.34	0.000	4.75
Net income/equity	0.013	0.34	0.014	0.36	0.002	0.44
Nasdaq			−0.000	−1.25		
Nasdaq ∗ VC dummy			0.000	1.98		
Num-IPO-VC					−0.001	−1.10
Market-share-mcap-VC					0.059	0.07
Industry + year dummies	Yes		Yes		Yes	
No of observ	2403		2403		1147	

VC-backing dummy. We find little support for this mechanism (see Table 11). Our findings indicate that there is no significant and consistent difference between VC-backed firms compared to non VC-backed firms. To analyze the potential effects of VC reputation and experience we employ the variables used in the grandstanding and certification analysis, too (see model (3) of Table 11). The variable that proves to be significant in the test of the certification hypothesis has no explanatory power in the underpricing regression. Our interpretation of this finding is that VCs and especially more reputable and experienced VCs pay for their willingness to take their firms to the market by giving up the possibility not to underprice their IPOs due to their reputation and certification ability.

6. Extensions and robustness

To strengthen our arguments and provide for a broader picture of the underlying mechanisms we first extend our analysis and consider further potential determinants of the decisions to go private. Second, we provide a number of robustness checks for our results.

6.1. Financial performance

A further hypothesis might be that the takeover is determined by the firm's performance. Firms that are doing badly in terms of financial performance (i.e. with regard to stock price developments) as well as with regard to operational performance will be more likely to leave the exchange and to do so faster. A look at the descriptive statistics suggests that both operative and financial performance seem to play important roles in the takeover decision (see Table 12).

While median share prices for the takeover subsample fall, there is barely any movement of share price for the median firm in the control group. The differences are both statistically and economically significant. The differences between the two subsamples are close to 5% for the median firms p.a. in the three-year period and for the five- and ten-year periods are close to 3 and 1% respectively. Nearly the same pattern can be observed when comparing VC- with non-VC-backed firms.

Table 12
Stock performance.
In this table we compare the stock performance between groups over different time periods. The first six columns represent a comparison between VC-backed and non-VC-backed companies, the second six columns state differences between firms that will later on been taken over and those staying on the exchange, whereby the last six columns additionally control for being VC-backed (Due to outliers we capped growth rates at +1000%/−1000%).

	VC vs. non-VC-backed				Takeover vs. still public				VC takeover vs. VC still public					
Growth rate of	Mean	Median	Sign.	Sign.	Mean	Median	Mean	Median	Sign.	Sign.	Mean	Median	Mean	Median	Sign.	Sign.	Mean	Median
Stock 3 years	0.122	−0.252	**	+++	0.214	−0.091	0.155	−0.218		+++	0.219	−0.066	0.143	−0.146		++	0.156	−0.143
Stock 5 years	0.275	−0.25		+++	0.291	−0.077	0.281	−0.214		+++	0.328	−0.079	0.266	−0.240			0.347	−0.178
Stock 10 years	0.443	−0.144		+++	0.499	0.065	0.412	−0.109		++	0.452	0.009	0.408	−0.155			0.314	−0.160

We must ask ourselves whether including financial performance has an effect on the VC-backing dummy in the Cox regression. Table 13 aims to answer this question.

Financial performance has a significant effect on the probability of going private (see model (1) in Table 13). However, our overall hypothesis remains unaltered. The VC-backed variable remains highly significant. Even after taking post-IPO financial performance into account, the basic finding that VC-backing dramatically increases the likelihood of a firm going private remains intact. We also check our hypotheses tests. Once again, the instrumented Cox regression in Table 13 provides an answer (see models (2) and (3)). The results signal the robustness of our findings in this respect as well. All our findings on the hot-issue market hypothesis (model (2)) are valid. The certification and grandstanding hypotheses (model (3)) do not change qualitatively. Hence, we can conclude that all of our results are robust to the inclusion of measures for operational and financial performance.

Table 13
Impact of financial performance.
In this table we check the robustness of our findings by controlling for the financial and operative performance of the firms. All models display Cox regressions with the left hand side representing the time since IPO. We use three main variables to control for financial and operative performance: the 5-year growth rate of net income/equity and of debit/assets for operative and the five-year growth rate of the share price for financial performance. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Model (1)		Model (2)		Model (3)	
	Coefficient	z	Coefficient	z	Coefficient	z
VC-backed	1.19	5.08	2.04	5.75		
Log sales	−0.006	−0.22	0.000	0.01	−0.008	−0.18
Capex/sales	−0.199	−1.87	−0.197	−1.85	−0.107	−0.68
Dividend dummy	−0.526	−5.03	−0.514	−4.91	−0.271	−1.67
Market value	0.000	0.45	0.000	0.41	0.000	0.37
Total assets	−0.000	−1.05	−0.000	−1.17	−0.000	−0.85
Market-to-book	−0.167	−6.42	−0.165	−6.34	−0.222	−5.40
FCF/total asset	−0.539	−5.80	−0.551	−5.85	−0.424	−2.61
Leverage	−0.035	−0.16	−0.038	−0.18	−0.217	−0.68
Age-at-IPO	−0.004	−1.82	−0.004	−1.84	−0.009	−2.26
Kaplan–Zingales dummy	−0.009	−0.09	−0.003	−0.03	0.038	0.25
Trading volume	−0.000	−1.22	−0.000	−1.28	−0.000	−1.49
Net income/equity	−0.000	−0.25	−0.000	−0.26	0.016	1.83
Growth rate share price	0.019	1.75	0.019	1.70	−0.005	−0.17
NASDAQ			0.001	4.12		
NASDAQ * VC dummy			−0.001	−3.33		
Num-IPO-VC					0.008	2.26
Market-share-mcap-VC					0.183	0.07
Industry + year dummies	Yes		Yes		Yes	
No of observ	19,646		19,646		7795	

6.2. The effect of the IPO year

Our data sample embraces quite a long time period. During this time period we observe a number of features that vary over time, as indicated in our discussion of the aggregated data. Most notably, we observe a significant increase in the number of transactions to go private in the post-1990 period compared to the years prior to 1990. Furthermore, not least due to the fact that VCs more often exited via trade sales in the post-1999 period, a significant drop in the number of IPOs has been noted (see Gao et al., 2013). Against this background, we ask whether our observed patterns hold true for the entire time period or whether the observed patterns differ across subperiods in which the market transactions (in either direction, i.e., going private or going public) are especially active? For example, are the firms that go public in the dot-com bubble years significantly different when compared to the other firms, with a significantly different pattern of going private? There are a number of potential approaches to address these questions. First, we could split the sample into parts, for example, into a subsample of firms that had their IPO prior to 1998 and those that went public after 1998. The problem with this approach is that it distorts the latter subsample in the sense that these firms are, on average, public for a much shorter time period because our observation period ends in 2011. An even more problematic way of dealing with the issue is to split the sample according to the takeover years, for example, having one sample with only the going private years before or after 1998. But this approach introduces a high degree of endogeneity into the sample.

We therefore choose what we think is the most appropriate way to address the issue: to allow for IPO-year fixed effects that control for unobserved effects in the years in which the respective firms went public. We introduce these IPO-year fixed effects into the Cox regression. This approach leaves our results unchanged. All of our previous results carry over to the inclusion of the IPO-year controls (see Table 14).

In order to further check whether the dot.com bubble period with its pecularities regarding especially the type of firms which went public (internet and high-tech firms; see Ljungqvist and Wilhelm, 2003 on this issue) is driving our results, we looked into this period separately. Doing this revealed that the conjecture is not true: the qualitative results are the same for this subperiod as the ones for the overall sample.

6.3. Different takeover modes

The question becomes whether LBOs in particular follow the same mechanisms as the ones described above. That is, are firms which are initially backed by VCs (an active investor) more likely to once again go into the hands of another

Table 14
Impact of IPO time periods/years.
In this table we check the robustness of our findings by controlling for the years in which the respective firms went public. We test the hot-issue market, the grandstanding as well as the certification hypothesis by allowing for IPO-year fixed effects. All models display Cox regressions with the left hand side representing the time since IPO. We use our main proxy for the hot-issue market hypothesis: IPO gross proceeds in general as well as the IPO gross proceeds times VC dummy interaction term. With regard to the grandstanding and the certification hypotheses we use the age of the VC firm, the independent-VC dummy as well as the VC-market share in accumulated IPOs as proxies. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Hot-issue market hypothesis		Grandstanding/certification hypotheses	
	Coefficient	z	Coefficient	z
VC-backed	2.227	6.51		
Log sales	−0.033	−1.37	−0.050	−1.28
Capex/sales	−0.343	−2.74	−0.279	−1.47
Dividend dummy	−0.534	−5.50	−0.243	−1.67
Market value	−0.000	−0.11	0.000	0.38
Total assets	−0.000	−1.02	−0.000	−0.82
Market-to-book	−0.135	−5.91	−0.202	−5.59
FCF/total asset	−0.460	−5.67	−0.422	−3.08
Leverage	0.110	0.77	−0.105	−0.39
Age-at-IPO	−0.003	−1.29	−0.006	−1.74
Kaplan–Zingales dummy	−0.088	−0.99	−0.001	−0.01
Trading volume	−0.000	−1.19	−0.000	−1.89
Net income/equity	−0.000	−0.11	0.014	1.81
NASDAQ	0.001	4.26		
NASDAQ * VC dummy	−0.001	−4.10		
Num-IPO-VC			0.008	2.31
Market-share-mcap-VC			−0.561	−0.25
Industry + IPO year dummies	Yes		Yes	
No of observ	20,381		8101	

active investor that takes the firm private to improve its corporate governance? In this particular case, we could interpret the being-public spell as a temporary exception to the firm's long-run need for an active investor who controls the firm tightly. Since the number of deals which are coded as LBOs is very small (we sense too small to be accurate), we have decided to look into those deals where the shareholders of the firm which is taken private receive cash payments only. This class of firms is larger than the one for leveraged buyouts, but it does contain leveraged buyouts. Private equity firms in contrast to other listed firms never pay the target with shares in the course of an LBO. This sample split provides affirmative answers to the above question. Even if we only compare these firms (which are in the 233 code of CRSP) with all firms in the control group, our qualitative findings remain unchanged. This finding suggests that there are indeed firms that only temporarily stay on the exchange, starting as VC-backed firms (at the IPO) and then going private (via a leveraged buyout). Furthermore, being acquired in the course of a leveraged buyout is more likely for firms that are initially VC-backed, a quite surprising and interesting result which calls for further research on the details of the mechanics behind this finding.

6.4. Concentrated ownership

Since the degree of ownership may play a crucial role in determining the likelihood of a merger, we check if our main results remain unchanged when we include a measure of ownership. As this can be especially crucial for formerly VC-backed firms, since after the VC divests their share holdings a lack of concentrated ownership emerges, we also check, if after including an interaction term of the VC and the degree of ownership our main results again stay qualitatively the same.

We investigate this question using the directors' relative share holdings (see Table 15). This is a quite natural proxy for institutional ownership but also it is more important for the ownership of active investors because VCs typically assign their own members to the board of directors. Their ownership most of the time represents the entire holdings of their fund.

We observe that our main results carry over when controlling for the degree of ownership and including an interaction term capturing the specific ownership effects of VC-backed firms.

6.5. Early versus late stage VC investors

As a final robustness check we distinguish in our VC sample between early stage and late stage investors (including buyout firms). For this purpose we restricted the VC sample to early stage VC investors only. We find (in untabulated regressions)

Table 15
Impact of ownership.
In this table we check the robustness of our findings by controlling for inside ownership. All models display Cox regressions with the left hand side representing the time since IPO. Besides the main firm characteristics as explanatory variables the regressions are amended by the accumulated shareholdings of all directors and the second regression is additionally amended by the interaction of the directors' shareholdings and the VC-backed dummy. The accumulated directors' shareholdings are our main proxy for the shares held by venture capitalists. We employ an instrumental variable approach to take into account the endogeneity due to the fact that a firm receives VC-financing. In order to provide efficient estimates in our non-linear duration model we use the NPLATE approach of Frölich (2007) in the Cox-estimations. We do not report the first-stage regression with geographic proximity between the firm and a VC-cluster. The VC-backed variable reported in the table denotes the standardized fitted value of the propensity score from the first-stage regression to receive VC-financing.

	Model (1)		Model (2)	
	Coefficient	z	Coefficient	z
VC-backed	0.936	1.51	1.444	1.94
Log sales	−0.265	−2.76	−0.268	−2.78
Capex/sales	0.113	0.22	0.137	0.27
Dividend dummy	−0.832	−3.09	−0.826	−3.07
Market value	−0.000	−0.73	−0.000	−0.74
Total assets	−0.000	−0.51	−0.000	−0.50
Market-to-book	−0.298	−3.09	−0.296	−3.08
FCF/total asset	1.120	1.10	1.155	1.13
Leverage	0.494	0.69	0.508	0.71
Age-at-IPO	−0.007	−1.20	−0.008	−1.33
Kaplan–Zingales dummy	−0.225	−0.77	−0.224	−0.77
Trading volume	0.000	2.20	0.000	2.15
Net income/equity	0.012	0.34	0.012	0.33
Director-share	−0.549	−0.76	3.697	1.07
Director-share * VC dummy			−6.072	−1.22
Industry + IPO year dummies	Yes	Yes		
No of observ	3951	3951		

no qualitative changes in our results. Hence, we infer from this exercise that it is not a group of VC investors with a particular investment stage preference that is driving our result.

6.6. Merging with the M&A database

To further check the robustness of our results, we merge our database with information on mergers and acquisitions from the Thomson Reuters SDC. On top of our previous classifications based on Compustat and CRSP we classify all entries where the target was publicly listed and the acquirer holds 100% of the target's shares after the transaction as a takeover. This exercise confirms our main results, both in terms of quantity and quality. We take this as a further affirmation of our results.

7. Conclusion

In this paper our main aim is to investigate the observed patterns associated with going public and then delisting via a takeover process: namely that firms backed by a VC in the course of their IPO are much more likely to reverse this step and leave the exchange via a takeover. We interpret this as a delayed trade sale, thereby shedding new light on the exit decisions of VCs from their entrepreneurial firms. Using firm and market characteristics in an non-parametrically instrumented Cox proportional hazard model, we show that the effect of the VC-backed variable on the takeover probability survives a more thorough analysis. When investigating the determinants of the ability of VCs to bring likely takeover candidates to the exchange, we find a rather clear-cut picture and evidence for the ability of experienced and reputable VCs to signal the quality of the firm; that is, certify the quality for the potential shareholders. In order to do so they forego their ability to bear lower underpricing costs. We therefore shed new light on the determinants of the delisting process. Even more importantly, we allow for a quite different interpretation of VC exits via an IPO. Rather than being the silver bullet and final step in the lifetime of a firm, we show that it is more likely only a temporary step for the firm that is made possible by experienced and reputable VCs backing the firm. The VCs contribute to overcoming the informational asymmetries for potential shareholders in the exchange.

There are a number of routes that future research can take on this issue. What detailed role do private equity firms play in the takeover decision of the firms that are initially VC-backed? To what extent do the dynamics of the VC's divestment in and after the IPO govern the decision to go private in general and its speed in particular?

Appendix A

In this appendix we outline our implementation of the nonparametric variable estimation of local average treatment effects (NPLATE) and its extension to covariates by Frölich (2007). Frölich (2007) derives a conditional NPLATE estimator, γ which is efficient and non-biased. In a binary-treatment and binary-instrument setting he shows that the conditional NPLATE estimator can be implemented in a propensity score function with the propensity-score matching by using (see Eq. (14) in Frölich, 2007):

$\gamma =$ (Difference in mean of outcome variable (conditional on covariates and given propensity score) between binary instrumental variable being one and zero) / (Difference in mean of endogenous regressor (conditional on covariates and given propensity score) between binary instrumental variable being one and zero).

In our case, the outcome variable is the going private variable while the endogenous regressor is the observed VC-backing variable.

We implement this approach in our data set by constructing a propensity score variable, VC-backed, which is derived for each of our firms at the time of the IPO by using the estimated likelihood of each firm to receive VC-financing depending on the realization of the instrumental variable which is either one if the firm is located in California or in Massachusetts or zero otherwise. In order to receive the respective propensity scores we run two sets of first-stage regressions thereby splitting the sample in two subsets. We split the sample according to whether the firm is located in Massachusetts or California or whether it is located in neither of the two states.

The results of these first-stage regressions are displayed in Table 16.

Table 16
First-stage regression of NPLATE approach.
In this table we display the results of our first-stage NPLATE regression with the endogenous regression variable VC-backing as left-hand side variable. We distinguish between the subsample with firms which are located in Massachusetts or California (model 1) and those which are located in neither of the two states.

	Model (1)		Model (2)	
	Coefficient	z	Coefficient	z
Log sales	0.068	0.88	0.021	0.59
Capex/sales	−0.001	−0.03	0.005	0.63
Dividend dummy	−0.419	−2.37	−0.196	−1.82
Market value	0.000	0.57	−0.000	−0.32
Total assets	−0.000	−1.64	−0.000	−1.99
Market-to-book	−0.004	−0.44	0.043	2.06
FCF/total asset	−0.935	−1.90	−0.484	−1.78
Leverage	−1.361	−2.15	0.164	0.56
Age-at-IPO	−0.029	−4.01	−0.005	−2.36
Kaplan–Zingales dummy	0.387	1.50	0.326	2.27
No of observ	883		1762	
R^2	0.07		0.03	

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