

Discussion Paper No. 04-32

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Non-technical Summary

This paper investigates the impact of venture capitalists (VCs) on the performance of their portfolio firms around and after initial public offering (IPO). The aim is to shed some additional light on the function of VCs in nurturing and developing their portfolio firms as well as on some mechanisms of the IPO market. Our main working hypothesis is that venture capital is too heterogenous to permit simple comparison between non venture and venture-backed firms. We investigate the hypothesis that different governance structures, objectives, and track records of different types of VCs have a significant impact on their respective IPOs. Doing this, we compare the extent of underpricing and the post-IPO returns and volatility.

We explore these issues using a data set embracing all IPOs that have occurred on Germany's *Neuer Markt*. This segment has proven to be a natural playing field for such a research strategy, deferring a number of obvious advantages. Its main advantage is that, due to the specific situation of the German venture capital market (a young, rapidly growing market coupled with a strong public sector), we find a wide array of different types of venture capitalists with quite different structures, objectives, and track records. Our main aim is to exploit just this difference and its impact on the performance of portfolio firms.

We find significant differences among different types of VCs with respect to the post-IPO market performance. It turns out that firms backed by independent VCs perform significantly better than firms of other VCs or non venture-backed ones. Firms backed by public VCs (only a small group of firms) underperform relative to their counterparts. In addition, we find that independent VCs have a significant impact on the reduction of firm-specific volatility. Thus, independent VCs bring about higher (relative) post-IPO returns and less risk.

This result is robust across various methodological approaches and specifications. The fact that this could occur (implying that market participants did not anticipate this development) can be interpreted as a clear sign of the immaturity of the market. Thus, we expect that such abnormalities will tend to go away as the market grows older and becomes more established. When looking into the determinants of underpricing we find rather little evidence that the extent of underpricing differs significantly between firms backed by different VCs.

Our findings on the post-IPO performance imply that the different types of VCs fulfill their overall task as specialized monitors, consultants, and financiers of young firms in quite different ways.

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Abstract: This paper sets out to analyze the influence of different types of venture capitalists on the performance of their portfolio firms around and after IPO. We investigate the hypothesis that different governance structures, objectives, and track records of different types of VCs have a significant impact on their respective IPOs. We explore this hypothesis using a data set embracing all IPOs that have occurred on Germany's *Neuer Markt*. Our main finding is that significant differences among the different VCs exist. Firms backed by independent VCs perform significantly better two years after IPO as compared to all other IPOs, and their share prices fluctuate less than those of their counterparts in this period of time. On the contrary, firms backed by public VCs show relative underperformance. The fact that this could occur implies that market participants did not correctly assess the role played by different types of VCs.

Keywords: Venture Capital, Initial Public Offerings, Long-Run Performance, Underpricing, Heterogeneity

JEL classification: G14, G24, G32

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1 Introduction

Venture capital and initial public offerings (IPOs) are closely inter-related. Venture capitalists crucially rely on the IPO market as an exit channel. It is often argued that the venture capital industry can not survive without a viable IPO market (see e.g. Black/ Gilson (1998)). Due to the fact that venture capital financing is a temporary engagement in the respective portfolio firm,¹ exiting is decisive for the venture capitalist (VC) and the expectation of potential exit pathways governs the behavior of VCs during the investment phase (see Cumming (2002)). VCs disinvest their most promising and profitable firms via an IPO. On the contrary, venture capital serves as a catalyst for IPOs. Without firms that want to issue equity, IPO markets would obviously lack supply. Since VCs are intermediaries specialized in nurturing young (innovative) firms, a viable venture capital industry “feeds” the IPO market.

Under these circumstances it is important to understand the role venture capitalists play with respect to the market performance (around and after the IPO) of their portfolio firms. There are a number of studies analyzing the impact of venture capital on underpricing and long-run returns. Our analysis differs from existing ones by looking into the differences between different types of VCs. The starting point of our analysis is the observation that VCs differ considerably in their objectives, track records, and governance structures. We conclude that different VCs resolve informational asymmetries and incentive problems to a different degree. Our working hypothesis is that these differences have a decisive impact on the market performance of the respective portfolio firms. So it turns out to be quite useful to split up

¹This can be seen as a mechanism to resolve informational asymmetry and incentive problems between the venture capitalist and its investors (see e.g. Gompers/ Lerner (1999b)). It is institutionalized in that venture capital funds are typically organized as closed-end funds.

the group of venture-backed firms, which in other studies were treated as more or less homogenous. A natural playing field for such analysis is the German venture capital and IPO market, with its wide variety of different types of VCs² active there. In order to pursue our goal, we hand-collected a data base of all IPOs on the *Neuer Markt* during the period 1997-2002.³

Our main results are as follows: We find significant differences among different types of VCs with respect to the post-IPO market performance. It turns out that firms backed by independent VCs perform significantly better than firms of other VCs or non venture-backed ones. Firms backed by public VCs (only a small group of firms) underperform relative to their counterparts. In addition, we find that independent VCs have a significant impact on the reduction of firm-specific volatility. Thus, independent VCs bring about higher (relative) post-IPO returns and less risk. This result is robust across various methodological approaches and specifications. The fact that this could occur (implying that market participants did not anticipate this development) can be interpreted as a clear sign of the immaturity of the market. Thus, we expect that such abnormalities will tend to go away as the market grows older and becomes more established.

Following Rock (1986), quite a substantial body of research has looked into the impact of venture capital on the degree of underpricing. Studies investigating the effect of venture capital do not show a clear-cut picture. In an early study, Megginson/ Weiss (1991) stress the certification role of venture capital. They find a negative impact of venture capital on underpricing. Barry et al. (1990) show, by looking

²Independent VCs, bank-dependent VCs, public VCs, and corporate VCs, young and experienced VCs, international and national VCs, etc.

³*Neuer Markt* was founded in March 1997 and closed in June 2003. However, in 2003 there were no IPOs in this market segment. A restructuring of the *Frankfurt Stock Exchange* led to a transfer of firms from the *Neuer Markt* to other market segments.

at a sample of venture-backed IPOs, that a higher monitoring effort by VCs leads to less underpricing. Ljungqvist (1999) and Smart/ Zutter (2003) challenge this view by analyzing US data. Ljungqvist (1999) relates the degree of underpricing to the behavior of old shareholders in general and not to the role of VCs per se. Smart/ Zutter (2003) find more underpricing with venture-backed firms than with non venture-backed ones. In a study of the German IPO market (using, by and large, a very similar data set to ours), Franzke (2001) finds, too, that venture-backed IPOs are more underpriced than non venture-backed IPOs.

On the other hand, several studies have addressed the post-IPO performance. Their message, however, is ambiguous: positive, neutral, and negative influences by venture capital financing can all be observed. Doukas/ Gonenc (2001) do not find any impact of venture capital on long-run performance. Brav/ Gompers (1997) show that, in the US from 1975-1992, venture-backed IPOs outperformed non venture-backed IPOs when measured via equal weighted returns. In their study, this outperformance cannot be confirmed using other methods. Audretsch/ Lehmann (2002) analyze the survival of companies on the *Neuer Markt* and find that the likelihood of firm survival decreases as the ownership share of the group of VCs increases, which indicates a negative effect on the part of venture capital.

None of the above mentioned studies, however, splits up the group of venture capitalists by looking into the effects of different types of VCs. Recently, Rindermann (2003) has distinguished between different types of VCs (public, bank-dependent and independent; national and international) in his analysis of the operating and market performance of IPOs in Germany, France, and the UK. He uses a different sample (only 1997 - 1999) and different methodologies from those employed in our study. In line with our results, he finds a positive

impact of international VCs and a negative influence of public VCs on the stock price performance (using three-year “wealth relatives” with *NEMAX All Share* Index as a benchmark).

The paper is organized as follows. The next section tenders a short historical and structural overview of the German venture capital and IPO markets. In this setting, our data set is described and some descriptive statistics are given. The third section analyzes the impact of different types of VCs on the post-IPO performance and contains the main body of our analysis. There, we address the post-IPO returns as well as the post-IPO volatility of share prices. In a first step, we use a cross-section analysis to address the determinants of post-IPO performance over a two-year period. In a second step, a matching approach is used to investigate post-IPO returns. In a final step in the third section, we consider the post-IPO idiosyncratic volatility of returns and the influence of different types of VCs on this volatility. The fourth section is devoted to analysis of underpricing in Germany’s *Neuer Markt* in terms of the VCs’ impact. The last section states our conclusions.

2 Structure of the German Venture Capital and IPO Market

Before delving into the details of our analysis, a short overview of the German venture capital and IPO markets will provide some insights helpful for our further analysis.

2.1 Structure and History

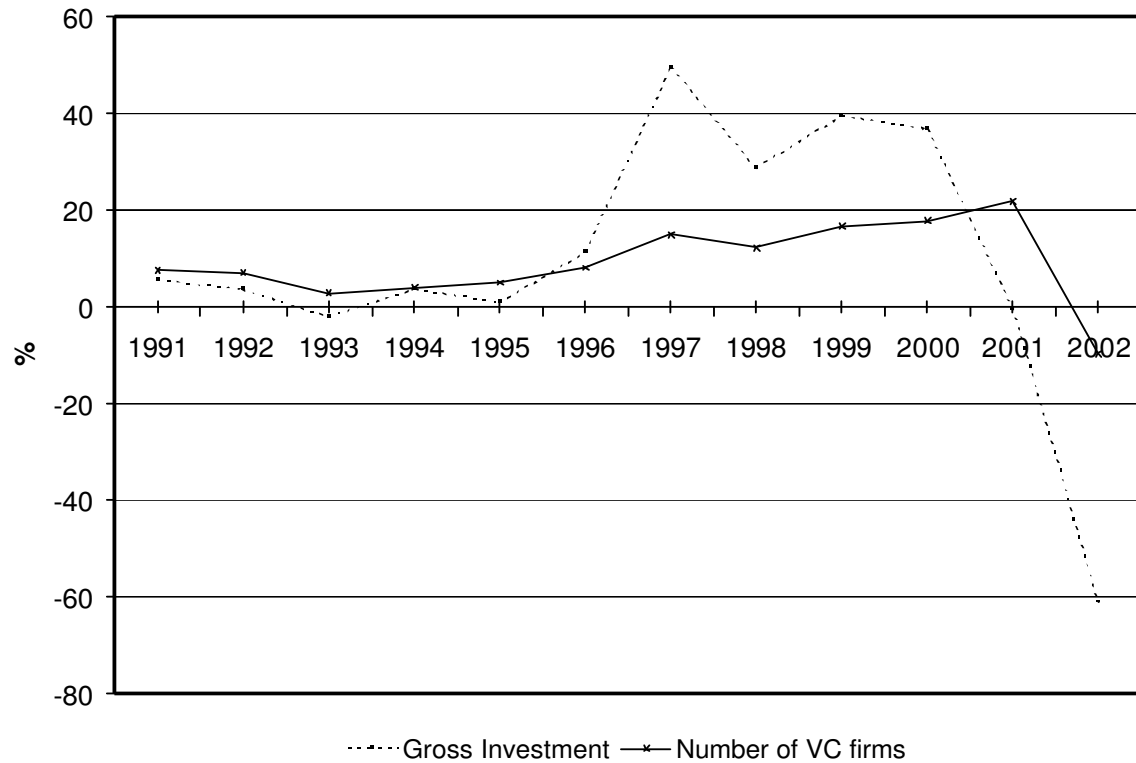
One of the prime characteristics of the German venture capital and IPO markets is that the main developments occurred in rather recent times. Before 1990 only a few venture capitalists existed. These few

were mainly quasi-public agencies which were established to promote regional policies (the *Mittelständische Beteiligungsgesellschaften*). In the period from 1965 to 1985 a number of firms entered the German market, concentrating mainly, however, on later-stage investing. As early as the 1980s, an attempt to initiate early-stage venture capital in Germany failed badly (see Becker/ Hellmann (2000) for details). This experiment, initiated in 1975 by the German government with support from the domestic banking industry, led the main financial institutions to conclude that venture capital and private equity were not part of their (core) business. The financial system was dominated by the banking industry which gave (or did not give) credit to young innovative firms. Access to organized capital markets was definitely an exception. Only few firms (mainly established, medium- and large-sized firms) undertook an IPO. In the period between 1970 and 1996, no more than 301 IPOs took place in Germany.

Until the 1990s the venture capital industry in Germany grew rather slowly. This changed quite drastically in the 1990s. The first push came through reunification, leading to the establishment of a private equity and venture capital market especially in East Germany. These operations were clearly driven by subsidies and dominated by public agencies (the *Mittelständische Beteiligungsgesellschaften*). The second push occurred after 1995 and was paralleled by establishment of the *Neuer Markt* in 1997. The growth rates of venture capital activities (either measured by capital invested or by the establishment of venture capital firms) accelerated substantially (see Figure 1).

Starting in 1997 with 11 initial public offerings, the *Neuer Markt* went through an unprecedented growth period. 41 IPOs in 1998 were followed by 130 IPOs in 1999. This number was even exceeded in 2000, the absolute peak of the market, with 133 IPOs. But already in the second half of 2000, market conditions deteriorated and market

Figure 1: The yearly growth rates of gross investments and number of venture capital firms (in %)



Source: BVK.

valuations went down, making IPOs more and more difficult to bring off. This was reflected by the drastic slow-down in the number of IPOs: In 2001 only 11 firms went public. In 2002 the situation became even more extreme, with only a single firm making it on the *Neuer Markt*. This was the last firm with an IPO on the *Neuer Markt*.

IPOs on Germany's *Neuer Markt* took place in a setting of pronounced volatility in share prices. The market development can be split into three parts (see Table 1). In the first one, the initial phase, share prices moved steadily upward. The second one, a hot issue period in 1999 and 2000, combined exploding share prices with a large number of IPOs. The last period was characterized by a rapid decline in share prices associated with a deterioration of the IPO-activity and

several cases of fraud, which led finally to the closing-down of the *Neuer Markt* in June 2003.

Table 1: Market development (1997-2003)

This table shows broad market development in terms of the level of *NEMAX All Share* Index at the end of each quarter.

Q/Year	03/97	06/97	09/97	12/97	03/98	06/98	09/98	12/98	03/99	06/99	09/99	12/99	03/00
<i>Nemax</i>	606	786	942	1000	2182	2333	2110	2745	3242	3412	2680	4572	6629
Q/Year	06/00	09/00	12/00	03/01	06/01	09/01	12/01	03/02	06/02	09/02	12/02	03/03	06/03
<i>Nemax</i>	5369	4875	2743	1684	1503	843	1095	1029	664	389	405	385	517

For a while the *Neuer Markt* seemed to have resolved the exit problem of venture capital firms. According to our definition,⁴ 123 of the 327 IPOs on the *Neuer Markt* were venture-backed. The boom in IPO activity was accompanied by a large inflow of capital into the venture capital market. This also led to the creation of many new venture capital firms as well as to the entrance of a considerable number of VCs from abroad into the German market (either through takeovers of local VCs or via establishment of local branches in Germany). By and large, it is fair to state that the German venture capital industry is quite a young one, with not many portfolio managers having experience in the industry exceeding five years.

For our purpose it is crucial that, due to a number of special influences in the German venture capital market, we distinguish a wide variety of VC-types (and thereby governance structures). First, traditionally and as a result of overall economic policy, there is a large proportion of venture capital organizations which are basically owned or controlled by the state or public agencies. We will refer to these VCs as public VCs, since their main objective, in most cases, is not maximization of returns for their investors but rather the promotion of local firms. In any case, their concentration on profit maximization

⁴See the next subsection for details.

is much less pronounced than is the case with the independent VCs. Second, as a result of the rapid growth of the venture capital market, a considerable proportion of independent VCs are from abroad; thus they have a quite different governance structure, corporate culture, and track record than their public, bank-dependent, and corporate counterparts. These differences are e.g. also reflected in the design of contracts with their portfolio firms (see for evidence in this respect Bascha/ Walz (2002)) as well as in their pre-IPO investment behavior and exit strategies (see Tykvová (2004)). Third, in the 1990s many players in the banking industry established their own private equity and/ or venture capital subsidiaries. The portfolio managers of these VCs act as employees of the mother company rather than as partners of an independent VC. Further, there has been some discussion in the literature about the motivation of banks to enter the venture capital market with their own subsidiary (see e.g. Hellmann et al. (2003)). All this makes investigating the impact of bank-dependent VCs on their portfolio firms (in the course of an IPO) worthwhile. Finally, we observe several corporate VCs.

In contrast to many other countries, other types of VCs than the independent ones have a considerable market share in Germany. This is especially true for the public ones. Despite this fact, the proportion of public VCs in our IPO sample is rather small. The main reason for this is that we focus on the lead VCs, whereas public VCs often syndicate with other VCs, leaving the leadership with their syndication partner. In addition, public VCs often invest in firms for which other exit strategies than IPOs clearly predominate. That is, the entrepreneurs do not consider the IPO as an interesting exit strategy in the first place, and make sure that they are able to pursue other exit strategies (mainly buying back the firm). In addition, due to their specific structure in which profit maximization and the building-up of

reputation are not the chief targets, public VCs are not that interested in IPOs themselves. This is reflected in the actual exit strategies of firms financed by public VCs (see BVK (2002) for the exit behavior of the *Mittelständische Beteiligungsgesellschaften*⁵).

We use these observations as the main starting point of our analysis, namely to look into the impact of different types of VCs on the performance of firms around and after the IPO. To a certain extent this wide variety of types of venture capital firms is reflected in our sample of venture-backed IPOs.

2.2 The Data Set

Our analysis is based on a unique hand-collected database of IPOs on Germany's *Neuer Markt*. We considered only "real" IPOs. Thus, we excluded firms that were listed on another exchange when going public on the *Neuer Markt*. The data were obtained from several sources. From the *Deutsche Börse AG* we received the following data: date of IPO, offer price, first price, issue size, classification of the industry, names of Designated Sponsors⁶, and shareholder structure immediately after IPO. The information on the duration of the venture capital financing before IPO, the firm age and size, the name(s) of the lead underwriter(s), the shareholder structure (prior to and immediately after IPO) and the book value at the IPO were collected from the listing prospectuses of the companies. When possible, these data were cross-checked against information from the *Deutsche Börse AG*.

We considered a firm as venture-backed if at least one of its shareholders was affiliated with a national or an international venture cap-

⁵52.2% (199) of the portfolio firms in 2001 were exited via a buy-back, 45.9% (175 firms) via liquidation, and only 1 firm via an IPO.

⁶Each share on the *Neuer Markt* had to have at least two Designated Sponsors. Their main task was to provide liquidity for the trading of this security.

ital association and owned at least five percent of the pre-IPO equity. In its short history, there were 327 IPOs on the *Neuer Markt*. According to our definition, 123 of them were venture-backed. The venture capital firm which held the largest share of the equity prior to the IPO was labelled the lead VC.

The data on venture capitalists (size, affiliation(s), age, type) were compiled from the following sources: the *VentureXpert* database, the directories of German, European, and US venture capital associations (*BVK*, *EVCA*, *NVCA*), and Webpages of venture capital firms on the Internet. We divided the venture-backed firms into four subgroups, depending on the institutional affiliation of the lead VC. We distinguished between four types of VCs: public, bank- (or insurance-) dependent, independent, and corporate. Further, we looked into whether or not the headquarter of the lead venture capital firm was in Germany. Of the 123 firms financed by venture capital ten were backed by a public VC and 8 by a corporate VC whereas in 38 cases the lead VC was a bank-dependent VC. The remaining 66 companies were backed by an independent VC (see Table 2). One of the venture-backed firms, VIVA, was removed from the sample since we have no information on the names and respective shareholdings of the venture capitalists financing this firm. In the entire sample we classified 61 cases as financed by a lead VC from abroad, 50 of them being independent VCs, nine bank-dependent VCs, and two corporate VCs. IPOs were rather heavily concentrated in 1999 and 2000. For our purpose it is important to note that, in the main, the different types of VCs do not show any special concentration of their IPOs in a particular period or year; thus they do not deviate from the overall trend.

We also collected data on the quality and experience of venture capitalists, underwriters, and Designated Sponsors. The rank coefficient of a VC (between 1 and 5) was based equally on its size (funds

Table 2: IPOs on Germany's *Neuer Markt* over time

This table depicts the number of IPOs on the *Neuer Markt*, sorted by year and type of VC.

Year	1997	1998	1999	2000	2001	2002	Σ
No. of IPOs	11	41	130	133	11	1	327
VC	7	15	45	53	3	0	123*
INDEP	2	7	25	30	2	0	66
BANK	4	8	12	14	0	0	38
CORP	0	0	2	6	0	0	8
PUBL	1	0	6	2	1	0	10

*This number includes VIVA, which was venture-backed. Since we do not have any information on the lead VC (or its type) we excluded it from our data sample.

under management) and its age. The rank of an underwriter (between 1 and 10) depended on his activities as the lead underwriter, namely the number of new issues on the *Neuer Markt* and their volume in the previous year. The rank of a Designated Sponsor was based equally on the number of his mandates on the *Neuer Markt* and on his rating with the *Deutsche Börse AG* in the preceding period, and was assigned quarterly. The reputation measures were designed in the following way: the lower the number, the better the rank (thus 1 indicates the best rank).

The (performance) index (*NEMAX All Share*, *DAX 100*) returns and the individual stock prices and dividends came from the *Bloomberg* database. A few companies were not found in *Bloomberg*, so we used *Thomson Financial Datastream* instead. For two firms, *FOCUS Digital AG* and *RT-SET Real Time Synthesized Entertainment Technology Ltd.*, we did not find data on their returns in either database. For seven firms that went public later than March 2001 we have no data on two-year-returns, because our time series on returns ends in March

2003. Eight firms left the market within two years. We excluded one particular outlier, EM.TV, from our calculations.⁷

Table 3 comprises our main variables and their abbreviations. All financial data before 1999 were converted into Euros.

2.3 Some Descriptive Statistics

In order to give a first impression of the characteristics of IPOs of the different types of VCs, Table 4 sets out the main variables and relates them to the different types of VCs. The IPOs differ widely sizewise in our sample. Small issues have to be compared to a few real “heavy-weights” having a market value of a couple of billion Euros (up to 43 billion Euros). Bank-dependent and public VCs were engaged in significantly smaller issues (SIZE) from firms with a lower market value (MV).

With respect to book-to-market ratios (BTM) we have 26 firms with negative values. Since the interpretation of negative book-to-market ratios might be problematic, in the following sections (3.3, 3.5 and 4) we calculate our regressions (i) using all observations, (ii) removing the companies with negative book-to-market ratios from the sample, and (iii) employing a dummy variable for negative/ positive book-to-market ratios.⁸ On average, bank-dependent VCs show significantly higher book-to-market ratios than their counterparts. On the contrary, independent and corporate VCs concentrated mainly on growth stocks.

The two-year abnormal returns (ABNORMAL2Y) vary widely as well. Since we consider the difference between individual returns and

⁷This firm shows impressive returns in the two-year post-IPO period, but from then on it turns out to be one of the most widely-discussed cases of fraud in the *Neuer Markt*. Since EM.TV outperforms extremely all other firms, it would clearly dominate our estimations. In order to exclude this particular influence, we decided to eliminate EM.TV from our sample.

⁸However, the results from approaches (ii), and (iii) do not considerably differ from (i).

Table 3: List of variables used

<i>MARKET</i>	
HOTISSUE	One between March 1, 1999 and November 30, 2000; zero otherwise
MARKET2Y	2-year post-IPO <i>NEMAX All Share</i> buy-and-hold return
RECENT	Underpricing of the five preceding new issues on the <i>Neuer Markt</i>
<i>FIRM</i>	
ABNORMAL2Y	RETURN2Y - MARKET2Y
AGE	Firm age at IPO (in days)
BTM	Book-to-market ratio ($\cdot 10^{-6}$)
MV	Market value at IPO (Mil. Euro)
RETURN2Y	2-year post-IPO buy-and-hold return
SIZE	Issue size (based on offer price, in Euro)
UNDERPRICING	(First price - offer price) / offer price
<i>VENTURE CAPITALIST(S)</i>	
BANK	One if the lead VC is a financial service / banking / insurance company or their subsidiary, zero otherwise
CORP	One if the lead VC is a corporate VC, zero otherwise
GERM	One if the lead VC is from Germany, zero otherwise
INDEP	One if the lead VC is an independent venture capital firm, zero otherwise
LOCK	Extent of the lock-up by the group of venture capitalists (% of their old shares retained beyond the IPO)
PREIPOLENGTH	Duration of the pre-IPO venture capital equity financing (in days)
PUBL	One if the lead VC is public, zero otherwise
RANK	Rank of the lead VC, depending on its age and size; range: 1 (highest rank) - 5 (lowest rank)
VC	One if the firm is venture-backed, zero otherwise
<i>OTHER MARKET PARTICIPANTS</i>	
DSRANK	Rank of Designated Sponsors of a company (average), depending on their rating and the number of companies they manage; range: 1 (highest rank) - 10 (lowest rank)
UNDRANK	Rank of lead underwriter of a company (if more lead underwriters: the average of their rank), depending on the number of issues and their volumes; range: 1 (highest rank) - 10 (lowest rank)

Table 4: Realizations of main variables for different types of VCs

This table contains descriptive statistics of our main variables as well as tests on the equality of means and medians of the variables for the respective groups and the rest. Before employing a t-test for the respective means we test for equal variances. Rejecting the null hypothesis of equal variances at the 5% significance level, we use a t-test with unequal variances; otherwise we use a t-test with equal variances (in italics). Additionally employed is a nonparametric two-sample test on the equality of medians with the test chi-squared statistic without a continuity correction and its p-value is reported.

The sample includes all venture-backed and non venture-backed IPOs for the 1997-2002 period on the *Neuer Markt*, Frankfurt. We excluded VIVA (all variables) and EM.TV (ABNORMAL2Y).

One, two, and three asterisks point to significance at the 10%, 5%, and 1% levels. An asterisk in brackets indicates significance at the 15 percent level.

Variable	Subsample	Observations	Mean	Minimum	Maximum	p-value (mean)	p-value (median)
MV	NON-VC	204	561.8	26.0	42867.0		
	VC	122	251.9	29.0	1716.7	0.150(*)	0.492
	INDEP	66	303.6	45.6	1716.7	0.300	0.270
	BANK	38	183.5	60.1	632.9	0.053*	0.038**
	CORP	8	285.5	68.0	996.3	0.345	0.152
	PUBL	10	142.8	29.0	555.0	0.034**	0.054*
BTM	NON-VC	204	26611	-272002	242827		
	VC	122	27292	-63831	131664	0.866	0.252
	INDEP	66	20681	-63831	102144	0.090*	0.168
	BANK	38	38659	-15466	131664	<i>0.041</i> **	0.016**
	CORP	8	20681	5278	31455	0.117(*)	0.474
	PUBL	10	33016	-12973	115958	<i>0.602</i>	0.199
BTM, positive	NON-VC	190	30421	10	242827		
	VC	110	32154	76	131664	0.643	0.231
	INDEP	56	27569	76	102144	0.319	0.374
	BANK	37	40122	1188	131664	<i>0.075</i> *	0.022**
	CORP	8	20681	5278	31455	0.013**	1.000
	PUBL	9	38126	7197	115958	<i>0.516</i>	0.310
ABNORMAL2Y	NON-VC	190	-0.092	-3.009	5.245		
	VC	118	0.290	-4.215	18.389	0.100*	0.348
	INDEP	63	0.536	-2.017	18.389	0.099*	0.323
	BANK	38	0.143	-3.989	8.803	0.779	1.000
	CORP	8	0.015	-0.194	0.212	0.713	0.474
	PUBL	9	-0.569	-4.215	0.495	<i>0.251</i>	0.735
UNDERPRICING	NON-VC	204	0.473	-0.250	4.333		
	VC	122	0.510	-0.118	3.400	<i>0.649</i>	0.492
	INDEP	66	0.506	-0.118	2.231	0.786	0.270
	BANK	38	0.534	-0.077	3.400	<i>0.668</i>	0.730
	CORP	8	0.255	0.000	1.000	0.091*	1.000
	PUBL	10	0.653	0.000	2.061	<i>0.459</i>	1.000
PREIPOLENGTH	VC	106	602	13	2990		
	INDEP	61	711	13	2412	<i>0.020</i> **	0.031**
	BANK	31	410	22	2990	<i>0.024</i> **	0.019**
	CORP	7	806	75	1726	<i>0.325</i>	0.241
	PUBL	7	300	37	891	<i>0.144</i> (*)	0.241
SIZE ($\cdot 10^6$)	NON-VC	203	83	8	3080		
	VC	121	58	10	302	0.148(*)	0.206
	INDEP	65	68	14	302	0.612	0.018**
	BANK	38	44	11	197	0.014**	0.167
	CORP	8	86	41	219	0.615	0.004***
	PUBL	10	25	10	58	0.000***	0.054*

the market return (*NEMAX All Share* Index), timing issues are potentially eliminated. The remarkable differences in average abnormal returns among venture-backed and non venture-backed IPOs, as well as for firms backed by independent VCs which turn out to be significant, already indicate that there are strong differences which might also show up when controlling for other factors of influence. The UNDERPRICING variable displays mostly positive levels in some cases at exorbitant levels. The univariate t-test, however, does not detect any significant differences among the groups, with the exception of corporate VCs which exhibit on average a lower degree of underpricing for their portfolio firms.

Our subsample of venture-backed firms contains quite different types of venture capital financing arrangements. Obviously, some just represent bridge financing with a rather short period of engagement (represented by the PREIPOLENGTH variable) of the VC in the portfolio firm. Especially bank-dependent and public VCs have on average a short holding period. Thus, they often did not fit the role of an active investor and monitor. The reverse is true for the independent VCs, who have a significantly longer mean and median duration of the pre-IPO financing.

Overall Table 4 reveals rather pronounced variations in the different variables among the firms backed by different types of VCs.

3 Post-IPO Performance

3.1 Background

Starting with the analysis of Ritter (1991) and Loughran/ Ritter (1995), the post-IPO performance of firms has attracted a lot of attention. Since then, a number of papers have challenged the initial findings by proposing different empirical techniques, without really

being able to fully explain the underperformance puzzle. Brav/ Gompers (1997) are the first to investigate the role of VCs in the long-run market performance of IPOs. They show that the underperformance documented in the initial studies comes mainly from small, non venture-backed IPOs. Thus, within the group of small companies, venture-backed firms are better prepared to perform well in the aftermath of the IPO.

Venture capitalists, however, differ to a large extent and do represent a quite disperse group of financial intermediaries. Depending on their main investor(s), we observe a wide heterogeneity of corporate governance as well as objectives and (in particular) experience among VCs. This heterogeneity exists in most countries and is especially pronounced in the continental European economies, particularly in Germany. The existence of a large public sector and an interventionist culture led to the establishment of a considerable number of public VCs. Given the country's bank-dominated financial system, it is not too surprising that commercial banks have created their own venture capital funds, which played an important role in the German venture capital market in the last couple of years. Finally, corporate venture capitalists do exist in Germany. They are mainly subsidiaries of their (industrial) mother companies and therefore often possess a different legal and economic structure compared to their independent counterparts.

In the following we will analyze the hypothesis that the different objectives of the different types of VCs (see on this e.g. Hellmann et al. (2003) and Gompers/ Lerner (2000)), as well as the diversity of these VCs' corporate governance (see Cumming (2000)) and experience (see Tykvová (2003)), will have a significant impact on the post-IPO performance of the firms they have taken public. Tykvová (2004) shows that independent VCs in Germany typically exhibit more sophisti-

cated investment patterns than do bank-dependent and public VCs. Thus, these VCs are probably able to add more value to their portfolio companies. We want to investigate whether investors assessed the role played by the different types of VCs correctly. In this case, no particular group should show a systematic over- or underperformance when controlling for other effects.

We proceed in two steps. The first step is to investigate post-IPO returns and ask, among other things, whether there are significant differences between different types of VCs. The second step is to look into the effect of VCs on IPO prices and post-IPO price fluctuations from a different angle. We analyze the pricing precision of venture-backed firms by looking at the post-IPO idiosyncratic volatility of returns on firms backed by different VCs. In pursuit of our first step we employ various techniques. First, we undertake a cross-section analysis of post-IPO returns. Second, we employ a matching procedure for purposes of comparing (abnormal) returns on similar firms. Carrying out the second step, we take up an argument made by Neus/ Walz (2002) on the basis of a theoretical analysis of the exit choices of VCs. They argue that experienced VCs are able to price their portfolio more precisely, leading to less volatility in the post-IPO market. This finding essentially rests on the fact that experienced VCs can use the reputation they have acquired as repeated players in the IPO market to signal the quality of their firms. Thus, they are able to exit at the “true” prices leading to less post-IPO volatility of returns.

Due to our data set and the specific situation of the German venture capital market, we concentrate on a two-year timespan after IPO. Since the bulk of all IPOs took place in 2000, a longer time period would exclude a large number of IPOs. On the other hand, a shorter timespan conflicts with our goal of investigating the long-run performance of shares in the post-IPO period. Accordingly, due to the

specific constraints of our data set, we deviate from the convention of researchers using US data to look at three or even five year returns (see e.g. Ritter (1991) and Brav/ Gompers (1997)).

3.2 Methodological Issues

A growing body of research analyzes the methodology of performance measurement and addresses the questions of how risk and return should be quantified appropriately and how well-specified test statistics should be designed. Ritter/ Welch (2002) argue that many of the phenomena found in the IPO-literature depend upon the time period examined. Most authors agree that the result of the performance measurement is always conditional on the underlying model (e.g. Brav/ Gompers (1997) and Gompers/ Lerner (2003)) and the statistical tests (e.g. Barber/ Lyon (1997), Lyon et al. (1999) or Kothari/ Warner (1997)) used. Therefore, we implement several methods to check whether our results are robust. In the following, the main findings from the recent literature will be summarized and reasons for the approaches used in this paper will be given.

The early research on post-IPO stock performance in the US market (and almost all studies for Germany) compares returns on newly listed firms to returns on market-wide indices. The basic shortcoming of this approach is that it implies for all firms a same average systematic risk (*beta* equal to one) that is constant over time. A lot of studies that use this methodology exist for the German data, analyzing performance of IPOs before the *Neuer Markt* was introduced. Two examples of English-written studies are Ljungqvist (1997) and Bessler/ Thies (2002).

More sophisticated methods that control for risk have been developed and used (for the US data). Beginning with Ritter (1991) various matching approaches have been introduced, putting sample

firms together with either single control firms (matching one-to-one) or with portfolios. In the earlier studies, firms were matched on size (Loughran/ Ritter (1995)) or size and industry (Ritter (1991)), in later studies on size and book-to-market ratio (Brav/ Gompers (1997) or Brav et al. (2000)). Barber/ Lyon (1997) have shown that matching on a one-to-one basis is the most adequate benchmark concept. It does not suffer from the rebalancing and the skewness bias (as methods using equally weighted portfolios do) since both the sample and control firm returns are calculated without rebalancing and without averaging. Our one-to-one matching approach in section 3.4 eliminates also the new listing bias, since both the sample and control firm are listed at “nearly” the same time. We use different approaches to match firms to control firms. In each of these approaches, sample firms are matched to control firms on the basis of specified firm characteristics (market value of equity and book-to-market ratio at IPO) and the IPO timing. However, matching one-to-one induces the noise of selecting potential outliers, particularly if samples are small. Thus we match, additionally, single sample firms to portfolios instead of single firms and obtain similar results.

Alternatively to matching, time-series three-factor models designed by Fama/ French (1993) are commonly used to analyze the post-IPO performance (e.g. Brav/ Gompers (1997) and Brav et al. (2000)). Here, portfolio returns are regressed on the market (beta) factor, size and book-to-market effects. Some studies consider additional factors, e.g. leverage and liquidity (see Eckbo/ Norli (2000)) or the previous return (see Brav et al. (2000)). Due to a short horizon and lack of data on factors for Germany, we do not perform factor model analysis. Instead, we employ in section 3.3 a cross-section analysis similar to Ritter (1991). We regress firm returns on the market return, various

control variables (size, book-to-market ratio, age, industry dummies) and VC characteristics.

In most of the analyses in the paper, we exclude firms that left the market during the period under consideration. We address the issue of the potential survivor bias in section 3.4, where we include the (eight) firms which left the market on the basis of their one-year return. The results did not change very much compared to the matching without these firms. Last but not least, the studies on performance often suffer from bad test statistics. However, using matching one-to-one as in section 3.4, the test statistics are well specified (see Barber/Lyon (1997)). We address this problem in section 3.3 too. We assume heteroscedasticity and employ corrected t-test statistics.

In this paper, the window for the measurement of the performance is two years. Post-IPO returns are typically measured as buy-and-hold (abnormal) returns. In section 3.4, we calculate the differences between the VC-types based on both the buy-and-hold returns and the wealth relatives. However, no considerable differences can be detected.

3.3 Cross-Section Analysis of Returns

In a first step, we explore the determinants of the post-IPO returns in a cross-section analysis. We define performance (r_t) as:

$$r_t = \frac{P_{t+2} + D_{t+2} - P_t}{P_t} ,$$

with P_t (P_{t+2}) being the share price at IPO (two years after IPO). Additionally the dividends during the two-year period (D_{t+2}) are taken into account. Our ultimate goal is to look into potential effects of different types of VCs on the returns on their portfolio firms. In order to isolate these effects, we include various variables which control e.g. for size, age, and industry (9 industry dummies) of the particular firm. We use the market value of the firms at the time of the IPO as proxy

for firm size. The book-to-market ratio (at the time of IPO) serves as an indicator for the market expectation of future growth potentials. Market return (measured as the two-year return on the *NEMAX All Share* Index) in the corresponding period takes market developments into account.

Table 5 delineates our results. We estimated seven models which differ with respect to sample size as well as variables included. The basic model (Model I) embraces the entire sample and includes, besides the main control variables, dummy variables depicting the different types of VCs. This model already reveals the main pattern, which turns out to be rather robust throughout the various specifications. We find in Model I a significant positive effect of INDEP on two-year returns. That is, firms backed by independent VCs performed significantly (at the ten percent level) better than their counterparts which were either backed by other VCs or not venture-backed at all. We find negative but insignificant coefficients for the PUBL and CORP variable. Our data also indicate that firms backed by bank-dependent VCs tend to perform relatively better than all other firms. This effect is, however, not significant. With respect to the control variables, we find a highly significant positive impact on the part of market returns. The remaining control variables are insignificant. In Model II we show that venture-backed companies perform generally better than non venture-backed companies.

In the third and fourth step (Models III and IV) we also include a variable measuring the national decent of the VC. This variable (GERM) indicates that firms backed by non-German VCs do outperform the others. This might be attributable to the longer track record of international VCs, an influence which is underestimated by the capital markets. The inclusion of other market participants (namely the

Table 5: Cross-section regressions of two-year post-IPO returns

This table reports the results of different cross-section OLS regressions of two-year post-IPO returns.

The sample includes all venture-backed and all non venture-backed IPOs for the 1997-2002 period on the *Neuer Markt*, Frankfurt. We excluded two firms, VIVA and EM.TV.

t-statistics (corrected for heteroscedasticity using the Huber-White-sandwich estimator) are in parentheses. Industry dummies are used as control variables, but not reported in the table. The coefficient of the constant used in the estimations is also omitted.

One, two, and three asterisks indicate significance at the 10%, 5%, and 1% levels. An asterisk in brackets points to significance at the 15 percent level.

	I:	II:	III:	IV:	V:	VI:	VII:
	Full Sample			VC-Sample			
		and VCs	and other market participants	and hot issue		and national origin	and reputation
MV (*10 ⁻⁶)	2.4 (0.26)	1.6 (0.18)	1.7 (0.20)	2.3 (0.26)	-1912 (-1.94)*	-2073 (-2.02)**	-1783 (-1.61)(*)
BTM (*10 ⁻⁶)	1.1 (0.65)	1.0 (0.64)	0.9 (0.55)	0.6 (0.36)	10.3 (1.53)(*)	8.4 (1.26)	9.8 (1.57)(*)
MARKET2Y	1.1 (2.76)***	1.1 (2.79)***	1.1 (2.52)**	1.5 (1.90)*	1.6 (2.92)***	1.6 (2.94)***	1.5 (2.56)**
AGE (*10 ⁻⁶)	-6.3 (-0.22)	-6.3 (-0.22)	-18.0 (-0.66)	2.5 (0.10)	-6.2 (-0.15)	-4.6 (-0.11)	-22.0 (-0.60)
BANK	0.2 (0.44)		0.5 (1.72)*	0.5 (1.41)	0.4 (0.47)	-0.3 (-0.44)	-0.7 (-1.25)
CORP	-0.01 (-0.03)		0.5 (1.64)(*)	0.3 (0.97)	0.8 (1.14)		
INDEP	0.6 (1.73)*		0.7 (1.79)*	0.8 (1.90)*	1.4 (1.68)*	0.2 (0.60)	0.1 (0.30)
PUBL	-0.5 (-0.98)		0.3 (0.57)	0.04 (0.07)		-0.6 (-0.78)	-0.9 (-1.27)
GERM			-0.7 (-2.38)**	-0.5 (-1.76)*		-0.7 (-1.92)*	
RANK							-0.3 (-2.01)**
VC		0.32 (1.71)*					
DSRANK			0.03 (0.45)				
UNDRANK			-0.02 (-0.78)				
HOTISSUE				1.3 (0.90)			
# of obs.	308	308	307	308	118	118	117
R ²	0.35	0.34	0.36	0.37	0.48	0.49	0.50

Additionally to the results presented in this table, we calculated all models alternatively (a) removing companies with negative book-to-market ratios and (b) employing a dummy variable for negative/ positive book-to-market ratio. The results did not differ considerably.

Designated Sponsors and the lead underwriters) or adding the HO-TISSUE variable does not really change the picture.

If we consider only our VC-Sample (Models V - VII) and thereby compare the different types of VCs with each other, the overall picture is not altered. Firms backed by independent VCs outperform firms financed by other VCs (see Model V). If we take GERM (see Model VI) or RANK (see Model VII) into account, most of the effect of INDEP is picked up by these variables. Companies backed by foreign VCs or by VCs with a large reputation perform better.

The overall picture is quite clear-cut. There are significant differences between the two-year performance of firms backed by different VCs and non venture-backed IPOs. In the group of the venture-backed firms we find a consistent pattern. Firms financed by independent VCs do significantly better (or, given the overall market trend in our period of investigation, not worse) than the other firms in the *Neuer Markt*. If we take the national origin of the VCs into account, we find that firms backed by international VCs (who mostly are independent) tend to perform significantly better than others. Further, a higher reputation on the part of the lead VC leads to a better performance. Obviously this effect, which probably results from the experience of international, independent, and high-quality VCs as monitors, is not discounted by the market participants reflecting the potential inefficiencies of a young capital market.

3.4 Matching Returns ‘One-to-One’

In the next step, we match similar firms on a one-to-one basis (using eight different approaches) and compare their returns. In order to deal with the differences between venture and non venture-backed companies and among different types of VCs, we divide the sample into six groups (VC, NON-VC, PUBL, BANK, INDEP, and CORP). For each

firm from a certain group (e.g. PUBL), we choose a control firm from another group (e.g. NON-VC). The differences between the matching methods used can be found in (a) the period in which the (abnormal) returns are measured and (b) the restrictions posed on the group of potential matching firms. For each of the eight approaches, the most similar firms are put together and their return differences analyzed. The “similarity” is measured in terms of size, book-to-market ratio, and IPO timing. We invariably use two-year buy-and-hold returns (BHR). The results are depicted in Table 6. The superior performance of venture-backed firms, particularly of the group financed by independent VCs, is confirmed. Moreover, firms backed by a public VC perform significantly worse than companies from other groups.

We use two different observation periods. In (1) - (4), we follow each issuing firm over two years from its IPO date. We compare the abnormal return (= firm return minus *NEMAX All Share* return) on the sample and the control firm and calculate the difference (matched return difference, MRD):

$$\text{MRD} = \text{ABNORMAL}_i - \text{ABNORMAL}_c.$$

Here, the periods in which returns on the firm i and c are measured may slightly differ because of different IPO dates. However, the inclusion of the market return should control for this effect.

In (5) - (8), the measurement period is exactly the same for both the sample and the control firm. It starts three weeks after the IPO of the firm with the later offering (time t) and lasts for two years (time $t + 2$).⁹ We compare the return on the sample and the control firm and calculate the difference (MRD):

$$\text{MRD} = (\text{BHR between } t \text{ and } t + 2)_i - (\text{BHR between } t \text{ and } t + 2)_c.$$

⁹The reason for not starting at the date of the later IPO is the high volatility immediately after the listing.

Table 6: Mean return differences between sample and matching firms

This table reports the means of the MRD between a sample firm i and a control firm c for venture-backed firms (VC), non venture-backed firms (NON-VC) and firms backed by different types of VCs (PUBL, BANK, INDEP, CORP). The sample includes all venture-backed and all non venture-backed IPOs for the 1997-2002 period on the *Neuer Markt*, Frankfurt. We excluded two firms, VIVA and EM.TV.

For (1) to (4): $ABNORMAL_i - ABNORMAL_c$.

For (5) to (8): $(\text{buy-and-hold return between } t \text{ and } t + 2)_i - (\text{buy-and-hold return between } t \text{ and } t + 2)_c$.

Standard deviations are in parentheses. Number of observations is in italics.

“+” indicates that the difference in means of the MRD between a certain group (VC, NON-VC, PUBL, etc.) and the rest is significant (a standard two-sided t-test allowing for unequal variances)

“*” indicates that the difference in medians of the MRD between a certain group (VC, NON-VC, PUBL, etc.) and the rest is significant (a nonparametric two-sample test on the equality of medians with the test chi-squared statistic without a continuity correction)

“†” indicates that the mean MRD in a certain group is significantly different from 0 (a standard two-sided t-test)

+++ , *** , † † † indicate significance at the 1% level; ++ , ** , † † indicate significance at the 5% level;

+ , * , † indicate significance at the 10% level; (+) , (*) , (†) indicate significance at the 15% level

DIFFERENCE BETWEEN ABNORMAL RETURNS, DIFFERENT PERIODS

	<i>VC</i>		<i>NON-VC</i>		<i>PUBL</i>		<i>BANK</i>		<i>INDEP</i>		<i>CORP</i>	
(1)	-		-		-0.55 (1.06) <i>9</i>	*	-0.44 (3.32) <i>38</i>	(*)	0.21 (1.88) <i>63</i>	**	-0.08 (0.35) <i>8</i>	
(2)	-		-		-0.19 (0.52) <i>9</i>	+ *	0.45 (2.43) <i>37</i>		0.30 (1.92) <i>62</i>	(*)	-0.20 (0.52) <i>8</i>	+
(3)	0.29 (1.95) <i>117</i>	+ (†)	-0.08 (1.55) <i>190</i>	+	-0.20 (0.55) <i>9</i>		0.45 (2.39) <i>38</i>		0.30 (1.92) <i>62</i>		0.00 (0.18) <i>8</i>	
(4)	0.29 (1.95) <i>117</i>	+++ (†)	-0.54 (2.51) <i>190</i>	+++ † † †	-0.20 (0.55) <i>9</i>	*	0.45 (2.39) <i>38</i>	+	0.30 (1.92) <i>62</i>	++	0.00 (0.18) <i>8</i>	(+)

DIFFERENCE BETWEEN RETURNS, SAME PERIOD

	<i>VC</i>		<i>NON-VC</i>		<i>PUBL</i>		<i>BANK</i>		<i>INDEP</i>		<i>CORP</i>	
(5)	-		-		-0.29 (0.84) <i>9</i>		-0.50 (2.18) <i>38</i>	+ (*)	0.25 (0.97) <i>59</i>	++ *	0.00 (0.10) <i>8</i>	†
(6)	-		-		-0.15 (0.50) <i>9</i>	+ **	0.67 (3.07) <i>36</i>		0.18 (1.47) <i>59</i>	(*)	-0.08 (0.35) <i>7</i>	(+)
(7)	0.31 (1.96) <i>112</i>	+ †	-0.07 (1.68) <i>185</i>	+	-0.15 (0.53) <i>9</i>	**	0.60 (2.88) <i>37</i>		0.24 (1.42) <i>59</i>		0.00 (0.12) <i>7</i>	
(8)	0.31 (1.96) <i>112</i>	+++ †	-0.53 (2.72) <i>185</i>	+++ † † †	-0.15 (0.53) <i>9</i>	**	0.60 (2.88) <i>37</i>	+	0.24 (1.42) <i>59</i>	++	0.00 (0.12) <i>7</i>	

To check whether the disparities are robust over different control firms' samples, we place varying restrictions on the group of matching firms. In (1) and (5), we match venture-backed firms only to venture-backed firms financed by a different type of venture capitalist. Thus, a firm backed e.g. by a public VC may be matched with a firm backed by a corporate, bank-dependent, or independent VC. Using this approach, the differences between different types of VCs can be targeted. In (2) and (6), we compare firms backed by different types of VCs to non venture-backed firms. Thus, each venture-backed firm is matched to the most similar non venture-backed firm. In (3) and (7), the group of potential matching firms includes all firms, with the exception of firms backed by the same type of VC as the sample firm. Thus, a firm backed e.g. by a public VC may be matched to a firm backed by a corporate, bank-dependent or independent VC or to a non venture-backed firm. In (4) and (8), the group of matching firms is restricted for the non venture-backed sample firms as well, since they are matched only to venture-backed firms. The group of potential matching firms for venture-backed firms includes all firms, with the exception of firms backed by the same type of VC as the sample firm. As a consequence of this design, in (1), (2), (5) and (6) the group of sample firms consists only of venture-backed firms, whereas in (3), (4), (7) and (8) non venture-backed firms are included in the analysis as well.

Having defined the group of potential matching firms (e.g. non venture-backed firms in (2) and (6)) for each sample firm i , we search within this group for such companies as went public in a period that started three months before and ended three month after the IPO of the sample firm i . Within this restricted group of potential matching firms for firm i , we choose that control firm c that minimizes:

$$\left| \frac{MV_c - MV_i}{MV_{average}} \right| + \left| \frac{BTM_c - BTM_i}{BTM_{average}} \right|,$$

where $MV_{average}$ and $BTM_{average}$ are measured over the whole sample of 326 firms.

The mean differences in returns between sample and control firms in each group (mean MRD) are depicted in Table 6. We have 117 (112) pairs of matched firms in the first group (VC), 190 (185) firms in the group NON-VC, 9 firms in the group PUBL, 36-38 firms in the group BANK, 59-63 firms in the group INDEP, and 7-8 firms in the group CORP. The reason for the difference in the number of matched pairs for different approaches is that in some cases no matching firm could have been identified, since the set of potential matching firms was empty. For seven firms that went public after April 1, 2001, we did not have data on two-year-returns, because our time series on returns ended in March 2003.¹⁰ Eight firms left the market during the two years after their IPO. These firms (two of them venture-backed) are not considered in Table 6.

Venture-backed firms perform significantly better than non venture-backed firms. This result is robust over the various matching approaches. The mean returns on firms backed by public VCs are always lower than the mean returns on their matched firms. The difference in (abnormal) returns is particularly large when we match publicly-backed firms only to firms financed by another type of VC (approaches (1) and (5)). On the whole, the difference in medians of the MRD is almost always highly statistically significant and negative for public VCs compared to other groups. The mean returns on firms backed by an independent VC are always higher than the mean returns on their matched firms. When we match only within venture-backed firms, firms backed by an independent VC are the only group that has a positive mean MRD on average. The mean MRD on firms backed

¹⁰Logically, for (5) - (8), where the measurement period starts three weeks after the IPO of the firm with the later IPO, the samples are smaller than in (1) - (4), where the two-year timespan begins at the IPO date.

by a corporate or a bank-dependent VC vary from approach to approach. Compared to other venture-backed firms, companies backed by a bank-dependent VC have (significantly) lower returns, while companies backed by a corporate VC have approximately the same returns on average.

We carried out three further analyses to check the robustness of our results. First, we included firms that left the market during the period under consideration on the basis of their one-year returns so as to control for the potential survivor bias. Second, we matched firms on a portfolio basis instead of on a one-to-one basis. Third, we used wealth relatives instead of the BHR. In all these alternative approaches, the positive impact of venture capital-backing, particularly of independent venture capital, on performance was confirmed. On the other hand, the inferior performance of companies backed by public VCs remained as well. The results are not reported here.

3.5 Post-IPO Return Volatility

In this section, we look at the differences in the two-year post-IPO idiosyncratic volatility of returns. In doing so, we want to explore whether venture capitalists (and different types of venture capitalists) are better able to overcome potential informational asymmetries with respect to firm characteristics. Here the basic idea is that venture capitalists can use their (current and/ or future) reputation to price the shares of their firms better than in the case of non venture-backed firms. This implies that, in the aftermath of IPO, there will be less adjustment towards the “true” market price, thus leading to less post-IPO fluctuation (see Neus/ Walz (2002) for a detailed theoretical model of this hypothesis).

In Table 7 we regress the two-year post-IPO idiosyncratic volatility (resulting from the CAPM) on some further variables concerning

Table 7: Cross-section regressions of the idiosyncratic volatility

This table depicts the results of cross-section OLS regressions of idiosyncratic volatility ($\cdot 10^5$), calculated on the basis of the CAPM.

The sample includes all venture-backed and all non venture-backed IPOs for the 1997-2002 period on the *Neuer Markt*, Frankfurt. We excluded two firms, VIVA and EM.TV.

t-statistics (corrected for heteroscedasticity using the Huber-White-sandwich estimator) are in parentheses. Industry dummies are used as control variables, but not reported in the table. The coefficient of the constant used in the estimations is also omitted.

One, two, and three asterisks indicate significance at the 10%, 5%, and 1% levels. An asterisk in brackets points to significance at the 15 percent level.

	I:	II:	III:	IV:	V:	VI:
	Full Sample			VC-Sample		
		and other market participants	and VCs	and other market participants	and national origin	and reputation
MV($\cdot 10^{-4}$)	-6.33 (-0.40)	-1.57 (-0.10)	-6.28 (-0.40)	-7.12 (-0.05)	-42.66 (-0.28)	-22.24 (-0.14)
BTM($\cdot 10^{-4}$)	1.22 (2.90)***	1.19 (3.23)***	1.25 (2.97)***	0.82 (1.00)	1.06 (1.42)	1.12 (1.51)(*)
AGE($\cdot 10^{-4}$)	-8.90 (-2.85)***	-12.41 (-4.32)***	-8.89 (-2.81)***	-8.42 (-1.99)**	-8.53 (-2.06)**	-9.53 (-2.29)**
SIZE($\cdot 10^{-10}$)	-20.50 (-0.09)	-109.00 (-0.50)	-19.90 (-0.09)	262.00 (0.36)	484.00 (0.67)	287.00 (0.39)
BANK	-21.74 (-3.51)***	-13.68 (-2.45)**				
CORP	-13.82 (-2.08)**	-12.33 (-1.77)*		-0.59 (-0.08)		
INDEP	-27.60 (-4.50)***	-18.28 (-3.47)***		-7.28 (-1.65)*		
PUBL	-23.06 (-2.71)***	-19.21 (-2.43)**		-6.18 (-0.79)		
GERM					5.79 (1.47)(*)	
RANK						2.27 (1.49)(*)
VC			-22.81 (-4.13)***			
LOCK	0.29 (4.19)***	0.20 (3.20)***	0.27 (3.84)***	0.21 (3.06)***	0.22 (3.18)***	0.20 (3.06)***
DSRANK		-3.24 (-5.03)***		-3.04 (-3.42)***	-3.13 (-3.40)***	-3.47 (-3.81)***
UNDRANK		0.36 (0.57)		-0.38 (-0.38)	-0.38 (-0.36)	-0.61 (-0.60)
HOTISSUE	-10.15 (-2.49)**	-6.27 (-1.77)*	-9.74 (-2.42)**	-4.80 (-0.85)	-4.82 (-0.92)	-6.00 (-1.13)
# of obs.	320	314	320	117	117	117
R^2	0.16	0.22	0.15	0.33	0.32	0.32

Additionally to the results presented in this table, we calculated all models alternatively (a) removing companies with negative book-to-market ratios and (b) employing a dummy variable for negative/ positive book-to-market ratio. The results did not differ considerably.

the firm characteristics, the market situation, the rank of Designated Sponsors and the lead underwriter(s), the VCs' characteristics and involvement. We estimate six models which differ with respect to sample size and included variables. Several of our variables help explain part of the idiosyncratic volatility.

In general, participation by venture capitalists decreases the volatility (see Models I - III) as implied by Neus/ Walz (2002). However, the venture capitalists' impact depends on their type and the extent of their lock-up. Within the VC-Sample we find, in line with our previous results, a positive impact of independent VCs (see Model IV). Companies backed by independent VCs show a relatively lower idiosyncratic volatility than do other firms (generating a higher return at the same time). Moreover, as expected, shares of foreign VCs and VCs with a better (=lower) rank, which also perform better, are less volatile (see Models V and VI).

As short-term investors, venture capitalists try to divest themselves of their shares rather quickly. This leads to an increase in the volatility of these shares. Thus, the larger the lock-up by venture capitalists is, the higher the idiosyncratic volatility. Younger firms, which typically are more risky than their older counterparts, show a higher idiosyncratic volatility.

Two results from Table 7 contradict our predictions: The finding of a positive impact of the book-to-market ratio on the idiosyncratic volatility is inconsistent with the Fama/ French (1993) result, namely that value stocks are actually less volatile than the general market. This result holds (albeit on slightly lower significance levels) even if we control for negative book-to-market ratios either by excluding companies with negative values or by employing a dummy variable for negative/ positive values (results not presented). We also cannot

explain why the reputation of Designated Sponsors plays a negative role, so that a better (=lower) rank increases the volatility.

4 Underpricing

Several studies look at the differences in underpricing of venture- and non venture-backed companies (see section 1). Our focus to a large extent is a different one. Instead of comparing venture- and non venture-backed IPOs, we follow our previous route of analysis and investigate potential underpricing differences between the different types of venture capital firms. Thus, we control for other factors such as market conditions (approximated by the average extent of underpricing in the five IPOs preceding the firm in question), firm age, growth potential (using the book-to-market ratio as proxy) and market value. We also include the issue size in order to take up the idea of Ljungqvist (1999). He argues that underpricing is less costly if the total size of the issue is small, thereby creating incentives to invest in costly marketing only for large issues, in order to induce lower underpricing.

We investigate the following VC-related hypotheses:

- In contrast to bank-based and public VCs, who typically are only bridge investors and are not very deeply involved in the hand-on management of their portfolio companies (see Tykvová (2004)), independent VCs typically are active, long-term investors. Thus, they are able to better resolve informational asymmetries. Their portfolio firms should display less underpricing.
- The more reputable and the older the VCs (see Gompers (1996) and Neus/ Walz (2002)) are, the less pronounced the underpricing that is expected to take place.

- Public, bank-dependent and corporate VCs are seen as having potential conflicts of interest, e.g. with their owners who may pursue some particular goals (see Hellmann et al. (2003)) or with the underwriters (see Hamao et al. (2000) and Gompers/ Lerner (1999a)), forcing them to underprice more than other venture-backed firms.

The results of our cross-section analysis are displayed in Table 8. By and large we can not find any significant effects of the different types of VCs on the extent of underpricing when controlling for market value, book-to-market ratio, age of the firm, market conditions, and the issue size. The coefficient of BANK is positive as expected, indicating that firms backed by these types of VCs are underpriced to a larger extent. The coefficients' signs of PUBL, CORP and INDEP are not clear-cut. However, none of these coefficients is significant. Our Models IV-VI reveal a significant influence of the VC's reputation on underpricing. The sign of RANK is, however, in contrast to our theoretical considerations: the more reputable a VC, the higher the degree of underpricing of its portfolio firm. This negative and significant coefficient remains even if we include the VC-type variables and the GERM variable, which has a positive impact, as expected, on the extent of underpricing (see Models V and VI). We do not find any support for the certification role of the underwriters.

The Ljungqvist-hypothesis that the size of the issue has a negative impact on the degree of underpricing is strongly supported in our regressions. We also find a strong positive impact of market conditions on the degree of underpricing. If previous issues have been heavily underpriced (indicating a hot issue period), it is likely to be true for the issue under consideration. The book-to-market ratio has always a negative impact. That is, firms with a higher expected growth potential (i.e. with a lower book-to-market ratio) are more underpriced.

Table 8: Cross-section regressions of underpricing

This table reports the results of different cross-section OLS regressions of underpricing. The sample includes the entire sample of all venture-backed and all non venture-backed IPOs for the 1997-2002 period on the *Neuer Markt*, Frankfurt. We excluded two firms, VIVA and EM.TV. t-statistics (corrected for heteroscedasticity using the Huber-White-sandwich estimator) are in parentheses. Industry dummies are used as control variables, but not reported in the table. The coefficient of the constant used in the estimations is also omitted. One, two, and three asterisks indicate significance at the 10%, 5%, and 1% levels. An asterisk in brackets points to significance at the 15% level.

	I:	II:	III:	IV:	V:	VI:
	Full Sample			VC-Sample		
	and VCs	and other market participants		and reputation	and national origin	and other market participants
MV(*10 ⁻⁶)	210.2 (4.19)***	205.0 (4.18)***	204.7 (4.16)***	2231.9 (3.75)***	2162.7 (3.73)***	2171.7 (3.59)***
BTM(*10 ⁻⁶)	-2.40 (-2.57)**	-2.53 (-2.56)**	-2.48 (-2.57)**	-2.27 (-1.44)	-2.46 (-1.59)(*)	-2.76 (-1.57)(*)
AGE(*10 ⁻⁶)	8.76 (1.08)	10.00 (1.15)	8.68 (1.05)	20.80 (2.20)**	22.30 (2.32)**	26.70 (2.49)**
SIZE(*10 ⁻⁹)	-2.92 (-4.58)***	-2.86 (-4.59)***	-2.85 (-4.56)***	-10.90 (-3.79)***	-10.20 (-3.70)***	-10.10 (-3.42)***
RECENT	0.75 (7.94)***	0.75 (7.77)***	0.75 (7.93)***	0.47 (4.65)***	0.47 (5.02)***	0.46 (4.60)***
BANK		0.09 (0.70)	0.08 (0.70)			
CORP		-0.05 (-0.44)	-0.04 (-0.37)			-0.07 (-0.32)
INDEP		0.01 (0.15)	0.02 (0.21)			-0.10 (-0.62)
PUBL		0.21 (0.81)	0.22 (0.94)			-0.04 (-0.18)
GERM					0.20 (1.98)*	0.18 (1.50)(*)
RANK				-0.07 (-2.09)**	-0.10 (-2.99)***	-0.11 (-2.92)***
VC	0.05 (0.78)					
LOCK				-0.004 (-2.01)**	-0.003 (-1.64)(*)	-0.003 (-1.59)(*)
DSRANK		-0.004 (-0.24)				0.004 (0.13)
UNDRANK		0.005 (0.28)				0.018 (0.68)
# of obs.	318	312	318	118	118	118
R ²	0.35	0.35	0.35	0.47	0.48	0.49

Additionally to the results presented in this table, we calculated all models alternatively (a) removing companies with negative book-to-market ratios and (b) employing a dummy variable for negative/ positive book-to-market ratio. The results did not differ considerably.

A higher VCs' retention rate (LOCK) is obviously interpreted by the market as a signal, so inducing a lower underpricing. Larger and older firms are underpriced more, which is not in line with our intuition.

5 Summary and Concluding Remarks

The main objective of the present paper was to investigate the impact of VCs' corporate governance, experience and objectives on the performance of their portfolio firms around and after IPO. In doing so, we wanted to shed some additional light on the function of venture capital in nurturing and developing their portfolio firms as well as on some mechanisms of the IPO market. Our main working hypothesis was that venture capital was too heterogenous to permit simple comparison between non venture and venture-backed firms.

In order to pursue our objective, we compared the performance of firms backed by different VCs and non-venture backed firms in the course of IPO, looking at the extent of underpricing and at post-IPO returns and volatility. Germany's *Neuer Markt* has proven to be a natural playing field for such a research strategy, deferring a number of obvious advantages (but also one disadvantage). The main advantage was that, due to the specific situation of the German venture capital market (a young, rapidly growing market coupled with a strong public sector), we found a wide array of different types of venture capitalists with quite different structures, objectives, and track records. Our main aim was to exploit just this difference and its impact on the performance of portfolio firms. The disadvantage was closely related to the advantages: due to the relative youth of the *Neuer Markt* we had at our disposal only a rather short time series, a fact that obliged us to restrict our analysis to this short timespan and, hence, to two-

year performance measures. Despite this limitation, we are very much convinced that the advantages clearly outweigh this disadvantage.

With respect to post-IPO performance, we found strong support for the hypothesis that VCs, and particularly independent and foreign VCs as well as VCs with a high reputation, added more value to their portfolio companies. This fact was underestimated by the market participants. Thus, investors who bought shares of firms backed by independent VCs did significantly better in a two-year period after IPO compared to investors who relied on other similar firms in Germany's *Neuer Markt*. Surprisingly, these investors were able to sleep better since prices of their shares fluctuated less. Investors who acquired shares of firms in which the lead VC was a public one bought into low returns. This leads us to conclude that different corporate governance structures, different experience levels, and different objectives among the different types of VCs actually did have an observable and significant impact on the portfolio firms' post-IPO performance.

When looking into the determinants of underpricing we found rather little evidence that the extent of underpricing differed significantly between firms backed by different VCs. Furthermore, we concluded – and this comes somewhat as a surprise – that the reputation of the VC had a positive impact on underpricing. The fact that we were not able (due to the lack of data on issue costs, see Ljungqvist (1999)) to fully eliminate potential endogeneity problems in our underpricing estimations, however, leads us to a rather cautious interpretation of our underpricing results.

Our findings on the post-IPO performance as well as the ones in Tykiová (2004) imply that the different types of VCs fulfilled their overall task as specialized monitors, consultants, and financiers of young firms in quite different ways. These differences were not correctly assessed by the market. Therefore, it would be very interesting

to see whether these differences also exist in the pre-IPO period. We leave the task of investigating this with pre-IPO cashflow data to our future research.

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