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Germany's Neuer Markt**

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Underpricing of Venture-Backed and Non Venture-Backed IPOs: Germany's Neuer Markt

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This paper analyzes a comprehensive data set of 160 non venture-backed, 79 venture-backed and 61 bridge financed companies going public at Germany's Neuer Markt between March 1997 and March 2002. I examine whether these three types of issues differ with regard to issuer characteristics, balance sheet data or offering characteristics.

Moreover, this empirical study contributes to the underpricing literature by focusing on the complementary or rather competing role of venture capitalists and underwriters in certifying the quality of a company when going public. Companies backed by a prestigious venture capitalist and/or underwritten by a top bank are expected to show less underpricing at the initial public offering (IPO) due to a reduced ex-ante uncertainty. This analysis provides evidence to the contrary: VC-backed IPOs appear to be more underpriced than non VC-backed IPOs.

JEL classification: G32, G24

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1. Introduction

Venture capitalists are described as experts in the field of high-risk company funding (see for example FENN/LIANG/PROWSE (1997), SAHLMAN (1990) and LERNER (1995)). They not only specialize by concentrating on certain industry sectors and specific stages of a company's development, but also actively engage in monitoring and consulting activities. Since they often serve as members on the "Aufsichtsrat"¹ and frequently invest their capital based on whether intermediate goals have been reached, they are able to influence the behavior and corporate strategy of the company under consideration. Their incentive to improve corporate governance is on the one hand due to the finite life of the partnership and - since their compensation is linked to the firm's performance - to the maximization of the exit price.² On the other hand, being repeat players who regularly have to raise new funds, venture capitalists face reputational risk. One would therefore expect that, much like prestigious underwriters or auditors, venture capitalists certify the quality of a company when going public.

Within the extensive underpricing literature some empirical studies examine whether the market honors the presumed monitoring-activities of venture capitalists. Since this control benefit may reduce the ex-ante uncertainty for future investors, it should lead to lower underpricing. Underpricing is defined as the spread between the initial offering price and the opening price on the first day of trading. However, empirical evidence is mixed. Among others, BARRY ET AL (1990), MEGGINSON/WEISS (1991) and LIN/SMITH (1998) confirm the certification role of venture capitalists for the US market. They find evidence for venture capital (VC)-backed IPOs suffering less underpricing than non VC-backed IPOs. On the other hand, FRANCIS/HASAN (2001) and SMART/ZUTTER (2000), who also analyze US data, find initial returns of venture-backed IPOs on average to be higher than those of non venture-backed IPOs.

LJUNGQVIST (1999) using the data set of MEGGINSON/WEISS (1991), demonstrates that the finding of venture-backed IPOs appearing less underpriced has to be attributed to the incentives of the old shareholders to reduce underpricing and not to the circumstance of venture-backing. Old shareholders will care for the pricing of an issue or for the choice of an

¹ The „Aufsichtsrat“ is similar to the supervisory board. However, German stock companies are governed by two boards. The supervisory board on the one hand is elected by and represents shareholders. Moreover, it appoints the company's executive board. The executive board on the other hand comprises firm managers and oversees day-to-day operations.

² When selling at the time of the initial public offering (IPO), this price is equivalent to the offer price.

underwriter to the extent that such decisions affect their wealth. Studies by HABIB/LJUNGQVIST (2001) and LJUNGQVIST (1999) illustrate, that underpricing-induced wealth losses increase with the number of shares sold in the IPO. As a consequence companies selling a lot of old shares should show little underpricing, due to the incentives of the old shareholders to reduce underpricing.

This study contributes to the underpricing discussion. It analyzes the certification role of venture capitalists and underwriting banks³ at the IPO, exploring a unique German data set of companies going public at Neuer Markt. Moreover, this study examines in line with the argumentation offered by BARRY (1989) the incentives of the old shareholders to take influence on underpricing. Similar to the studies by HABIB/LJUNGQVIST (2001) and LJUNGQVIST (1999), who model underpricing as endogenous to the pre-IPO shareholders' problem of minimizing the total wealth loss in an IPO, two-stage least square regression calculations are applied. The analysis of the German market is of special interest, since it offers the opportunity to analyze a market, in which banks have considerable importance serving as underwriters and at the same time as founders of VC companies and/or their financiers, which contrasts to the Anglo-American markets. Moreover the German VC market has only recently gained some importance within the financial services industry. As a consequence only little empirical work is available to date.⁴ Few information exist about the players on the German VC market, their investments and divestment activities. Thus, this paper has two objectives, first, to enlarge the level of knowledge with respect to venture capital financing in Germany focusing on underpricing and second to compare the results found with those of international studies.

The main result of this study with respect to underpricing is, that venture-backed IPOs at Neuer Markt experience considerably *more* underpricing than non-venture backed IPOs. This phenomenon can not be explained following arguments in the literature.

The paper is organized as follows: Section 2 summarizes the history of venture capital in Germany and its driving factors briefly. Section 3 outlines the impact of the introduction of the Neuer Markt at Frankfurt Stock Exchange on the primary equity market in Germany.

³ Due to the narrow underwriting market until 1998, only two empirical studies exist analyzing the certification role of underwriters in Germany (see WASSERFALLEN/WITTELEDER (1994) and KASERER/KEMPF (1995)).

⁴ Of recent date are the papers by TYKVOVA (2003), RINDERMANN (2003), SCHÄFER/WERWATZ/ZIMMERMANN (2003), BOTTAZZI/DA RIN (2002) and FRANZKE/GROHS/LAUX (2003), which analyse the German Venture Capital Market.

Moreover, it provides an analysis of the IPO-costs for Neuer Markt issues. In section 4 – based on the theoretical literature on underpricing and certification mechanisms – the testable hypotheses are formulated. Section 5 describes the data set and the design of the empirical analysis. In sections 6 and 7 descriptive statistics and the empirical results are presented. The paper concludes with a summary and an outlook in section 8.

2. Venture Capital Financing in Germany

The definition of “venture capital” differs in the literature⁵. In the Anglo-American understanding “venture capital” is often used in the context of early-stage (such as seed and start-up financing) and expansion financing. In Germany, “venture capital” is more comprehensive, since it also includes later-stage capital (such as bridge-, buy out-, and turnaround-financing).⁶ While the former types of investments are crucial for the development and implementation of business ideas by young growth companies, the latter types of investments are important for capital structure reasons of more mature, small to medium-sized companies. To be aware of venture capital’s different meanings is important when interpreting (German) figures and in particular when comparing empirical results of various international studies.

In the 60s, about twenty years later than in the UK and the US, the first German equity investment companies were founded, most of them as subsidiaries of banks.⁷ Nevertheless, before the early 80s a German VC market did not really exist despite early and continuing attempts by the German government to stimulate the availability of equity financing for small to medium-sized companies. The literature analyzing the manifold reasons for the backwardness of the German VC industry discusses in particular the social environment (e.g., status of entrepreneurs, the relationship of academia and trade and industry), legal and tax regulations and the exit conditions for venture capitalists in a bank-dominated financial system (see e.g. LEOPOLD/FROMMANN (1998), BECKER/HELLMANN (2002), HELLMANN/FIEDLER (2001), BETSCH/GROH/SCHMIDT (2000) and FRANZKE/GROHS/LAUX (FORTH-COMING)).

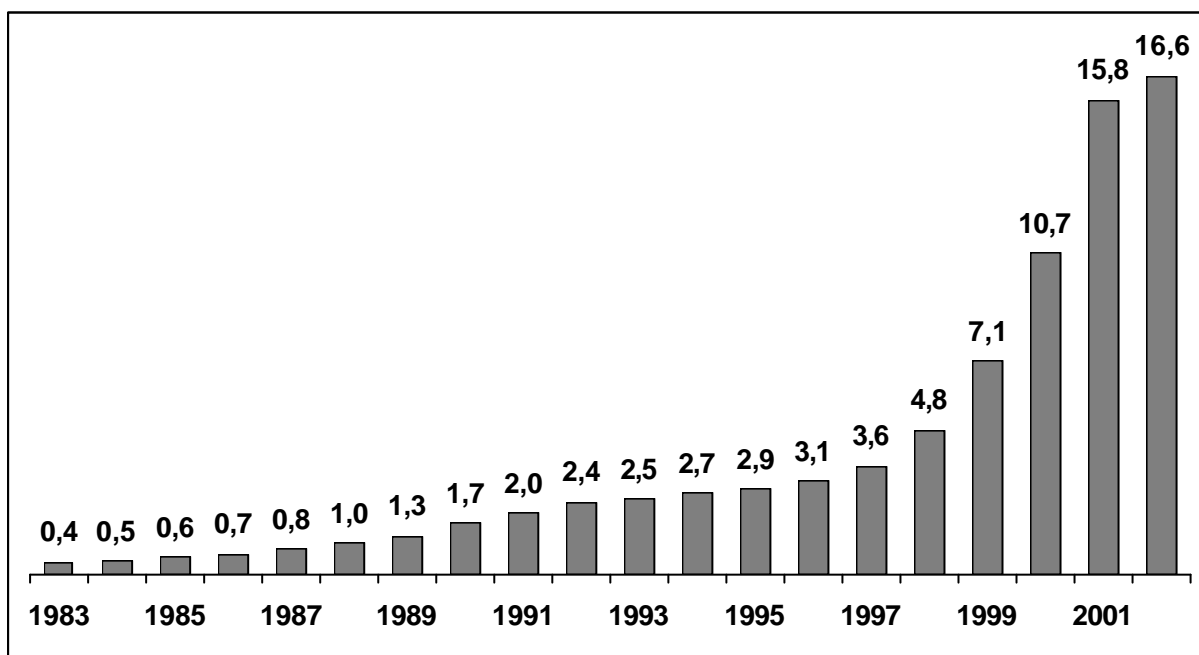
⁵ For a deeper discussion see e.g. BYGRAVE/TIMMONS (1992), STEDLER (1987), BETSCH/GROH/SCHMIDT (2000) and BALZER (2000).

⁶ This broader expression is comparable to the American understanding of private equity.

⁷ See LEOPOLD/FROMMANN (1998) and NEVERMANN/FALK (1986). In England (UK) the *Industrial and Commercial Finance Corporation Ltd.* (ICFC), today known as *3i*, was established, i.e. in 1945, by the initiative of the Bank of England and in cooperation with major banks. Also, in the United States (US) the first professional VC company named *American Research and Development Corporation* (ARD) was already founded in 1949.

However, finally in 1997 the German VC industry entered into an unprecedented period. A remarkable development not only in terms of volume, but also with regard to the distribution of the funds among financial stages and industrial sectors took place.^{8, 9}

Figure 1: Total Portfolio Held by Members of the BUNDESVERBAND DEUTSCHER KAPITALBETEILIGUNGSGESELLSCHAFTEN E.V. (BVK) (in €Billion)



Between 1996 and 2000, about €10.8 billion in total were newly invested in 6300 companies, which is 68% of total new VC investments and 47% of all VC financed companies over the last 30 years.¹⁰ With regard to the distribution among financing stages a strong movement towards early-stage financing could be discerned. While in 1996 only about 14% of gross investments were in early-stage companies, this reached about 36% in 2000.

The expansion would have been impossible without a fundamental change in Germany's funding and investment environment. Accompanied by regulatory changes¹¹ and an upswing in the German equity culture¹², the launch of the Neuer Markt in March 1997, offering a

⁸ See Figure 1. Figures containing data of the members of the BVK account to (according to BVK) 90% of the volume of the German VC market.

⁹ For the development of gross investments of members of the BVK (in € Mio.) and the number of beneficiary companies see figure A.1. in the appendix.

¹⁰ Compare BVK (Yearbook 2001).

¹¹ Amendment of the "Gesetz für Unternehmensbeteiligungsgesellschaften" (UBGG) within the changes of the 3rd „Finanzmarktförderungsgesetz“.

¹² The DAI-FACTBOOK (2002) of the "Deutsches Aktieninstitut" (DAI) shows that stocks constitute about 12% (8%) of the financial assets of private households in 2000 (1996).

further exit mechanism for venture capitalists, has to be seen as most stimulating for the German venture capital industry.¹³ Compared to other strategies, exiting a VC investment by means of an IPO became a truly attractive proposition, not only as it led to high valuations of the portfolio companies but also opened venture capitalists the opportunity to attract attention and credit within a still relatively young VC market.¹⁴

The increasing importance of IPOs as exit vehicle for German venture capitalists in times of active stock markets is clearly reflected in the numbers of the volume and the corresponding percentage of exit vehicles as stated by BVK Statistics (2002) and shown in Table 1. From 1998 to 2000 the Neuer Markt covered on average about 68% of the volume of all venture-backed IPOs by members of the BVK.¹⁵

Table 1: Volume and Percentage of Exit Vehicle as stated by BVK Statistics (2002)

The classification "Other" contains, among other things, selling to a financial investor or a venture capitalist (i.e. secondary purchase). The abbreviation "n.a." stand for "not available".												
	1997		1998		1999		2000		2001		2002	
	€ Mio	%	€ Mio	%	€ Mio	%	€ Mio	%	€ Mio	%	€ Mio	%
IPOs total	19.9	2.7	75.2	14.0	97.1	12.6	116.3	9.2	7.3	0.4	0.0	0.0
IPOs NM	n. a.	n. a.	47.0	8.8	44.5	5.8	105.8	8.4	2.1	0.1	0.0	0.0
Divestment after IPO	n. a.	n. a.	n. a.	n. a.	48.6	6.3	40.4	3.2	138.5	7.5	122.3	5.7
<i>Trade Sale</i>	248.5	34.1	119.6	22.3	192.8	25.1	492.4	39.0	379.1	20.4	651.6	30.6
<i>Buy Back</i>	157.0	21.6	161.1	30.0	159.5	20.7	215.7	17.1	333.8	18.0	78.1	3.7
Write Off	109.4	15.0	91.5	17.0	161.1	21.0	232.1	18.4	673.8	36.3	941.2	44.1
Other	193.3	26.6	90.0	16.8	110.0	14.3	164.6	13.1	322.6	17.4	338.7	15.9
Total	728.1	100.0	537.4	100.0	769.1	100.0	1,261.5	100.0	1,855.1	100.0	2,131.8	100.0

However, as can be seen in Table 1 since 2001 parallel to the collapse of stock markets the issuing activity of venture-backed companies has come to a near stand still. At the same time the percentage of companies that had to be written off increased to more than 35%.

¹³ According to BECKER/HELLMANN (2002), the launch of the "Geregelter Markt" in 1987 had almost no effect on the venture capital industry.

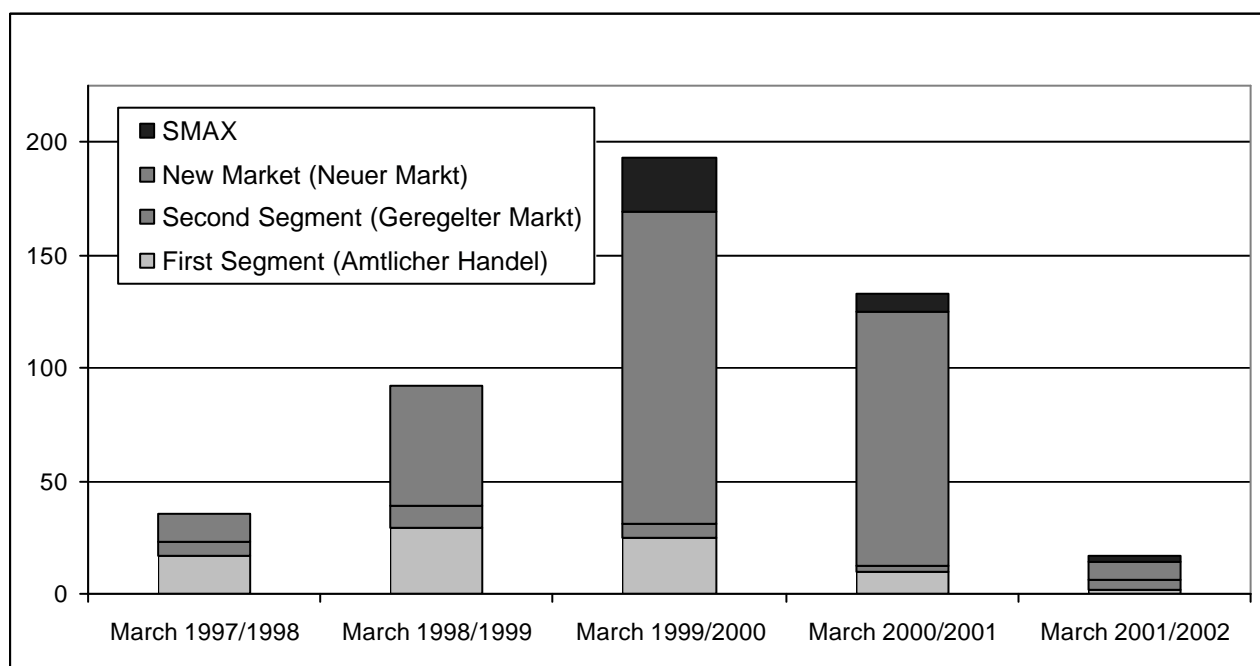
¹⁴ See for example SMITH/SMITH (2000). For an empirical analysis on the efficient pattern on exit vehicles see CUMMING/MACINTOSH (2003)

¹⁵ The remaining 32% can be split into IPOs on other German stock markets (14%) and listings on foreign stock exchanges (18%) such as the NASDAQ.

3. Germany's Neuer Markt and the Costs of Raising Capital

The Neuer Markt was Germany's trading segment for innovative growth companies. It was launched on March 10, 1997 as a subsidiary of the Deutsche Börse AG, with the objective to attract small- to medium-sized, young technology firms. As figure 2 indicates, the number of companies that have gone public in Germany or rather on the New Market increased dramatically during the IPO boom period. From March 1997 through March 2000, over 200 companies went public on the Neuer Markt, while at the same time new listings at the first and second segment stayed close to their previous levels. In total about 320 new listings were recorded at Frankfurt Stock Exchange for that period.¹⁶ However, as a consequence of the down turn of shares listed at the Neuer Markt since March 2000, the going public of companies became much more difficult and finally almost impossible, which is particularly reflected in the numbers for the period March 10, 2001 to March 10, 2002. Finally in 2003 the Neuer Markt has been dissolved.

Figure 2: New Issues at Frankfurt Stock Exchange¹⁷ (in Numbers) during the Period March 10, 1997 to March 10, 2002



¹⁶ According to JOHNSON (2000), from 1949 through 1996 a total of only 356 companies went public in Germany.

¹⁷ On the SMAX (Small Cap Exchange) - introduced in April 1999 - second market stocks were traded. The listing requirements of the SMAX followed - apart from small modifications - those of the Neuer Markt.

Although Neuer Markt had from the very beginning much stricter listing and disclosure requirements than the established exchanges¹⁸, Deutsche Börse AG deemed it necessary to tighten these again and again (five times since March 1997), demanding further transparency of the companies listed and extending the package of sanctions Deutsche Börse AG was able to apply.

What is remarkable about the “how to go public” at the Neuer Markt is that from March 1997 to March 2002 all but one company (TRIOUS AG)¹⁹ chose book-building to price the shares.²⁰ Although during the observation period two out of three issues were oversubscribed²¹, the final issue price was always fixed within the book-building range²² and never above; merely 2.8% of all IPOs at Neuer Markt²³ were priced below the minimum price limit. Following LJUNGQVIST/JENKINSON (2000), the reluctance to price outside the range is distinct in Germany compared to international practice. The major potential benefit of book-building, to raise the price, if demand is unexpectedly high, seems hardly be exhausted.²⁴ This is worth mentioning as the pricing has influence on the costs of going public.

In order to analyze the issuing costs for companies at Neuer Markt in more detail, one can distinguish between direct and indirect costs, as listed in Table 2.²⁵

The direct costs contain for example auditing and consulting fees, underwriting fees, marketing costs, or fees raised by the Frankfurt Stock Exchange for the admission to the first segment, for the filing of the prospectus and for services provided by Deutsche Börse AG.²⁶

¹⁸ JOHNSON (2000) describes and compares the listing standards in Germany (all markets of the Frankfurt Stock Exchange) and the United States (NYSE, NASDAQ) in detail. The studies by LEUZ (2000), CERKE/BOSCH (2000) and THEISSEN (1998) assess, whether the high listing and information demands of the Neuer Markt lead to the desired increased transparency and improved liquidity, thus providing confidence to investors.

¹⁹ Trius AG went public by using a tender procedure, selling the stocks via an auction.

²⁰ Until 1995 it was common to use the fixed-price method in Germany. One of the main imperfections of this method in comparison to book-building is, that underwriting banks have a vital interest to set up a low offer price: Since they do not receive any information concerning demand (e.g. through bids by institutional and retail investors) before the price fixing, they have more to care for the placement risk.

²¹ This is in the interest of the management as an oversubscription of the offering enables the management to take more influence on the allotment (see among others BRENNAN/FRANKS (1997)).

²² 72.8% of the IPOs of the sample have been fixed exactly at the upper price limit.

²³ These companies have been ArtStor AG, biolitec AG, e.multi Digitale Dienste AG, Euromed AG, GericomAG, MSH International Services AG, Neue Sentimental Film AG, nexus AG, Paragon AG.

²⁴ LJUNGQVIST/JENKINSON (2000) merely conjecture that local regulations, the costs caused by price revisions or the market power of domestic investors could serve as explanations for the unwillingness to raise the price.

²⁵ For a cross-sectional analysis of the costs of raising capital in Germany, see KASERER/KRAFT (2000).

²⁶ Strictly speaking the value of the greenshoe option has to be added to these costs. To stabilize the stock price following the IPO, the issuer grants the underwriter the option to sell additional shares at the issue price and trade them for a time period of thirty days, if necessary. According to OCHNER (2000), underwriters do almost constantly retain the earnings gained by selling additional shares at the issue price (or

The numbers quoted here are calculated from information indicated in the issuing prospectuses of the companies under consideration. During the period of March 1997 through March 2002, companies going public on the Neuer Markt had to bear on average total direct flotation costs of 8.89% of gross proceeds. As part of these costs the average underwriting fee amounted to 5.27% of gross proceeds, respectively.

Table 2: Costs of Going Public at the Neuer Markt (March 1997 - March 2002)

„Money left on the table“ is calculated by multiplying the total volume of issues with the initial return or rather the underpricing, which is the spread between the opening price at the first day of trading and the initial offering price. Dividing the direct flotation costs by the gross proceeds of an issue, one receives the relative direct costs. The relative underwriting fee is defined as the underwriting fee paid at IPO normalized by the gross proceeds of the issue.						
In € thousand respectively %	Mean	Median	Std.Dev.	90%- quantile	10%- quantile	Obs.
Direct flotation costs	4,723	3,139	7,317	8,527	1,498	300
Underwriting fees	3,138	1,981	5,746	5,210	809	300
Indirect costs: Money left on the table	27,916	7,735	52,912	75,432	-267	300
Gross issue proceeds	69,438	38,713	180,000	116,852	15,750	300
Relative direct costs	8.89%	8.32%	3.30%	12.43%	5.78%	300
Relative underwriting fees	5.27%	5.20%	1.21%	6.23%	4.05%	300
Initial return	49.81%	18.51%	73.13%	160.00%	-0.97%	300 ²⁷

The indirect costs in the form of underpricing²⁸ average 49.81%. In other words, the average issuing company could have raised about € 28 million more, if the first market price would have been in correspondence with the offering price.

Compared to the degree of underpricing on the German IPO market earlier studies²⁹ report, the extent of underpricing at the Neuer Markt seems to be remarkably high. This might be in line with the finding of STEHLE/ERHARDT (1999), that small, relatively unknown companies have high initial returns. However, RITTER/WELSH (2002), who analyze a data set of US IPOs

eventually a higher secondary market price) and purchase them back as soon as the price of the shares falls below the issue price. For an in-depth analysis of the use of the greenshoe option on the Neuer Markt see FRANZKE/SCHLAG (2002).

²⁷ 31 of the 300 observations are overpriced as indicated by the negative initial return. 34 observations have an initial return of 0.00%.

²⁸ Underpricing is equivalent to a positive initial return, as the first market price exceeds the offer price.

²⁹ See for example ERHARDT (1997), LJUNGQVIST (1997), KASERER/KEMPF (1995) or WASSERFALLEN/WITTLIEDER (1994). A study by LÖFFLER (2000) on the Neuer Markt offers comparable numbers.

covering the years of the years 1999 to 2000, find issues to be underpriced by 65% on average.

4. Related Literature and Hypotheses

The theoretical literature on underpricing (for an extensive overview, see RITTER/WELSH (2002) and JENKINSON/LJUNGQVIST (2001)) can be divided into two main categories.

There is theoretical work, which focuses on asymmetric information i) within the group of investors, ii) between issuer and underwriter, iii) between issuer and investors and iv) between underwriter and investors. Secondly, there are institutional explanations that try to attribute the existence of underpricing to factors such as price support by the underwriting bank, liability regarding the statements made in the issuing prospectus or aspects of corporate ownership and control.

This paper focuses on theories based on asymmetric information *between issuer and investors*. Within this branch different methods are discussed in order to reduce this “market imperfection”. Signaling models e.g. by ALLEN/FAULHABER (1989), GRINBLATT/HWANG (1989) or WELCH (1989) suggest that from the level of underpricing investors can draw conclusions about the quality of the issuing companies.³⁰ CARTER/MANASTER (1990) and BOOTH/SMITH (1986) however emphasize the signaling and certification-of-quality role fulfilled by prestigious underwriters, the like goes for auditors and venture capitalists. In the following I will concentrate on the latter explanatory approach.

The certification mechanism works according to the subsequent principle: Given that outside investors believe in the information advantage of a third party (underwriter or venture capitalist), this party is able to certify the quality of a company going public if it has reputational capital at stake, “which must be greater than the largest possible one-time wealth transfer or side payment which could be obtained by certifying falsely. Furthermore it must be costly for the issuing firm to purchase the service of the certifying agent.” (MEGGINSON/WEISS (1991, p. 881))

³⁰ The authors hypothesis is, that given companies plan to carry out a seasoned equity offering, a separating equilibrium of high- and low-value firms exists, permitting high-value firms to costly signal their quality by underpricing. JENKINSON/LJUNGQVIST (2001) criticize, that the whole mechanism of the models using the level of underpricing as signal depends on a two-stage selling decision, which has to preclude shareholder’s pre-emptive rights to seasoned offerings of primary equity, in order to recoup the costs of the signal.

Underwriters and venture capitalists should be able to carry out the role of a certifying authority, as they often have insider information. The underwriting bank's information results from the involvement in due diligence activities and a potential lending relationship³¹ prior to the IPO. Their incentive to examine the quality of the firm in detail goes back to their liability extending to statements made in the issuing prospectus.³² Since venture capitalists belong to the actively engaged group of owners, they have profound knowledge about the company's history, quality of management, financial situation and so on. Moreover they involve themselves merely out of self-interest, due to the circumstance that their compensation is linked to the partnership's performance.

Both parties have reputational capital at stake as their future success is closely linked to their current reputation. The better the reputation, the easier the attention of trading partners can be caught: Underwriters regularly have to attract issuers and venture capitalists frequently have to raise new funds.

One can therefore conclude that the involvement of a prestigious underwriter or venture capitalist should certify and credibly signal the quality of the issuing company to the market. I thus assume that it should pay to hire a prestigious intermediary, as it leads to a higher offer price, which in turn implies lower underpricing.

Going back to ROCK (1986), CARTER/MANASTER (1990) and BOOTH/SMITH (1986) the following hypotheses are formulated:

1. The higher the ex-ante uncertainty concerning the issue (*vola*), the higher the expected underpricing.
2. The more prestigious the underwriter (*UWrank*) involved in the IPO, the lower the underpricing.
- 3a. The more prestigious the venture capitalist backing the company before the IPO (*VCrank*), the lower the underpricing.

Because the incentive to engage in the venture-backed company and thus the informative value of the signal "backed by a prestigious venture capitalist" depends in particular on the

³¹ For an extensive discussion of the characteristics of relationship lending in Germany see ELSAS (2001).

³² It has to be mentioned that this liability can lead to a considerable litigation and thus lawsuit risk. Therefore a competitive approach e.g. by TINIC (1988) suggests, that intentional underpricing may serve as an insurance against such securities litigation. For counterarguments see ALEXANDER (1993).

venture capitalist's equity holdings prior to the IPO³³, hypothesis 3a should be narrowed down:

- 3b. The more prestigious the venture capitalist and the bigger the venture capitalist's equity holdings of the issuer prior to the going public (*VCstake*), the lower the underpricing.

Following BARRY (1989) a focus on underpricing alone possibly misleads: Underpricing per se is uninformative when not controlling for the former shareholders' incentives to influence underpricing. They will take influence on the pricing of an issue if their wealth is negatively affected by the price setting. Figuratively spoken, entrepreneurs and venture capitalists will not care for the wealth loss occurring through underpricing when selling a single share, but they will care the higher their participation in the offering, i.e. the more shares they sell at the IPO.³⁴

In line with this hypothesis 4 is introduced:

4. The higher the participation ratio (*participation*) of former shareholders (e.g. venture capitalists or managers, respectively) the lower the underpricing.

HABIB/LJUNGQVIST (2001)³⁵ and LJUNGQVIST (1999) extend this idea and model underpricing as endogenous to the problem of minimizing the former shareholder's total wealth loss when going public. They assume that the wealth loss of former shareholders at the IPO is a function of a.) underpricing, when selling old shares, b.) the dilution of the value of retained shares³⁶ and c.) costs arising in connection with activities that reduce underpricing and wealth losses, such as extensive marketing efforts prior to the IPO.

What follows is that there is a trade-off for such shareholders between investing in costly actions to reduce underpricing and tolerating higher underpricing. In order to take the endogenous relation between the direct non-underwriting costs (*exp*) (normalized by the issuing volume) and underpricing into account, I apply a two-stage least squares approach.³⁷

³³ This is in line with earlier findings of BARRY ET AL (1990).

³⁴ The participation ratio (*participation*) is calculated dividing the number of old shares sold by the number of shares outstanding before flotation.

³⁵ In the appendix I present the underlying model by BARRY (1989) and the extension by HABIB/LJUNGQVIST (2001).

³⁶ The dilution factor (*dilution*) is determined dividing the number of new shares by the number of shares outstanding before flotation. In line with LJUNGQVIST (1999) the dilution factor is taken into account, as well, when running the regressions. However, the predicted sign of this parameter is unclear.

³⁷ The estimation method solves the problem of the ordinary least square approach that "least square estimates are inconsistent estimates of a structural equation precisely because they are consistent estimates of a mixture of all the equations in the model included" (see GREEN (1997), p. 736).

For this technique an instrumental variable is needed, which is correlated with the costs, but not with underpricing. I choose to use the log of the issuing volume (*ln_volume*) for this purpose.

5. Data Set and Design of Analysis

In total the collected data set contains 353 companies. Each of these companies was listed for the first time during the period of March 10th, 1997 to March 10th, 2002 on the Neuer Markt. The employed sample (comprising 300 IPOs) does not contain those 28 companies that merely changed the market tier or had already been listed at a foreign stock exchange before going public at the Neuer Markt.³⁸ In addition, four companies from the financial services industry were excluded due to extraordinarily high values for the book value of assets or the issue volume.³⁹ Finally, another 21 companies could not be taken into consideration, since the issuing prospect was missing (in one case) or the total flotation costs were not available.

Given the differences in the definition of venture capital in the US and Germany, I establish comparability of the empirical studies by dividing the Neuer Markt data set into three groups: 160 non venture-backed IPOs (53.33%), 79 venture-backed IPOs (26.33%) and 61 companies (20.33%)⁴⁰, that merely received bridge financing by investors. As the latter investors typically have not invested seed, start-up and expansion capital next to bridge financing and therefore engage themselves at a rather late stage of the development of a company, the division made can be justified by the assumption that monitoring activities and thus the insider knowledge of these investors is of lower quality and thus of less worth with respect to their certification ability.⁴¹

³⁸ The following 28 companies have therefore been excluded: BB Biotech, BB Medtech AG, Bertrandt AG, Bipop-Carire S.p.A., Broad Vision Inc., COPE Inc., COR AG Insurance Technologies, Cybernet Internet Services International, Inc., Dialog Semiconductor Plc., DICOM Group, ebookers.com Plc., Electronics Line Ltd. (EL), Eurofins Scientific S.A., Fortec Elektronik Vertriebs AG, GfN AG, integra S.A., LHS Group Inc., Lösch AG, Lobster Technology Holding AG, Micronas Semiconductor Holding AG, Mühl Product & Services AG, Pankl Racing Systems AG, Pfeiffer Vacuum Technology AG, Quiagen N.V., SCM Microsystems Inc., Sero AG, TEAM Communications Group Inc. and TIPTEL AG.

³⁹ These companies are ConSors Discount Broker, Comdirect AG, Direkt Anlage Bank AG and Entrium Direct Bankers AG.

⁴⁰ The sum of companies in the VC- and bridge financed group is lower than the number of venture-backed IPOs indicated by Deutsche Börse AG. The reason for this is that some of the backed IPOs have received equity as indicated by Deutsche Börse AG, which can neither be called venture capital nor private equity (including bridge financing). Instead, the capital these companies received was offered by investment companies, e.g. by DEKA mbH., Rothschild Asset Management Ltd. or Invesco, without a selling intent. These IPOs have not been considered as backed IPOs.

⁴¹ In order to find support for this assumption the monitoring skills of venture capitalists in comparison to those of bridge financiers are examined in more detail using proxies such as: the fraction of the issuing firm's shares owned by the venture capitalist/bridge financier or the length of time that a venture capitalist/bridge financier has served on the supervisory board, see table 4.

In the descriptive study I therefore separately compare the venture-backed group and the sub sample of companies that received bridge financing to the non-venture backed group.⁴² Because of the focus on venture capitalists and their certification role, I concentrate on the venture and non venture-backed sub samples when testing the hypotheses.

Detailed information was collected from the issuing prospectus for each IPO on the total volume of issues, the issuing procedure, the offering expenses, the number of shares outstanding, the age of the company, the number of employees, the ownership structure, who is members of the “Aufsichtsrat”, the identity of invested venture capitalists or rather private equity companies and underwriters, and data of the financial statements.

Additionally, further information was obtained through the media such as the first day of trading, the book-building spread, the initial offering price and the closing day bid price for the first day and 20 days after the IPO and information on the over-allotment option exercise (greenshoe).

To clearly identify the VC-firms and private equity companies and their age, internet pages and company reports (if available), as well as the list of the full members of Bundesverband Deutscher Kapitalbeteiligungsgesellschaften – German Venture Capital Association e.V. (BVK) and the European Venture Capital Association (EVCA) were used.

For the construction of the underwriter’s rating the information needed on lead management at all Frankfurt stock market segments since 1990 was provided by Deutsche Börse AG.

A total of 104 different underwriters (45 different *lead* underwriters) have been involved in IPOs at Frankfurt stock exchange from March 1997 to March 2002.⁴³ Because of the changing or rather increasing issuing activity during that time period I construct a rating for each year⁴⁴. That is because the rating of an underwriter can change over time. The data of banks that merge during the investigation period (such as Bankhaus Gontard and Metallbank or Bayerische Vereinsbank and Bayerische Hypotheken- und Wechselbank) are aggregated in order to avoid major changes in the rating. However, changes in rating are desired in case of a relative increase of the issuing activity or a relative increase of the underwritten volume of

⁴² For the results of the tests (for equality of means (t-test) and equality of median (Mann-Whitney) see table 3, 4 and table 6.

⁴³ WASSERFALLEN/WITTELEDER (1994) stress the dominant role of Deutsche Bank in the underwriter market during the time period 1961 to 1987, since Deutsche Bank has functioned as lead manager for almost 60% of the issues. This has changed during the time period 1990 to 2000. Although Deutsche Bank still belongs to the top issuers, their supremacy in underwriting has relatively been decreasing.

⁴⁴ Table A.2. presents the twelve best-rated underwriters serving as lead underwriter at Neuer Markt during the time period 1997 – 2002.

issues. The parent population is divided into seven rating categories and condensed to a dummy in the regressions.⁴⁵ In detail, the ratings of the years 1998, 1999, 2000 and 2001 are constructed using equally the track record of each underwriter as gauged by the relative share of lead management at all Frankfurt stock market segments since 1990⁴⁶ and the relative volume of proceeds of launched issues at the Neuer Markt⁴⁷ as reported on December 31st of the precedent year. Due to the lack of a track record of the relative volume of launched issues at the Neuer Markt for the year 1997, the rating of 1997 is solely based on each bank's relative share of lead management at all Frankfurt stock market segments since 1990.

However the rating that represents the quality of the venture capitalists and private equity companies is mainly based on the age of the company. VC and private equity companies founded before 1980 receive a very good rating (equivalent to 1), companies founded during the period 1980 to 1995 receive a mediate rating (equivalent to 2). Companies founded after 1995 get the lowest rating (equivalent to 3). For some companies it was impossible to find information regarding their age. In these cases the assumption of little prestige resulting in a low rating (equivalent to 3) seems to be reasonable. The motive for using first of all the age as proxy for reputation is that in general there is a lack of a past performance. This fact is reflected in a total of 148 venture funds/companies⁴⁸ or private equity companies backing 140 IPO firms: 99 of these (66.90%) back only one IPO firm, 34 (23%) back up to 4, and only 15 (10.1%) back more than 5, up to 21 IPOs during the time period March 1997 – March 2002. Thus only in six cases⁴⁹ a relative high backing activity leads to an upgrade in rating during the period under consideration. In analogy to the underwriters' rating, the information concerning the quality of the lead venture capitalist is condensed to a dummy in the regressions.⁵⁰

⁴⁵ The dummy has the value one in case the underwriter's rating is very good; in any other case (1.5, 2, 2.5 or 3, 3.5 and 4) the dummy is equivalent to zero. From 300 IPO companies under consideration, 102 have been underwritten by a prestigious lead underwriter rated very good.

⁴⁶ The relative share of lead management at all Frankfurt stock market segments for each year is calculated by cumulating the number of lead management for each bank since 1990 and dividing this number by the cumulated number of IPOs that took place since 1990.

⁴⁷ In order to calculate the relative volume of issues at the Neuer Markt for each bank I cumulate the volume of issues in €million each bank has underwritten (as lead- or co-underwriter) since 1997 and divide it by the total volume of issues in €million of all IPOs at the Neuer Markt since 1997.

⁴⁸ Only a third of these are member of the BVK.

⁴⁹ These financial intermediaries have been Advanced European Technologies N. V., Commerz Unternehmensbeteiligungs AG, TFG Venture-Capital AG & Co. KGaA Unternehmensbeteiligungsgesellschaft, Gold Zack AG, TVM Techno Venture Management GmbH and Schroders Ltd.

⁵⁰ The dummy is equal to unity if the financier's rating is very good (this is the case for 29 out of the 79 venture-backed IPOs or rather for 10 IPOs out of 61 backed by bridge financing); in any other case (2 or 3) the dummy is equivalent to zero. (Table A.3. in the appendix presents the twelve best rated venture capitalists during the time period March 1997 - March 2002).

In line with LJUNGQVIST (1999), the venture capitalist with the biggest stake (which usually corresponds with the longest investment horizon within the portfolio company) is defined as the lead venture capitalist. 81 of the 148 venture funds/companies or private equity companies act as lead financier, whereas the remaining 67 merely engage themselves within a syndicate.

6. Descriptive Statistics

In terms of *issuer characteristics* (see Table 3), venture-backed companies differ most from non-venture backed with regard to EBIT (earnings before interest and tax) in thousand EURO per employee and profit on sales. Both ratios are on average significantly smaller: -11 versus 24, and -44 versus -5. Given no significant differences in the number of employees, in age and balance sheet total, there seems to be evidence that these otherwise comparable IPO companies are less profitable when going public. This is remarkable.⁵¹

At the first glance the findings concerning *offerings characteristics* are in line with the results of LJUNGQVIST (1999). Venture-backed companies sell significantly more old shares when going public than non venture-backed companies. This is reflected by an average of 20.49% versus 13.20% of secondary sales of the total volume issued, and by an on average higher participation ratio of old stockholders (10.33% versus 5.22% of the shares outstanding before flotation). But – and that might have a reversal effect to venture-backers being more concerned with pricing – the average and median participation ratio of managers in venture-backed IPOs is significantly lower. To keep an eye on that and to differentiate between different groups of former stockholders, such as venture capitalists, managers and underwriters owning shares of the issuing company before the IPO seems to be worthwhile when running the regressions.⁵²

Furthermore, the univariate analysis shows that venture-backed companies neither do seem to be less underpriced nor invest more money in marketing activities or the hiring of an expensive underwriter compared to those, which are non venture-backed. For both of the samples an underpricing of about 50% and a gross spread of about 5% can be reported (see Table 3).

⁵¹ See also RITTER/WELCH (2002, p. 1801). They mention that “[...] during the bubble, firms with no immediate prospect of becoming profitable became common.”

⁵² These groups do overlap as venture capitalists sometimes belong to the management.

Table 3: Issuer and Offering Characteristics and Costs of Venture-Backed respectively Bridge Financed Companies to Non Venture-Backed Companies Listed at the Neuer Markt.

The data set consists of 160 non venture-backed IPOs (NVC), 79 venture-backed IPOs (VC) and 61 companies (BF) that received bridge financing. The participation ratio (for instance of the manager) is calculated by dividing the number of old shares sold (by the manager) by the (manager's) number of shares outstanding before flotation. Underpricing is measured as the spread between the initial offering price and the opening price at the first day of trading. NEMAX is the stock market index of the Neuer Markt at Frankfurt stock exchange. The test for differences in means is a standard <i>t</i> -test, allowing for unequal variance. The test for differences in medians is the Kruskal-Wallis test. One, two and three asterisks indicate significance at the 10%, 5% and 1% level, respectively.						
		Obs.	Mean	<i>p</i> -value	Median	<i>p</i> -value
Employees	NVC	160	243		130	
	VC	79	223	0.6422	113	0.8214
	BF	60	132	0.0182**	64	0.0004***
Age of company	NVC	160	11.5		9.5	
	VC	79	10.5	0.5458	8.0	0.4023
	BF	61	9.5	0.1613	7.0	0.1735
Balance sheet total, in million €	NVC	160	34.3		15.0	
	VC	79	29.2	0.5359	12.4	0.5200
	BF	61	13.8	0.0057***	8.5	0.0009***
EBIT in thousand € per employee	NVC	160	23.9		8.4	
	VC	79	-10.8	0.0009***	-7.3	0.0000***
	BF	59	-11.9	0.0048***	0.6	0.0001***
Profit on sales in % = EBIT in thousand € per sales revenues in thousand €	NVC	158	-5.14		6.59	
	VC	77	-44.40	0.0010***	-7.39	0.0000***
	BF	59	-38.31	0.0086***	0.64	0.0000***
Issuing proceeds incl. greenshoe option in million €	NVC	160	82.67		38.24	
	VC	79	62.55	0.4646	47.60	0.1510
	BF	61	43.64	0.2107	30.26	0.0334**
Old stocks sold in % of total volume of issues	NVC	160	13.20		7.33	
	VC	79	20.49	0.0013***	18.35	0.0016***
	BF	61	12.85	0.8764	9.96	0.8639
Participation old stockholders	NVC	160	5.22		2.39	
	VC	79	10.33	0.0000***	7.49	0.0002***
	BF	61	5.15	0.9373	3.95	0.6874
Participation managers	NVC	160	3.39		1.78	
	VC	78	1.26	0.0243**	0.24	0.0042***
	BF	61	1.42	0.0596*	0.00	0.0026***
Underpricing in %	NVC	160	48.38		17.50	
	VC	79	52.44	0.6962	24.00	0.2528
	BF	61	50.17	0.8738	18.43	0.5411
Relative direct costs	NVC	160	8.82		8.09	
	VC	79	8.68	0.7573	8.08	0.9287
	BF	61	9.35	0.2849	8.94	0.0597*
Relative underwriting fees (Gross spread)	NVC	160	5.31		5.17	
	VC	79	5.12	0.2741	5.13	0.4970
	BF	61	5.30	0.9469	5.37	0.0988*
40 day log return of NEMAX before IPO ln %	NVC	160	2.56		-3.63	
	VC	79	5.77	0.3501	0.36	0.3489
	BF	61	0.55	0.5973	-5.44	0.4934

Before turning to the empirical results I will briefly highlight some further characteristics of venture-backed companies that distinguish them from those which received bridge financing and justifies the three categories made: On average about two thirds of the VC-backed companies have been financed by a syndicate before the IPO,⁵³ whereas issuing companies that received bridge financing dealt with more than one bridge financier only in one out of three cases (not reported).

Table 4: Characteristics of Financial Intermediaries and Offering Characteristics of Venture-Backed and Bridge Financed IPO Companies at the Neuer Markt.

The data set consists of 79 venture-backed IPOs (VC) and 61 companies (BF) that received bridge financing. The participation ratio (e.g., of the lead venture capitalist or bridge financier, respectively) is calculated by dividing the number of old shares sold (by the lead venture capitalist or bridge financier, respectively) by the (lead venture capitalist's and bridge financier's respectively) number of shares outstanding before flotation. The test for differences in means is a standard <i>t</i> -test, that allows differences in variance. The test for differences in medians is the Kruskal-Wallis test. One, two and three asterisks indicate significance at the 10%, 5% and 1% levels, respectively.						
		Obs.	Mean	<i>p</i> -value	Median	<i>p</i> -value
Number of venture capitalists or bridge financiers forming a Syndicate	VC	79	2.68	0.0000***	2.00	0.0000***
	BF	61	1.36		1.00	
Stake of lead venture capitalist/ lead bridge financier before IPO, in %	VC	78	27.10	0.0000***	22.55	0.0000***
	BF	61	11.32		9.40	
Stake of venture capitalists/ bridge financiers before IPO, in %	VC	79	40.31	0.0000***	36.00	0.0000***
	BF	61	12.80		10.00	
Stake of lead venture capitalist/ lead bridge financier after IPO, in %	VC	78	15.54	0.0000***	12.90	0.0000***
	BF	61	6.87		4.89	
Stake of venture capitalists/ bridge financiers after IPO, In %	VC	79	23.14	0.0000***	21.36	0.0000***
	BF	61	7.91		6.30	
Participation venture capitalists/ bridge financiers	VC	79	17.89	0.3934	16.67	0.0689*
	BF	61	21.44		8.24	
Seats on the "Aufsichtsrat" held by venture capitalists Or bridge financiers, in %	VC	79	26.52	0.0000***	33.33	0.0001***
	BF	61	13.46		0.00	
Duration of financial relationship in months	VC	78	30	0.0000***	23	0.0000***
	BF	59	7		6	
Dummy rating of lead venture capitalist/ bridge financier = 1	VC	79	39.24	0.0064***	0.00	0.0068**
	BF	61	18.03		0.00	

⁵³ On average a venture-backed company is financed by about three (see table 4), on maximum by twelve different venture firms/funds.

As can be seen in Table 4, compared to the stake of the lead venture capitalist that of the lead bridge financier is on average significantly higher before (27.10% versus 11.32%) and also after the IPO (15.54% versus 6.87%)⁵⁴. This fact is all the more true for the average stake of the syndicate of venture capitalists compared to the stake of the group of bridge financiers (before the IPO 40.31% versus 12.80%; after the IPO 23.14% versus 7.91%). In addition, both groups of financial intermediaries sell on average about 20% of their pre-IPO stake at the IPO which seems to be much higher than in the United States.⁵⁵

Furthermore, venture capitalists are more likely to command over more inside information than bridge financiers, since the former hold an average of 26.52%⁵⁶ versus 13.46% of the seats on the “Aufsichtsrat”. Besides venture capitalists have engaged themselves much longer in the issuing company before the IPO, namely about two years longer on average. And finally on average about 37% of the VC-backed sample are backed by a venture capitalist rated very good, while this is in only 16% the case within the sample containing IPOs backed by financial intermediaries offering private equity.

Taking the proportion of ownership and degree of insider knowledge into account the bridge financiers’ certification ability seems to be modest. Therefore the results presented in the following are dispensed with the bridge financed sub sample.

7. Empirical Results

The determinants of underpricing are examined applying a two-stage least square approach.

In order to measure the ex-ante uncertainty concerning the value of an IPO company three different proxies are used: Similar to e.g. RITTER (1984), WASSERFALLEN/WITTLER (1994) and PRABHALA/PURI (1998) for each IPO company the annualized volatility of the 20 daily returns from day 1 to 21 (*vola*) are calculated, which I expect to reflect the degree of dispersed information or rather uncertainty. Theory predicts a positive relation between uncertainty and underpricing. Since this proxy might be distorted due to underwriter price support in the aftermarket (see LJUNGQVIST (1997)) the log of the number of employees

⁵⁴ The numbers are much higher compared to those stated by BARRY ET AL. (1990) or HAMAQ/PACKER/RITTER (2000).

⁵⁵ According to a study by BARRY ET AL. (1990) US venture capitalists own on average 34.3% prior and 24.6% after the IPO, thus they sell on average only 6.6% of their pre-IPO shares.

⁵⁶ This number is lower as the one reported by BARRY ET AL. (1990).

(*empl*) is included, as well. Large companies that go public and employ many people should be less underpriced than small companies.⁵⁷

Following LJUNGQVIST/JENKINSON (2000) and LOUGHRAN/RITTER (2002), I calculate to what extent the book-building range (*bookb*) was exhausted. Issues priced at the maximum price limit, exhausting 100% of the book-building range, should be more underpriced compared to IPOs with an issue price that falls within the book-building range or below the minimum price limit.

Besides I use the market trend, a proxy LÖFFLER (2000) and earlier UHLIR (1989) employed in their examination of underpricing. The market trend is estimated using the NEMAX⁵⁸ for the period forty days before the IPO (*nemax*). As LÖFFLER documents, there seem to exist (psychological/market) factors that lead to a significant positive relation between the trend of the Nemax and the degree of underpricing. Moreover in order to consider the different periods the data set is covering, i.e. a bull-market followed by a bear-market, a dummy (*bear-market*) is introduced. The dummy is equal to unity, given the IPO took place after the 10th of March 2000.

One can either apply a dummy for “backed by venture capital” or less condensed information, i.e., the percentage of the venture capitalists’ equity holdings prior to the IPO (*VCstake*). Since it should make a difference whether a venture capitalist holds for instance 5% or 50% of a company prior to IPO, (as explained in section 4, see hypothesis 3b) I will use the latter.

For the calculation of the non-underwriting costs of the going public process (*exp*) I use the log of the issuing volume (*ln_volume*) as instrumental variable, i.e. it should be correlated with *exp* but not with *underpr*. Moreover, in line with HABIB/LJUNGQVIST (2001) and LJUNGQVIST (1999) I control for the participation ratio (*participation*), that is the fraction of shares former shareholder sell in the offering and the dilutions factor (*dilution*), which is determined as the number of new shares divided by the number of shares outstanding before flotation.

With reference to the hypotheses discussed in section 4 and taking the trade-off between investing in costly actions that reduce underpricing and tolerating underpricing into account, this leads to the following system of regressions (regression coefficients with a positive predicted sign are written in bold letters):

⁵⁷ I also checked whether the age or the total volume of assets could serve as an explanatory variable for the amount of underpricing, but found no significant correlation.

⁵⁸ NEMAX is the stock market index of Neuer Markt at Frankfurt stock exchange. The introduction of this variable does not affect the other results found.

$$\begin{aligned} \text{underpr} = & \alpha_0 + \alpha_1 \text{vola} + \alpha_2 \text{bookb} + \alpha_3 \text{empl} + \alpha_4 \text{nemax} + \alpha_5 \text{bear-market} + \alpha_6 \text{Uwrank} \\ & + \alpha_7 \text{VCrank} + \alpha_8 \text{VCstake} + \alpha_9 \text{participation} + \alpha_{10} \text{dilution} + \alpha_{11} \text{exp} + \mathbf{e}_1 \end{aligned}$$

$$\text{exp} = \beta_0 + \beta_1 \text{participation} + \beta_2 \text{dilution} + \beta_3 \text{ln_volume} + \beta_4 \text{underpr} + \mathbf{e}_2$$

The estimation results are presented in Table 5.

First of all I have to remark, that there is no evidence for a trade-off between non-underwriting costs (*exp*) and underpricing. In both regressions the variable under consideration (*underpr* and *exp*, respectively) lacks of significance. What follows is that there seems to be no trade-off for issuers at the Neuer Markt between investing in costly actions to reduce underpricing and tolerating higher underpricing.

However, with regard to the regression for the normalized direct non-underwriting costs (*exp*), it can be stated that in line with the findings by HABIB/LJUNGQVIST (2001) the former shareholders (see column IV and V) seem to spend more on non-underwriting costs the more shares they sell, i.e. the more they participate in the offering. In contrast to the study by HABIB/LJUNGQVIST I find the normalized non-underwriting costs to be significantly *negatively* related to the ratio of new shares divided by the number of shares outstanding before flotation. The explanation for that might be similar to that for the regressor *ln_volume*. On average there are economies of scale. The higher the issuing volume the lower the amount of non-underwriting expenses per unit of issuing proceeds.

My findings regarding the underpricing regressions do not support the concepts of BARRY (1989), HABIB/LJUNGQVIST (2001), and LJUNGQVIST (1999) (see hypothesis 4) that former shareholders selling large fractions of their pre-IPO assets do particularly care for the pricing. Due to the availability of data I could control for the incentives of the group of the former shareholders as a whole, for the managers (not reported) and venture capitalists (see columns III and VI) separately. But since the variables *participation* and *dilution* lack of significance - irrespectively of the identity of the group controlled for - I am not able to find evidence for underpricing to be lower due to incentives of former owners with a high selling intensity at the IPO.

Also, concerning the certification role of venture capitalists and underwriters, I do not find any support either for hypotheses 2 or 3. On the contrary, companies that are backed by a prestigious venture capitalist experience *greater* underpricing: The coefficient *VCrank=1* is positive and significant at the 5% level. Remarkably, there is no significant outcome when

Table 5: Test of the Certification Hypotheses (I)

In the following a two-stage least square approach is applied. The dependent variables are underpricing (*underpr*) and the normalized non-underwriting costs (*exp*). The variable *vola* is equivalent to the annualized volatility of the 20 daily returns from day 1 to 21, *empl* represents the log of the number of employees, *bookb* reflects the extend to which the book-building range was utilized, *nemax* incorporates the market trend forty days before the IPO. The dummy *bear-market* is equal to unity, given the IPO took place after the 10th of March 2000. The variables *UWrank=1* and *VCrank=1* are dummies for underwriters and venture capitalists rated very good. *VCstake* presents the venture capitalist's equity holding prior to the IPO, *participation* and *dilution* are explained in footnotes 33 and 35, respectively. Throughout, the inference is based on White's heteroskedasticity-consistent standard errors. One, two and three asterisks indicate significance at the 10%, 5% and 1% level, respectively.

	I (1) <i>underpr</i>	II (2) <i>underpr</i>	III (3) <i>underpr</i>	IV (1) <i>exp</i>	V (2) <i>exp</i>	VI (3) <i>exp</i>
Variables:						
<i>constant</i>	0.389 <i>0.3292</i>	0.403 <i>0.3098</i>	0.464 <i>0.2130</i>	4.428*** <i>0.0000</i>	4.412*** <i>0.0000</i>	4.110*** <i>0.0000</i>
<i>vola</i>	0.295*** <i>0.0049</i>	0.294*** <i>0.0053</i>	0.299*** <i>0.0078</i>			
<i>empl</i>	-0.083* <i>0.0795</i>	-0.083* <i>0.0766</i>	-0.083* <i>0.0755</i>			
<i>bookb</i>	0.165** <i>0.0349</i>	0.152** <i>0.0476</i>	0.152* <i>0.0502</i>			
<i>Nemax</i>	1.288*** <i>0.0000</i>	1.298*** <i>0.0000</i>	1.303*** <i>0.0000</i>			
<i>bear-market</i>	-0.137 <i>0.1157</i>	-0.156* <i>0.0753</i>	-0.150* <i>0.0718</i>			
<i>UWrank=1</i>	0.048 <i>0.5917</i>	0.044 <i>0.6086</i>	0.047 <i>0.5940</i>			
<i>VCrank=1</i>	0.310** <i>0.0350</i>	0.768** <i>0.0105</i>	0.708** <i>0.0183</i>			
<i>VCstake</i>	-0.395** <i>0.0350</i>	-0.284 <i>0.1275</i>	-0.250 <i>0.2854</i>			
<i>participation_Old</i>	0.022 <i>0.9674</i>	0.054 <i>0.9166</i>		1.349* <i>0.0527</i>	1.348* <i>0.0526</i>	
<i>dilution_Old</i>	0.241 <i>0.4398</i>	0.245 <i>0.4302</i>		-0.938*** <i>0.0013</i>	-0.939*** <i>0.0013</i>	
<i>participation_VC</i>			-0.091 <i>0.8829</i>			0.762 <i>0.4316</i>
<i>dilution_VC</i>			0.023 <i>0.6427</i>			-0.059 <i>0.1470</i>
<i>ln_volume</i>				-0.238*** <i>0.0000</i>	-0.237*** <i>0.0000</i>	-0.232*** <i>0.0000</i>
<i>underpr</i>				0.074 <i>0.4779</i>	0.079 <i>0.4387</i>	0.092 <i>0.3682</i>
<i>Exp</i>	0.057 <i>0.7683</i>	0.044 <i>0.8194</i>	0.059 <i>0.7720</i>			
Interaction term: <i>VCrank=1 * VCstake</i>		-1.278** <i>0.0309</i>	-1.190** <i>0.0422</i>			
Adj. R ²	32.13%	33.08%	32.73%	14.35%	14.25%	8.46%
Number of observations	238	238	238	238	238	238

controlling for venture capitalists with a lower rating (not reported). However, the effect found seems to be obscured: When interacting the dummy for the rating of prestigious venture capitalists with the percentage of the venture capitalists' equity holdings prior to the IPO, this interaction term is negative and significant. But, in addition I do find an increase of the positive coefficient for prestigious venture capitalists. What follows, is that overall venture-backed issues appear, if anything, to be *more* underpriced.

This is in line with the results of LJUNGVIST (1999) for the 1990's and those of FRANCIS/HASAN (2001) and SMART/ZUTTER (2000). Though it is in contrast with the results of LIN/SMITH (1998) or BARRY ET AL. (1990). The latter empirical studies show that the higher the venture capitalist's reputation (measured for example by the venture capitalist's age and the former backing activity), the lower the underpricing. I have re-estimated the regression using other factors that usually serve as proxies for the monitoring or backing-quality of venture capitalists, such as the natural logarithm of the age of the lead venture capitalist at IPO, the number of seats on the "Aufsichtsrat" held (in percent) and the age of the financial relationship. Unfortunately I did not get any further insights. Since the venture capitalists' rating is mainly based on the age of the lead venture capitalists, it is not astonishing that this coefficient behaves equivalent to the dummy for the VC-rating: it is positive and significant. Concerning the other two coefficients, they are not statistically significant.

With regard to the marginal effect of underwriter reputation I have to observe a general lack of significance of the coefficients. This suggests that companies, that have hired a prestigious lead underwriter when floating stocks are not better off than others. This result corresponds to earlier findings of KASERER/KEMPF (1995) for the German market. As expected, I obtain the same result when adding a term to the regression that interacts the rating of the underwriter with that of the venture capitalist (not reported).

However, I find that all parameter estimates that represent the degree of ex-ante uncertainty (*vola*, *bookb*) or size (*empl*) show the predicted signs on a significant level. The smaller the issuing company and the annualized volatility of the 20 daily returns from day 1 to 21, the higher the underpricing. In addition, the more the book-building range was exhausted, the higher the underpricing. These results are in line with earlier studies on the German market, such as WASSERFALLEN/WITTELEDER (1994). The highly significant coefficient for the market trend (*nemax*) supports the findings of LÖFFLER (2000): The initial return rises on average about 1.29% to 1.30% with each percentage point the log return of the Nemax is rising prior

to the IPO. Moreover, I do find evidence that the point in time a company went public had an influence on the level of underpricing. Companies going public in bear-markets, i.e. after March 10th, 2000, showed on average a lower underpricing.

In summary, no certification effect at the IPO could be found for venture capitalists or underwriters. Furthermore, there is no evidence that former stockholders selling shares at the IPO are particularly concerned about wealth loss and thus take influence on the pricing of an issue. Only hypothesis (1), which offers ex-ante uncertainty as a factor that determines underpricing finds considerable support.

Extensions

The question is why issues backed by prestigious venture capitalists appear to be *more* underpriced.

It seems to be puzzling, but similar results have been found before. FRANCIS/HASAN (2001) analyze a data set of companies going public in the United States during the period 1990 – 1993 using a stochastic frontier model. They show that VC-backed IPOs suffer higher underpricing due to greater pre-market pricing inefficiencies, which are to a significant part deliberate and should compensate investors for information production. The study by SMART/ZUTTER (2000) examines dual- and single-class IPOs and indicates underpricing to be more pronounced among VC-backed companies, too. They attribute this result to the circumstance that an increasing number of IPO companies has been financed by younger VC companies, that possibly engage in “grandstanding”⁵⁹ by taking their companies earlier to the market and at a larger discount than do established VCs.

LJUNGQVIST (1999), who analyzes a 1990s data set of IPOs, finds evidence that top underwriters are associated with significant increases in underpricing. An effect, which is in particular concentrated amongst venture-backed IPOs. But why do venture capitalists choose to work with prestigious investment banks whose pricing is so much worse? LJUNGQVIST offers an explanation: There are situations, that are characterized by a conflict of interest between entrepreneur and venture capitalist. He considers the case, that the entrepreneur sells some shares at the IPO but the lead venture capitalist none. In such situation the venture capitalist is *not* concerned about engaging a prestigious underwriter who underprices more

⁵⁹ For an intense study on the phenomenon “grandstanding”, see GOMPERS (1996).

than the average, since the incurring wealth losses have to be borne primarily by the selling owner rather than by himself.

In my sample, in particular IPOs backed by *prestigious* or rather older venture capitalists are considerably *more* underpriced than IPOs that belong to any other segment. On average they are underpriced by 75.32% compared to 39.16% when backed by a less prestigious, younger venture capitalist or 48.38% when non venture-backed. It is surprising as these companies seem to be relatively large with respect to employees and EBIT in thousand EURO. IPOs backed by prestigious venture capitalists (PVC) have on average 243 employees (compare Table 3) and report on average earnings before interest and tax amounting to €729 thousand⁶⁰. Moreover this result contradicts the idea of “grandstanding” and thus the explanation offered by SMART/ZUTTER (2000). It thus seems to be rather interesting to analyze, whether the significant differences in underpricing can be explained by a non-selling behavior of venture capitalists, too.

Table 6: Characteristics of IPOs Backed by Prestigious Venture Capitalists (PVC) and Those With Lower Reputation (NPVC) at the Neuer Markt

The test for differences in means is a standard <i>t</i> -test, that allows differences in variance. The test for differences in medians is the Kruskal-Wallis test. Two asterisks indicate significance at the 5% level.						
		Obs.	Mean	<i>p</i> -value	Median	<i>p</i> -value
Underpricing in %	PVC	29	78.32	0.0240**	51.97	0.0335**
	NPVC	50	39.16		11.56	
No sale venture capitalists	PVC	29	17.24	0.4874	0.00	0.4839
	NPVC	50	24.00		0.00	

The descriptive statistic shows that 24% of the prestigious and about 17% of the lowest rated venture capitalists do not sell at IPO. These are 17 out of 79 VC-backed cases in total. In column (VII) of Table 7 I re-estimated the previous regression including a dummy for venture capitalists not selling at the IPO (*nosal_VC*). Indeed, the impact of such a non-selling behavior of venture capitalists is in any case (regardless of the rating) a significant increase in underpricing. This result is robust but does not solve the original puzzle, since the coefficient for the dummy of IPOs backed by prestigious venture capitalists remains significant and positive, though smaller.

⁶⁰ Non venture-backed companies reported on average earning before interest and tax amounting to €2.830 thousand.

Table 7: Test of the Certification Hypotheses (II)

In the following a two-stage least square approach is applied. The dependent variables are underpricing (*underpr*) and the normalized non-underwriting costs (*exp*). The variable *vola* is equivalent to the annualized volatility of the 20 daily returns from day 1 to 21, *empl* represents the log of the number of employees, *bookb* reflects the extend to which the book-building range was utilized, *nemax* incorporates the market trend twenty days before the IPO. The dummy *bear-market* is equal to unity, given the IPO took place after the 10th of March 2000. The variables *UWrank=1* and *VCrank=1* are dummies for underwriters and venture capitalists rated very good. *VCstake* presents the venture capitalist's equity holding prior to the IPO, *participation* and *dilution* are explained in footnotes 33 and 35, respectively. Throughout, the interference is based on White's heteroskedasticity-consistent standard errors. One, two and three asterisks indicate significance at the 10%, 5% and 1% level, respectively. In columns VII and VIII, the effect of the presence of a prestigious venture capitalist is tested in an F-test.

Variables:	VII (1) <i>underpr</i>	VIII (2) <i>underpr</i>	X (1) <i>exp</i>	XI (2) <i>exp</i>
<i>Constant</i>	0.351 0.3654	0.336 0.3843	4.429*** 0.0000	4.403*** 0.0000
<i>Vola</i>	0.304*** 0.0039	0.309*** 0.0031		
<i>Empl</i>	-0.088* 0.0583	-0.087** 0.0616		
<i>Bookb</i>	0.185** 0.0177	0.185** 0.0206		
<i>Nemax</i>	1.248*** 0.0000	1.234*** 0.0000		
<i>bear-market</i>	-0.150* 0.0845	-0.165* 0.0627		
<i>UWrank=1</i>	0.047 0.5830	0.063 0.4674		
<i>VCrank=1</i>	0.719*** 0.0052	0.644*** 0.0058		
<i>VCstake</i>	-0.446** 0.0267	-0.462** 0.0201		
<i>Participation_Old</i>	0.396 0.4617	0.286 0.5915	1.350* 0.0527	1.347* 0.0520
<i>Dilution_Old</i>	0.263 0.3922	0.297 0.3318	-0.938*** 0.0013	-0.939*** 0.013
<i>Ln_volume</i>			-0.238*** 0.0000	-0.237*** 0.0000
<i>Underpr</i>			0.074 0.4623	0.083 0.4216
<i>Exp</i>	0.058 0.7562	0.048 0.8044		
<i>nosal_VC</i>	0.337** 0.0347	0.296* 0.0560		
<i>Conflict</i>		0.223 0.2723		
Interaction term: <i>VCrank=1 * VCstake</i>	-1.159** 0.0260	-1.004** 0.0371		
Adj. R ²	33.75%	34.05%	14.35%	14.19%
F-test: <i>VCrank, VCrank*VCstake</i>	0.0252	0.0497		
Number of observations	238	238	238	238

A further explanation why VC-backed IPOs are *more* underpriced is offered by HAMAQ/PACKER/RITTER (2000). These authors examine IPOs in Japan. In Japan, venture capital funds are often affiliated with major financial institutions. This circumstance can lead to potential conflicts of interest, since the underwriting bank, if an owner of the issuing company, is interested in setting a higher offer price than it would if it was merely acting as a financial intermediary. Furthermore, these banks have increased incentives to overstate the company value to investors. Given that IPO investors do anticipate this conflict of interest, they will, according to theory, demand more underpricing as compensation.

In line with this, HAMAQ/PACKER/RITTER find higher initial returns for IPOs in which the lead venture capitalist is also the lead underwriter.⁶¹ Although affiliations between venture capitalists and underwriting banks exist in Germany, too,⁶² they are not as common as in Japan.

I have tried to control for this phenomenon of affiliation for the German market, though I have only sixteen observations in the sample under consideration. However, the result lacks of significance and thus does not support this explanatory approach (see Table 7, column VIII).

Even though I could demonstrate that the non-selling behavior of venture capitalists drives underpricing, the appearance of IPOs backed by prestigious venture capitalists being more underpriced deserves further examinations.

Finally I would like to conclude with an illustration of the relative effect of underpricing on the venture capitalist's return on investment when selling at IPO:

A major German venture capitalist provided data on the historical costs of the shares of four IPO companies in my data set. I calculated the approximate return⁶³ from investment until IPO, using the offering price (*OP*) and the closing price (*CP*) on the first trading day.⁶⁴ As easily can be seen in Table 7, each of these investments was a success story for the venture capitalist, which partially was realized through selling at IPO.⁶⁵ But at least in the first three

⁶¹ Apart from this special case mentioned, HAMAQ/PACKER/RITTER (2000) find that VC-backed IPOs exhibit a significant reduction in underpricing relative to other issues.

⁶² Examples are Deutsche Venture Capital Gesellschaft and Deutsche Bank, Beteiligungsgesellschaft für die Deutsche Wirtschaft and Dresdner Bank AG, TFG Venture Capital and Concord Effekten AG or Commerz Unternehmensbeteiligungs AG and Commerzbank AG.

⁶³ As no information regarding the exact date of the initial investment is available, I am not able to calculate a time-adjusted return.

⁶⁴ In cases A, B and C, the offering price was fixed at the maximum price limit. In case D, which was overpriced, the offering price was fixed at the lower bound of the book-building range.

⁶⁵ As mentioned, on average venture capitalists sell 20% of their pre-IPO stake. Dividing the group into venture capitalists that sell and those that do not sell, the venture capitalists who sell shares at the IPO, sell on average about 28%. Only in one case the venture capitalist sold 100%.

cases the good result was accompanied by the knowledge, that the return on investment could have been better, if there had been no underpricing.

Table 7: Returns on Four Investments of one Major German Venture Capitalist

	A	B	C	D
Return <i>OP</i>	258%	132%	200%	519%
Return <i>CP</i>	294%	182%	530%	506%

Given, for the period under consideration the four companies above are a good example for an IPO portfolio of a venture capitalist in Germany, I would like to formulate some hypotheses, that could serve as further explanations for the findings of my empirical study and should therefore be tested in future:

Venture capitalists seem not to care particularly about underpricing, as the bad news of money left on the table comes as part of a package that includes the good news of a successful partial exit.⁶⁶ Moreover venture capitalists seem to be more concerned about the long-run performance and the timing of the further exit, since they retain on average more than three-quarters of their shares beyond the IPO-date.⁶⁷

8. Summary and Outlook

The main contribution of this empirical study is to shed further light on the growing importance of venture capital in Germany after the introduction of the Neuer Markt at the Frankfurt Stock Exchange. In particular the role of venture capitalists and underwriters in certifying the quality of a company when going public is examined.

Papers by CARTER/MANASTER (1990) and BOTH/SMITH (1986) argue, that the spread between the initial offering price and the opening price on the first day of trading (underpricing) should be lower for venture-backed IPOs compared to non venture-backed IPOs due to a reduced ex-ante uncertainty concerning the value of the issuing company.

However, to focus only on underpricing might be misleading. According to BARRY (1989) HABIB/LJUNGQVIST (2001), and LJUNGQVIST (1999) the behavior of old shareholders at the IPO is essential. The more they participate in the offering, that is the more shares they are

⁶⁶ A similar argumentation based on the prospect theory can be found by LOUGHRAN/RITTER (2002), see also KAHNEMAN/TVERSKY (1979).

⁶⁷ For empirical studies on the U.S. market see for instance BRAV/GOMPERS (1997).

selling at the IPO, the more they have incentives to take influence leading to a reduced underpricing.

When running the regressions to test the hypotheses that venture-backed IPOs are less underpriced compared to non venture-backed IPOs, I control for ex-ante uncertainty, for the market phase, for the venture-capitalists' share of the company prior to the IPO, and, taking Ljungqvist's argument into account, for the incentives of old shareholders to reduce underpricing.

Turning to the results of this study, the huge number of financial intermediaries engaged in IPOs at Neuer Markt is worth mentioning: 104 underwriters and 148 venture capitalists or rather private equity companies.

Concerning the companies that went public at the Neuer Markt, I found that VC-backed companies are less profitable compared to non venture-backed companies. Though, they are similar with respect to number of employees, age, balance sheet total or the amount of underpricing and the relative fee charge by the underwriting banks. Venture-backed firms issue significantly more old shares compared to non venture-backed ones. The fact that the group of venture capitalists sells on average 20% of their pre-IPO stake at the IPO supports this assumption.

More than two thirds of the VC-backed companies have been financed by a syndicate of venture capitalists. They seem to have considerable influence, since they hold on average a stake of about 40% of the company before the IPO and about 26.5% of the seats on the "Aufsichtsrat".

When running the regressions I consider the approach of HABIB/LJUNGQVIST (2001), who take underpricing as endogenous to the problem of minimizing the former shareholder's total wealth loss when going public. Thus, a two-stage least square approach is calibrated. However, there is no evidence for a trade-off between non-underwriting costs and underpricing. In both regressions the variable under consideration (*underpr* and *exp*, respectively) lacks of significance.

With reference to the results of the regressions, there is strong evidence that the higher the ex-ante uncertainty about the value of a company going public the higher the underpricing. Furthermore, the market trend has a non-negligible positive impact on the amount of underpricing. However, the use of this variable does not affect the other results found.

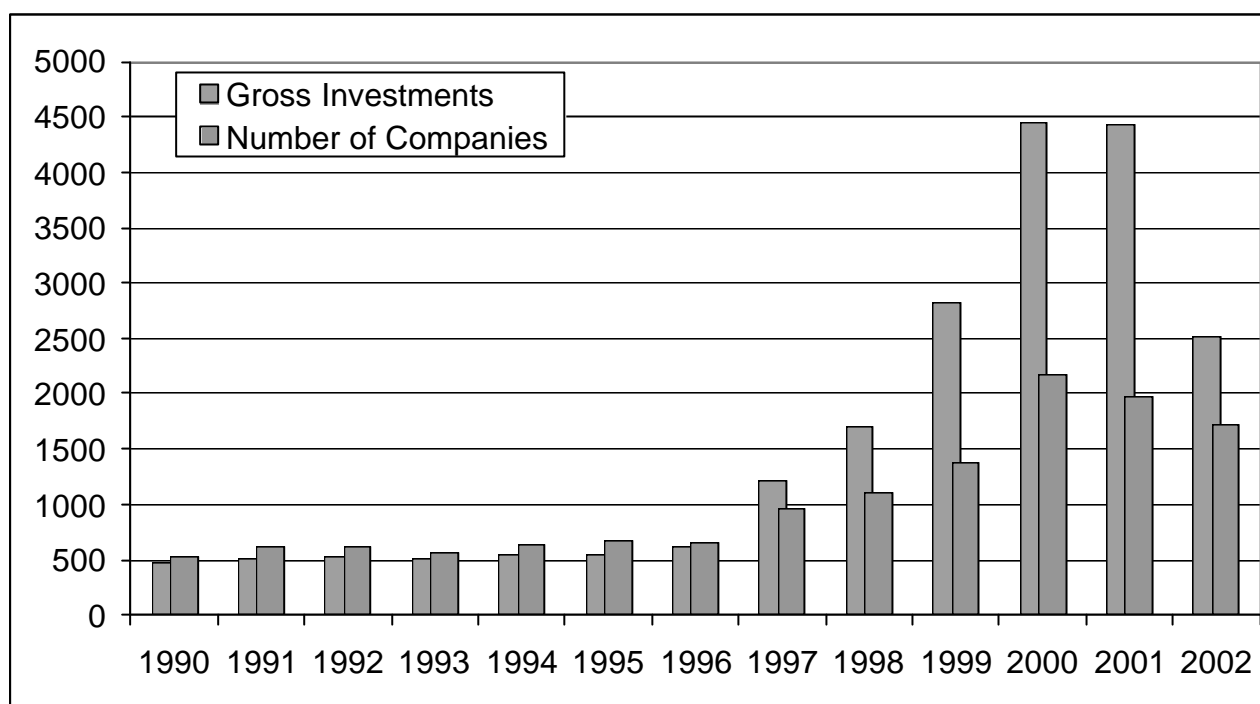
With regard to the certification role of underwriters and/or venture capitalists, I am unable to provide evidence. It does not seem to pay to hire a prestigious intermediary, at least as far as

underpricing is concerned. On the contrary: The involvement of a prestigious venture capitalist leads to a higher underpricing. This finding holds, irrespective of whether I control for venture capitalist not selling at the IPO (following the argumentation of LJUNGQVIST (1999)) or for conflicts of interest due to an affiliation of the venture capitalist and the underwriting bank (in line with HAMAQ/PACKER/RITTER (2000)). The finding that prestigious venture capitalists appear to lead to more underpricing, warrants further research.

When interpreting these results one should keep in mind that venture capitalists sell only on average about 20% of their shares at the IPO. Thus an examination of their further exit strategy would be of utmost interest. Not least as the (timing of the) exit seems to be decisive for the venture capitalist's return on investment and thus the building up of further reputation.

Appendix Figures:

Figure A.1: Development of Gross Investments of Members of the BVK (in €Mio.)
and Number of Beneficiary Companies



Appendix Tables:

Table A.1: Data Set Neuer Markt - March 10, 1997 - December 31, 2001⁶⁸

Year	Number of Venture-Backed IPOs	VC in %	Number IPOs Backed by Bridge Financing	BF in %	Number of Non Venture-Backed IPOs	NVC in %	Total
1997	3	37.50%	1	12.50%	4	50.00%	8
1998	10	27.03%	6	16.22%	21	56.76%	37
1999	30	24.79%	23	19.01%	68	56.20%	121
2000	34	27.42%	29	23.39%	61	49.19%	124
2001	2	20.00%	2	20.00%	6	60.00%	10
Total	79	26.33%	61	20.33%	160	53.33%	300 ⁶⁹

⁶⁸ There were no IPOs in 2002 until March 26.

⁶⁹ The original sample consisted of 353 issues, 53 of which had to be deleted due to either data problems, extreme values for issue size, or because the issue merely represented a change of market segment.

Table A.2: The Twelve Best Rated Underwriters Serving as Lead Underwriter at the Neuer Markt During the Time Period 1997 - 2001

This table contains the twelve best rated underwriters serving (more than 5 times) as lead underwriter at the Neuer Markt during the time period 1997 to 2001. The underwriter rating of the year 1997 is based on the relative share of lead management at all Frankfurt stock market segments since 1990; ratings of the years 1998, 1999 and 2000 are using equally weighted the track record of each underwriter concerning the relative share of lead management at all Frankfurt stock market segments since 1990 and the relative proceeds of issues launched at the Neuer Markt since 1997. A top rating is equivalent to one, the lowest rating equals the value of 4 (non rated).

Underwriter	Rating 1997	Rating 1998	Rating 1999	Rating 2000	Rating 2001
Deutsche Bank AG	1.0	1.0	1.0	1.0	1.0
Bayerische Hypo- und Vereinsbank AG (Bayerische Hypotheken- u. Wechselbank / Bayerische Vereinsbank)	1.0	2.0	1.0	1.0	1.0
Commerzbank AG	1.0	2.0	2.0	1.0	1.0
DG BANK AG	2.0	2.0	1.0	1.0	1.0
Dresdner Bank AG	2.0	1.5	1.5	1.0	1.0
BHF-Bank AG / ING Group	2.0	2.5	2.0	2.0	2.0
Goldman Sachs	3.0	3.0	2.0	1.5	1.5
West LB Girozentrale	3.0	2.5	2.0	2.0	1.5
HSBC Trinkaus & Burkhardt KGaA	3.0	3.0	3.0	2.0	1.5
Sal. Oppenheim jr. & Cie.	4.0	3.5	2.0	1.5	2.0
Credit Suisse First Boston	4.0	2.0	2.5	2.5	2.5
Gontard & MetallBank AG (Heinrich Gontard & Co. OHG/ Metallbank GmbH)	4.0	3.0	2.5	2.0	2.0

Table A.3: The Twelve Best Rated Venture Capitalists / Private Equity Companies
 Backing Companies that Went Public
 at Neuer Markt During the Period March 1997 - March 2002

The rating representing the quality of the venture capitalists and private equity companies is mainly based on the age of the company. Venture capitalists and private equity companies founded before 1980 received a very good rating (equal to 1), companies founded before 1995 and after 1980 received a mediate rating (equivalent to 2). Companies founded after 1995 got the lowest rating (equivalent to 3). Thus only in six cases (Advanced European Technologies N. V., Commerz Unternehmensbeteiligungs AG, TFG Venture-Capital AG & Co. KGaA Unternehmensbeteiligungsgesellschaft, Gold Zack AG and TVM Techno Venture Management GmbH) an relative high backing activity during the time period under consideration leads to an upgrade in rating.

VC / private equity companies	Founded in	Backed IPO companies (as Lead VC)	Rating
3i Group Plc. /3i Deutschland	1945	21 (16)	1
Apax Partners & Co. Beteiligungsberatung AG	1969	5 (2)	1
Atlas Venture Germany	1980	5 (2)	1
Deutsche Beteiligungs(gesellschaft) AG	1965	3 (2)	1
BdW Beteiligungsgesellschaft für die deutsche Wirtschaft mbH & Co. KG	1969	2 (1)	1
VC Baden-Württemberg GmbH	1970	2 (2)	1
WestKB Westdeutsche Kapitalbeteiligungs mbH	1969	2 (1)	1
Gold-Zack AG	1990	13 (12)	2 upgrade to 1 in 1999
Advanced European Technologies N.V.	1995	7 (6)	2 upgrade to 1 in 1999
TVM Techno Venture Management GmbH	1983	6 (3)	2 upgrade to 1 in 2000
Commerz Unternehmensbeteiligungs AG	1987	6 (2)	2 upgrade to 1 in 1998
TFG Venture-Capital AG & Co. KGaA	1994	5 (4)	2 upgrade to 1 in 2000

Appendix

Model of BARRY (1989), extended by HABIB and LJUNGQVIST(2001):

Consider a company that has (S_0) shares outstanding prior to going public and that issues (S_N) new shares at the IPO. In such a case the former shareholders suffer a wealth loss due to underpricing and dilution. The amount of wealth loss is inter alia dependent on the participation ratio and the dilution factor.

The participation ratio (*participation*) is the ratio of the number of old shares sold ($S_{0,s}$) to the number of shares outstanding before the flotation (S_0). The dilution factor (*dilution*) is the ratio of new shares (S_N) to the number of shares outstanding before the flotation (S_0).

$$participation \equiv \frac{S_{0,s}}{S_0} \qquad \qquad \qquad dilution \equiv \frac{S_N}{S_0}$$

Let (P_0) be the initial offer price, and let (P_1) be the opening price at the first day of trading. In an efficient-market, this opening price at the first day of trading should reflect the (unobservable) value of the company prior to the IPO ($S_0 P^*$) plus the value of the money raised through flotation (ignoring the commission and other direct costs of going public):

$$P_1 = \frac{(S_0 P^* + S_N P_0)}{(S_0 + S_N)} \qquad \text{by transformation this is equivalent to}$$

$$P^* = P_1 + \frac{S_N}{S_0}(P_1 - P_0)$$

The smaller the offering in relation to the number of shares previously outstanding, the smaller the dilution effect. Thus the aggregated wealth loss of the former stockholders per old share (*awl*) is equivalent to:

$$awloss \equiv \frac{S_{0,s}}{S_0}(P^* - P_0) + \frac{S_N}{S_0}(P^* - P_1)$$

Given that the offering is underpriced, that is $P^* > P_1 > P_0$, old shareholders suffer the greatest aggregate wealth loss when selling all of their shares in the IPO. In summary, former owners “will be more concerned with underpricing as the size of the issue grows (relative to their own holdings) or as they participate more by offering more of their own shares” (BARRY (1989), p. 1102).

The extension of this model takes the possibility of costly actions into consideration, namely actions that influence the offer prices and thus reduce underpricing and wealth losses. Such costs (*exp*) could for example arise in connection with extensive marketing efforts prior to the IPO. These costs have to be added to the aggregated wealth loss arising from underpricing and dilution. Former shareholders therefore are assumed to minimize these so called total wealth losses per old share (*twl*):

$$twl \equiv awl + exp$$

“There is a trade-off between spending more (higher *exp*) and tolerating higher underpricing. At the optimum, the marginal effect of increasing *exp* to reduce underpricing should equal the marginal costs of doing so, implying that total wealth losses are invariant, at optimum, to *exp*.” (see LJUNGQVIST (1999), p. 6).

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