

DISCUSSION PAPER SERIES

No. 3656

**DEBT OR EQUITY? THE ROLE OF
VENTURE CAPITAL IN FINANCING
THE NEW ECONOMY IN GERMANY**

David B Audretsch and Erik Lehmann

INDUSTRIAL ORGANIZATION



Centre for Economic Policy Research

www.cepr.org

Available online at:

www.cepr.org/pubs/dps/DP3656.asp

DEBT OR EQUITY? THE ROLE OF VENTURE CAPITAL IN FINANCING THE NEW ECONOMY IN GERMANY

David B Audretsch, Indiana University and CEPR
Erik Lehmann, Universität Konstanz

Discussion Paper No. 3656
November 2002

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programme in **INDUSTRIAL ORGANIZATION**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as a private educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions. Institutional (core) finance for the Centre has been provided through major grants from the Economic and Social Research Council, under which an ESRC Resource Centre operates within CEPR; the Esmée Fairbairn Charitable Trust; and the Bank of England. These organizations do not give prior review to the Centre's publications, nor do they necessarily endorse the views expressed therein.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

Copyright: David B Audretsch and Erik Lehmann

ABSTRACT

Debt or Equity? The Role of Venture Capital in Financing the New Economy In Germany

Using a dataset of the firms listed on the *Neuer Markt* in Germany, this Paper demonstrates that venture-backed firms differ from firms with other financial resources, especially debt. Thus, the results of this study provide evidence for the hypothesis that small and innovative firms are more likely to be financed by venture capitalists instead of banks. We also provide evidence that the presence of venture capitalists enhances the growth rates of firms positively.

JEL Classification: G32

Keywords: corporate governance, entrepreneurship, New Economy and venture capital

David B Audretsch
Institute for Development Strategies
Indiana University
1315 East 10th Street
SPEA 201
Bloomington
IN 47405-2100
USA
Tel: (1 812) 855 6766
Fax: (1 812) 855 0184
Email: daudrets@indiana.edu

Erik Lehmann
Univesität Konstanz
Fach D 144
78457 Konstanz
GERMANY
Tel: (49 7531) 882 968
Fax: (49 7531) 884 456
Email: erik.lehmann@uni-konstanz.de

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=101520

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=126500

Submitted 22 October 2002

1. Introduction

It is often argued that a bank-based system like Germany suffers from inadequate financing of young and innovative firms.¹ But, following the famous Modigliani and Miller theorem (Modigliani/Miller 1958), the way a project or firm is financed does not matter. Thus, high-tech firms could either be financed by banks via debt or venture capitalists, via equity. However, an implicit assumption of Modigliani and Miller (1958), is the existence of an ideal world without taxes² and incentive problems. Since taxes could not be the main reason explaining the bias of small business financing in favor of debt over equity³, an alternative explanation could be the greater incentive problems resulting from greater information asymmetries. Although there is overwhelming evidence that banks as financial intermediaries play a major role in the reduction of agency costs (Diamond 1984), they may fail in providing debt when the degree of asymmetric information is too high. In this case, a profit maximizing bank cannot capture the expected costs of debt by the interest rates of the loan (Stiglitz/Weiss 1981). As a consequence, the lack of venture capital in Germany would hinder young and innovative firms from competing with firms from other countries, especially the US.

¹ As the current Foreign Minister of Germany remarked (when he was a member of the German Parliament), “If Bill Gates were German, there would be no Microsoft.” (“Those German Banks and their Industrial Treasures,” *The Economist*, 21 January, 1995, 75-76.)

² As mentioned by Hart (2001), if taxes are the main factors influencing the debt-equity ratio, we should see much higher debt-equity ratios than we actually do. See also Myers (2001) for a recent survey on the determinants of capital structure.

³ Berger and Udell (1998) report that in 1993 in the US about 36% of the external funds for small business are originated from commercial banks and only about 3.5% from venture capitalists. Five years later, Ueada (2000) shows that in 1998 the external funds from venture capital exceed the amount of bank loans in financing small business firms in the US.

Gompers and Lerner (2001) have identified the important that venture capital plays in financing young and innovative firms in the U.S. However, virtually nothing is known whether this role is the same or different in a bank-based country such as Germany. In fact, there are both theoretical and empirical reasons casting doubt that the role of venture capital is invariant between countries with bank-based systems and those with more specialized markets (Black and Gilson 1997). On the one hand, Germany has a long tradition of specific regional and national financial institutions financing the *German Mittelstand*, or small- and medium-sized enterprises. On the other hand, a new generation of venture capitalists has emerged that provides finance to highly innovative firms. The purpose of this paper is to explicitly test the hypothesis that the role of venture capitalist in promoting young and innovative firms in a bank-based system differs systematically from the findings of Gompers and Lerner (2001) for the U.S. In particular, we examine why some firms receive venture capital while others do not. We then examine the impact of the mode of finance on firm performance. These hypotheses are tested using firm-level data from Germany's *Neuer Markt*, or New Market, consisting of innovative and mainly young and small firms.

The remainder of the paper is organized as follows. The next section compares the different roles of venture capital and banks in financing high-tech firms. The scant empirical evidence on venture capitalists in Germany is also summarized. The underlying hypotheses and the data are described in section 3. Section 4 presents the empirical analysis of the level of the pre IPO data of the 341 firms listed on the *Neuer Markt* in Germany from March 1997 until March 2002. Using a probit model, the results show that

a higher amount of debt financing is associated with a lower likelihood of receiving venture capital. The tobit estimation shows that the share of financing accounted for by venture capital is lower for firms with higher amounts of debt.

In addition, we find striking evidence that venture-backed firms outperform non-venture-backed firms. Based on quantile regressions, the results indicate that venture backed firms are associated with higher post-IPO growth rates. Based on these findings, the paper concludes in Section 5, that new economy firms need venture capital. The emergence of venture capital as the source of financing growth also requires a concomitant new role for the board of directors, where human capital and knowledge transfer take on primary importance.

2. The impact of venture capitalist in financing innovative firms

It has long been long been assumed that venture capital has no advantage over banks in financing firms in traditional industries, where innovation plays a minimal role. However, Aghion and Bolton (1992) showed that the double moral hazard problem in financing young entrepreneurs arises in innovative industries, reducing the efficiency of bank finance. The literature of financial contracts especially deals with this problem by focusing on young and highly innovative firms in a dynamic context (Hart 2001). As the relationship between the financier and the entrepreneur develops over time, eventualities arise that could not easily have been foreseen or planned for in an initial contract (Aghion/Bolton 1992). Due to the disutility of effort neither the entrepreneur nor the venture capitalist may not undertake first-best actions in order to enhance the expected

outcome of the project (see Aghion/Bolton 1992, Luelfesmann 2001). This creates a two-sided moral hazard problem where the entrepreneur as well as the venture capitalist has to be induced to undertake effort (see Inderst/Mueller 2002). Gompers (1995, 1996) and Kaplan/Stroemberg (2000, 2002) have all described the complexity of venture capital contracts. Double moral hazard is not discussed as a widespread phenomenon between banks and firms. Here, the relevant actions are included in a standard loan contract (Gale/Hellwig 1985). The decision rights in such a contract are well defined: In the case of a successful project, the entrepreneur receives the benefits minus the costs of the credit. When the project fails or the credit is not repaid within a certain time, the creditor receives the control rights over the firm and its assets and can seize or foreclose on the firm's assets or push the firm into bankruptcy (see Hart 2001). However, the very nature of entrepreneurship prevents start-ups and their financiers from writing complete contracts where the obligations are specified in all relevant conceivable future contingents (Hart/Moore 1998). There are three main explanations for why the optimal contract between start-ups and financiers should differ between venture capital and debt (Admati/Pfleiderer 1994, Hellmann 1998). First, venture capitalists take an equity linked stake in the firms they finance, sharing in both upside and downside risks. Second, they also are assumed to have a higher technological expertise which allows them both to better identify projects than banks and to undertake the projects without the original entrepreneur (Bergloef 1994, Udea 2000). Hellman (1998) shows that the expertise of a venture capitalist in replacing underperforming entrepreneurs as the CEO is necessary to ensure an optimal allocation of control rights.⁴ Empirical studies provide evidence that

⁴ In his framework, Hellmann (1998) assumes that the financing of start-ups takes the form of convertible bonds.

venture-backed firms frequently replace the original founders as CEO (Hellmann/Puri 2000, Gorman/Sahlman 1989, Lerner 1994).

Third, a further distinction from banks is the role played by venture capital in staging the investments to reduce agency and verifiability problems (Bergemann/Hege 1998, Gompers 1995). After their initial investment, venture capitalists provide entrepreneurs with access to consultants, accountants and play active role as monitors (Lerner 1995) and provide information for other stakeholders of the firm. Thus, venture capitalists play an important role in the corporate governance of high-tech firms (Hellmann 1998, Baker/Gompers 1999). Finally, they take an active part in guiding the exit decision either by selling their shares directly to other firms or investors or by an Initial Public Offering (IPO) (Lerner 1994, Gompers 1995, Cummings/MacIntosh 2002).

Although Germany is the largest venture capital market in Continental Europe, there is only scarce evidence about the impact of venture capital in financing young and innovative firms in a bank-based country. Black and Gilson (1997) point out the importance of an active stock market for the development of venture capital – which is not the case in a bank-based country like Germany. The increasing importance in bringing the firms to public and thus the necessity of a stock market is shown by several studies of venture capital backed firms (Cummings/MacIntosh 2002, Bottazzi/Da Rin 2002).⁵ Becker and Hellmann (2001) analyze the rise and fall of the first German venture capital company, founded in 1974. They show that an active stock market as proposed by

⁵ However, financing high-tech start-ups and bringing them to public are highly positively correlated since venture capitalists tend to reinvest gains from the IPO to fund new firms. This explains the fact that the financing of small firms by venture capitalists could more be explained by *waves* instead of a continuous process (Gompers/Lerner 2001).

Black and Gilson (1997) may be a necessary condition but by no mean sufficient. The reasons of the failure of the WFG lies in the different strategies pursued by their shareholders (the German Governance and large German Banks) and the lack of managerial skills by the entrepreneurs. Their finding is congruent with conclusions that highly innovative firms may have no incentive to make an IPO and consequently provide the public with information about their research activities and findings.

Bascha and Walz (2001) confirm that Germany differs from Anglo-Saxon countries in that public-private venture capitalists (with private and state-owned banks as the major shareholders) are the dominant form of venture capitalists; they also underperform compared to private partnerships. Dittmann et al. (2001) focus on the different evaluation methods used by venture capitalists and their different impact on performance. One of the broadest surveys of venture capital in Germany and its comparison to the US is provided by Pfirrmann et al. (1997). However, their analysis ends before the *Neuer Markt* was created in 1997. Franzke (2001) shows that venture capital backed IPOs appear to be more underpriced than non venture capital backed IPOs. Finally, Bottazi and Da Rin (2002) analyzed the role of venture capital in Europe. Most of the firms included in their analysis are from the *Neuer Markt* from Germany. Their results show that venture-backed companies do not grow and create jobs faster than do non-ventured-backed companies. However, their study suffers from the aggregation problem.⁶

⁶ For example, they do not control for the difference in the accounting standards in Germany (*US-GAAP* versus *IAS*), which leads to significant differences in the balance sheet data or differentiate between venture capital firms and investment banks (such as *Gold-Zack AG*, their second largest venture capitalist with 12 investees or the *Concordia Effekten AG*).

3. Hypotheses, Data, and Measurement

In this section we briefly outline the hypotheses that underlie our empirical analyses. Since very little is known about the availability and the amount of venture capital provided, we build our hypotheses on general findings from the literature. An important question is, whether young and innovative firms, especially in a bank-based country like Germany, differ in their ability to attract equity by venture capitalists. In particular we examine the interrelationship between the age and the innovative activity of a firm and the type of financing - venture capital or some other mode of finance.

3.1 Determinants of receiving venture capital

Our first null hypothesis is that financing by venture capitalists is independent of the age of the firm and its innovative activity. There are at least two alternative hypotheses. The first alternative hypothesis is that venture capitalists prefer to invest in young and innovative companies. Those firms capture a higher risk but are also associated with higher expected returns in the future. Since they also act as monitors in related firms, each investment lowers the costs of monitoring⁷ but also generates external effects which can be used in the assisting and mentoring of other firms. Also their specific technological expertise generates higher marginal returns compared to unspecific financiers. Thus, venture capitalists can presumably assess the profitability of the projects more accurately than can a bank (Udea 2000). A second alternative is that venture capitalists are also responsible to their own investors and may thus be reluctant to invest in young and highly innovative firms (Hellmann/Puri 2000) and prefers firms for which

⁷ The effect of decreasing costs of monitoring is one explanation of the intermediation of banks.

business concepts are easier to comprehend and communicate and have some experience in the product market.

Our second null hypothesis is that the possibility of receiving venture capital is independent of the amount of debt of a firm. Although there are theoretical and empirical arguments that the existence of financial constraints may lead to a financial pecking order (Myers/Majluf 1984), we assume that the choice of a venture capitalist to invest depends on a firm's amount of debt. It is often argued that banks in a bank-based country like Germany face some advantages in financing small and medium sized firms, there is at least another point which is often neglected. The bank as the outside financier is more protected by law than the equity holders. Here, the bank has recourse against the entrepreneur up to the amount of debt owed by the entrepreneur's firm. Consequently, the venture capitalist as the provider of equity has only a small possibility to sell some assets to lower his loss in the case of firm failure. Thus, the first alternative hypothesis is that the higher the amount of debt, the lower the likelihood of receiving venture capital. The second alternative hypothesis refers to the argument presented by Lel and Udell (2002): The amount of debt of an entrepreneur signals both his capability and personal guarantees. Venture capitalists may thus take debt as a quality signal.

The third null hypothesis refers to the role of intangible assets like human capital and intellectual property. The underlying null hypothesis is that neither human capital nor intellectual property influence the likelihood of obtaining and the amount of venture capital. The alternative hypothesis is that both factors have a positive influence on the decision behavior of venture capitalists. In the *Neuer Markt*, competitive advantage largely comes from non-physical assets including human capital, ideas and intellectual

property rights (see Audretsch and Stephan 1996, or Rajan and Zingales 2000). Since human capital is assumed to play a dominant role in founding new firms in the high technology sector (Audretsch and Stephan 1996, Bates 1990, Zucker et al. 1998) one could assume that human capital and intellectual property also play a decisive factor in the decision making process of venture capitalists. Lazear 2002, Audretsch/Stephan 1996, Zucker et al. 1998, and Bates 1990 have suggested that the human capital of a firm is reflected by the academic background of the entrepreneur. Audretsch and Lehmann (2002) extend this approach by including the academic degree of the board of directors. They show that for *Neuer Markt* firms, the board of directors not only takes on the role of controlling and monitoring the managers, but also provides value-adding advice and knowledge. Intellectual property also plays a major role in new economy firms (Blair et al. 2000). While firm patents are certainly not a perfect measure for intellectual property (Griliches, 1990), Kortum and Lerner (2000) provide evidence that patent activity reflects the innovative potential of venture-backed firms.

3.2 Performance of venture-backed firms

Our third null hypothesis is that the performance of firms, as measured by growth, is not influenced by the mode of finance. In fact, Bottazzi and Da Rin (2002) found that venture-backed firms do not differ in growth from non venture-backed companies. There are at least two alternative hypotheses. First, as Brander et al. (2002) argue, venture capital not only provides financial resources but also value enhancing advice to the firm. If this hypothesis holds, venture-backed firms should outperform non-venture backed firms. Otherwise, venture capitalists would only invest in high risk firms. Given the low

survival rate of venture-backed firms of 20% (Gompers and Lerner, 2001), firms financed by venture capital would be expected to exhibit lower growth rates.

However, as often neglected, the presence of venture capital depends not only on the decision of the venture capitalists, but also on the entrepreneur selecting this kind of finance. Hellman and Puri (2000) provide anecdotal evidence about the costs and benefits of venture capital financing. They conclude that venture capital may be an expensive source of capital, which in turn reflects the benefits of having an involved investor. Otherwise, if an entrepreneur is able to attract money from friends and family members,⁸ she avoids the cost of having an involved investor with the disadvantage of strategic advice and other benefits. Thus, we assume that equity ownership by friends and family members is rather a substitute than a complementary for venture capital and include different large shareholder as further variables in the estimations. We also control for different factors which may influence both the determinants of receiving venture capital and the performance of firms, such as the time of the IPO, the industry in which the firm operates, the kind of accounting system before the IPO, and national identity of the firm.

3.3. Data, Measurement and Descriptive Statistics

To conduct this study we use a unique dataset of 341 firms who are or were listed on the *Neuer Markt* in Germany from 1997 until 2002. This dataset is collected combining individual balance sheet data from IPO prospectus, publicly available information from

on-line data sources such as the *German Patent office*, and the *Deutsche Boerse*. The impact of venture capitalists is expressed by both, the presence of one or more venture capitalist (*venture-backed*) and the amount of equity hold by venture capitalists (*venture capital ownership*). The role of banks in financing new economy firms is expressed by the amount of *debt* and the equity hold by banks on those firms (*bank equity ownership*).⁹ We follow Lazear (2002) that the educational background of the managers plays a key role in entrepreneurship. Since major decisions are made by the board of managers, we take the academic degree of the board of managers (*executive human capital*) as a measure of the human capital of a firm. We also add the academic degree of the board of directors (human capital directors). The academic degree is expressed by the numbers of board members - either managers or directors - which posses a doctoral degree (Ph.D) or are professors¹⁰. Intellectual properties are expressed by the number of patents (firm patents). The data are taken from the *Deutsche Patentamt* (www.dpma.de) to identify patent activity. Using the name of the firm as well as the name of the executives provides information about the number of patents and the underlying property rights. The *number of employees* is used as a measure for the firm size before IPO. The difference in size before and after the IPO of the firm constitutes the *growth rates* of the employees (as measured by the difference of the natural logarithm). Those data are taken from annual reports and the online database www.marketone.com.

⁸ Luelfelsmann (2001) makes this assumption in his model on financial contracts. He shows that the double moral hazard problem is more relevant when the entrepreneur is credit constraint and needs an outside investor to finish his project.

⁹ There is a large amount of literature pointing out the influence of banks on firms in Germany (see Lehmann/Weigand 2000).

¹⁰ We did not include academic degrees given as honoris causa (Dr. h.c.).

The use of balance sheet data to compare the firms before and after IPO is rather problematic, since firms have the choice between US-GAAP and IAS (International Accounting Standard) as the main accounting system as one criterion for the listing at the *Neuer Markt*. In contrast to Biattozzi and Da Rin (2002)¹¹ we include a dummy variable to correct for the main accounting system which takes the value one for IAS and zero respective for US-GAAP. We include the ownership concentration of the *CEO, the board of directors, friends and families, and venture capitalists*. Ownership concentration is measured by the Herfindahl Index. Since patents are not included in the annual reports, we use the database from the *Deutsche Patentamt* (www.dpma.de) for further information.

Furthermore, we include dummy variables to control for the different time of the IPO and industry specific fixed effects. Since it is often argued that German firms may receive lower venture capital compared to firms in other countries, especially the UK and US, we include a dummy variable indicating that the firms are located in *Germany* (see also table 1 for the definitions of the variables).

The descriptive statistics presented in table 2 indicate that venture-backed firm have significantly less debt. Thus, equity provided by venture capital appears to be a substitute rather than a complement to debt. The equity held by banks is also lower in the venture-backed group. Both findings suggest that banks play a minor role in financing and

¹¹ Biattozzi and Da Rin (2002) used R&D spending as a measure for the innovation activity of firms. This leads to a selection effect for German firms (the major of their sample), since those data do not have to be expressed in the annual balance according to the IAS. Since firms may have a choice using IAS or US-GAAP, only the firms using US-GAAP are thus included in their estimations.

controlling new economy firms compared to traditional firms.¹² The descriptive statistics also provide first evidence that on average, venture-backed firms are younger, smaller, and have significant more patents than do non venture-backed firms. Finally, the data show that the entrepreneurial decision to increase the equity base of the firm includes not only venture capital but also firms and friends and families. Thus it could be assumed that the mode of finance selected by the entrepreneur is not independent of the type of equity chosen. Table 2 also shows that venture capitalists typically specialize in a small group of targeted industries, including Biotech, Medicine & Life Science, and Technology. These are all industries where their technological expertise can be leveraged for higher returns for both the firms as well as the venture capitalists, compared to banks.

4. Empirical results

In this section, we explore the determinants of receiving venture capital and the performance of venture-backed firms. In the first subsection, we analyze the main factors influencing the kind of financing obtained by firms listed on the *Neuer Markt*.

4.1 Determinants of receiving Venture Capital.

We apply to different estimations to analyze the determinants of receiving venture capital. First, we use a simple probit approach with a dummy variable indicating whether

¹² see Lehmann/Weigand 2000 for the role of banks in large and medium sized German firms.

the firm is venture-backed or not. Assume that there is a an underlying variable y_i^* defined by the regression relationship

$$(1) \quad y_i^* = \beta' x_i + u_i$$

and y_i^* is unobservable. Only the dummy variable

$$(2) \quad \begin{aligned} y &= 1 && \text{if } y_i^* > 0 \\ y &= 0 && \text{otherwise} \end{aligned}$$

can be observed. Hence, the realizations of y follow a binomial process with probabilities $\text{Prob}(y_i = 1) = \text{Prob}(u_i > -\beta' x_i) = 1 - F(-\beta' x_i)$, where F is the cumulative distribution function for u . The probability varies from trial to trial depending on x_i . In the following probit estimation, y indicates the observable dummy variable for a venture backed firm. Thus, we estimate the following estimation:

$$(3) \quad \text{Prob}(y=1) = f(\text{debt, ownership structure, size, age, industry, IPO Year, accounting system}) + u$$

The determinants on the amount of venture capital a firm receives can be tested using a two-limit Tobit-Model. Since the endogenous variable is truncated at both high and low values (minimum zero percent equity ownership of venture capitalists and maximum 100 percent), we use the tobit model instead of the OLS-approach. Let

$$(4) \quad y_i^* = \beta' x_i + u_i$$

with y_i^* as the latent variable (desired or potential equity holding by venture capitalists). Further, x_i is a vector of exogenous variables (see equation 3 above) and u_i are disturbances with $E(u_i) = 0$. The observed variable y_i is given by

$$(5) \quad y_i = \begin{cases} \underline{c}_i & \text{if } y_i^* \leq \underline{c}_i \\ y_i^* & \text{if } \underline{c}_i < y_i^* < \bar{c}_i \\ \bar{c}_i & \text{if } \bar{c}_i \leq y_i^* \end{cases}$$

where $\underline{c}_i, \bar{c}_i$ are fixed numbers representing the censoring points of equity ownership by a venture capitalists before IPO. Thus, we estimate the following equation:

$$(6) \quad y \text{ (amount of equity hold by venture capitalists)} = f(\text{debt, ownership structure, size, age, industry, IPO Year, accounting system}) + u$$

Table 4 provides the results of estimating the Probit model in the second column and the Tobit model in the third column. The negative coefficient on *debt* indicates that the likelihood of obtaining venture capital is inversely related to the extent to which the firm is financed by debt. Similarly, the amount of venture capital obtained is also negatively related to the degree of debt finance. This effect may be typical for bank-based countries like Germany: The providers of debt are stronger protected by the law than the providers

of equity. If an entrepreneur is financed by both, debt and venture capital, it is the bank which first gets the money back from selling some assets or collaterals owned by the entrepreneur or the firm. Thus, debt reduces the incentive of a venture capitalist to invest in such firms.

The human capital of the board of directors is found to have a positive impact on both the likelihood of obtaining and the amount of venture capital. Ownership share, both by executives and by other firms, reduces the likelihood of obtaining venture capital. It also reduces the size of the amount of venture capital obtained. The negative coefficient on the dummy variable for Germany indicates a lower likelihood of obtaining venture capital and a lower level of venture capital funding for German-based firms.

The type of accounting system used by the firm also impacts its ability to attract venture capital. Those firms relying on the International Accounting Standard (IAS) compared to the U.S. General Accepted Accounting Principles (GAAP) face a lower propensity for attracting venture capital.

4.2 Performance of venture-backed firms

To examine the impact of mode of finance on firm performance, two different kinds of estimations are used. First, we estimate a simple OLS regression as used by Bottazzi and Da Rin (2002) and the related literature. Applying the same estimation method ensure comparability of the results.

$$(7) y (\text{growth rate}) = f(\text{debt, ownership structure, size, age, industry, IPO Year, accounting system}) + u$$

In addition, we follow the example in the labor market literature by using the method of quantile regression estimation. This semi-parametric technique provides a general class of models in which the conditional quantiles have a linear form. In its simplest form, the least absolute deviation estimator fits medians to a linear function of covariates. The method of quantile regression is potentially attractive for the same reason that the median or other quantiles are a better measure of location than the mean. Other useful features are the robustness against outliers and that the likelihood estimators are in general more efficient than least square estimators. Besides the technical features, quantile regressions allow that potentially different solutions at distinct quantiles may be interpreted as differences in the response of the dependent variable, namely the growth rates, to changes in the regressors at various points in the conditional distribution of the dependent variable. Thus, quantile regressions reveal asymmetries in the data, which could not be detected by simple OLS estimations.¹³

In detail, let (y_i, x_i) , $i=1, \dots, n$, be a sample of firms, where x_i is a $K \times 1$ vector of regressors. Assume that $Quant_\theta(y_i, x_i)$ denotes the conditional quantile of y_i , conditional on the regressor vector x_i . The distribution of the error term $u_{\theta i}$ satisfies the quantile restriction $Quant_\theta(u_{\theta i}, x_i) = 0$ (Buchinsky 1998). Thus, we estimate

$$y_i = Quant_\theta(y_i, x_i) + \mu_{\theta i}, \text{ or, with } Quant_\theta(y_i, x_i) = x_i' \beta_\theta$$

$$(8) y_i = x_i' \beta_\theta + \mu_{\theta i},$$

The variables included in the estimation of equation (8) are the same as used in the OLS regression. We analyze three different quantiles. The 0.20 quantile includes the less performing firms based on column 3 in Table 4.¹⁴ The median quantile is based on the 0.50 quantile in Column 4 of Table 4. This regression is closest to the OLS approach, where the expected mean value is used in the estimation instead of the median. Finally, we use the .80 quantile with the higher performing firms. As one increases θ from 0 to 1, one traces the entire conditional distribution of the endogenous variable y , conditional on x . The quantile's coefficient could be interpreted using the partial derivative of the quantile of y with respect to one of the regressors, say j . This derivative can be interpreted as the marginal change in the θ th conditional quantile due to marginal change in the j th element of x .

The results of the three different estimations are depicted in table 5. The positive and statistically significant coefficient on venture capital ownership indicates that growth rates are systematically higher in venture-backed firms. The one exception is in the high performing cohort, where venture capital ownership has no influence on performance. Thus, it seems that growth rates in the lower quantile group react more sensible towards an increase in venture capital. This is in line with other empirical evidence documenting the disciplining influence of venture capitalists in poorly performing firms (Hart 2001,

¹³ see Buchinsky (1998) for a survey of the method and some application in the labor markets.

¹⁴ As an example, the 0.20 quantile divides the dataset into two parts, whereas 20% of the included firms have growth rates less or equal the 0.20 quantile and 80% of the firm have higher growth rates.

Kaplan/Stroemberg 2002). There is at least some evidence that intellectual property, as measured by firm patents, has a positive impact on firm growth, at least for the median quantile. This also holds for the human capital of the Board of Directors, which is found to be positively related to firm growth for the median quantile.

Not only do the positive and statistically significant coefficients of ownership concentration by executives and other firms indicate a superior performance when CEOs and external firms have a high degree of ownership, but they also indicate that the control group, firms owned predominantly by friends and family, exhibits a systematically lower level of performance. Interestingly and in contrast to the equity held by venture capitalists, growth rates in the higher quantiles react more sensible towards an increase in both, equity held by firms and executives. This may be a first hint that equity provided by outside investors like firms and venture capitalists may be rather substitutes than complementary. The variable indicating equity ownership by banks remains not significant in all estimations. Once again, German firms exhibit systematically lower levels of performance. Control variables indicating industry effects, the IPO date and firm size play a further role in explaining firm growth. The quantile regressions also document some asymmetries in the data set. However, the .20 and the median quantile seem to be more different than the median quantile and the .80 quantile.

5. Conclusion

The German system of bank-based finance was at least partially responsible for the post-War *Wirtschaftswunder*, or Economic Miracle, envied by much of the World. Even as

recently as 1988 (Mayer 1988), whether other countries, such as the U.S. and U.K., should adapt a similar bank-based system of finance was hotly debated. The findings summarized by Gompers and Lerner (2001) suggest that banks are incapable of adequately financing innovative firms, and in particular, high-tech startups. Rather, venture capital proved to be a superior form of finance in innovative industries. These findings posed a challenge to the bank-based finance countries, such as Germany. Is it possible to sustain high growth and generate innovative startups in countries dominated by traditional banking systems.

The evidence provided by this paper is that it is not – as long as finance is restricted to the traditional banks, innovative firms, and in particular technology-based startups, will suffer a lower performance. However, to the degree to which new institutions can be developed facilitating venture capital, such as the *Neuer Markt* in Germany, high-growth innovative firms can be generated. Thus, the constraint on innovation is not necessarily specific to the country, but rather to its institutions, in this case the need to develop an equity market facilitating the development of venture capital finance.

In particular, this paper provides evidence for the necessity for institutions such as the *Neuer Markt*, because venture capital and debt provided by banks is found not to be a complements but rather a substitutes. Banks are found to play only a minor role in financing and controlling innovative firms.

A great debate has raged about the efficacy of debt finance relative to equity (Myers, 2001). The results of this paper suggest this may be the wrong question for the New Economy. While it is clear that equity is a superior mode of finance for innovative activity (Hart, 2001), it is less clear about how the source of that equity shapes

performance. Future research needs to focus directly on the impact of the source of equity on subsequent firm performance.

Table 1: Definitions of the explanatory variables

This table presents the definitions of the variables used throughout the regressions. Pre IPO measures the last fiscal period before the IPO.

VC-Backed	One if the firm is financed by one or more venture capitalists
Debt	Log of (Short term + long term + advances payable)
Firm Patents	Number of patents of a firm
Human Capital Executives	Number of academic degrees (doctoral or professor) of the board of executives
Human Capital Directors	Number of academic degrees (doctoral or professor) of the board of directors)
Size pre IPO	Number of employees before the IPO
Size post IPO	Number of employees after the IPO
Growth rate	Difference of the log of the number of employees before and after the IPO
Age	Log of firm's age
Ownership Venture Capitalists	Equity ownership of the firm held by venture capitalists before IPO
Ownership Banks	Equity ownership held by banks before IPO
Ownership Firm	Equity ownership held by other firms before IPO
Ownership Executives	Equity ownership of the board of executives before IPO
Ownership Friends and Family	Equity ownership of all persons which are neither member of the board of directors or executives nor members of the management of the firm.
IAS	One, if the firm uses the International Accounting Standard (in contrast to the HGB or the US-GAAP).
Germany	One, if the firm is located in Germany
IPO 1997	One, if the IPO occurred in 1997, zero otherwise
IPO 1998	One, if the IPO occurred in 1998, zero otherwise
IPO 1999	One, if the IPO occurred in 1999, zero otherwise
IPO 2000	One, if the IPO occurred in 2000, zero otherwise
IPO 2001	One, if the IPO occurred in 2001, zero otherwise
Software	One, if the firm belongs to software industry, zero otherwise
Service	One, if the firm belongs to service industry, zero otherwise
E-Commerce	One, if the firm belongs to E-commerce industry, zero otherwise
Computer	One, if the firm belongs to computer & Hardware industry, zero otherwise
Telecommunication	One, if the firm belongs to telecommunication industry, zero otherwise
Biotechnology	One, if the firm belongs to biotechnology industry, zero otherwise
Life Science & Medicine	One, if the firm belongs to life science or medicine technique industry, zero otherwise
Entertainment	One, if the firm belongs to media and entertainment industry, zero otherwise
Technology	One, if the firm belongs to technology industry, zero otherwise
Others	One, if the firm belongs to others than the listed industries, zero otherwise

Table 2: Descriptive Statistics

The table provides the descriptive statistics for the explanatory variables. The first part of the table shows the mean and the standard deviation of both groups, the venture-backed firms and the firms which are financed without venture capital. The table also presents the results of a two-tailed test of equal means. The second part of the table presents the included dummy variables and their distribution between both groups. A test of independence between both groups is made using Pearson's chi-square as the underlying test statistic. The stars *, **, and *** indicate significance at the 10-percent, 5-percent, and 1-percent level, respectively

Variable	Mean		Std. Deviation	
	Non-venture (N=188)	Venture-backed (N=157)	Non-venture backed	Venture backed
Debt***	48.65	11.11	206.368	21.825
Patents**	2.94	5.56	12.331	15.80
Human Capital Executives**	.46	.64	.719	.922
Human Capital Directors	1.42	1.52	1.204	1.267
Size pre IPO***	239.89	182.35	314.02	325.59
Size post IPO	325.80	287.07	416.67	391.27
Growth rate	.39	.58	1.68	1.44
Age	11.14	9.26	12.87	8.46
Ownership Venture Capitalists	-	29.42		22.89
Ownership Banks	3.41	1.74	13.76	5.77
Ownership Firms***	20.25	7.28	34.56	18.77
Ownership Executives**	38.31	32.58	34.07	29.13
Ownership Friends & Family **	23.49	18.58	29.16	22.79
Percent				
Variable (Observations)	Non-venture (N=188)	Venture-backed (N=157)		
IAS (106)***	.63	.37		
Germany (292) **	.56	.43		
IPO 1997 (14)	.64	.36		
IPO 1998 (44)**	.68	.31		
IPO 1999 (137)	.59	.41		
IPO 2000 (138) **	.46	.53		
IPO 2001 (12) ***	.25	.75		
Software (63)*	.65	.35		
Service (78)	.55	.45		
E-Commerce (25)	.52	.48		
Computer (27)	.53	.47		
Telecommunication (26)	.53	.47		
Biotechnology (18)***	.16	.84		
Life Science & Medicine (13)**	.31	.69		
Entertainment (40) **	.67	.33		
Technology (34)	.47	.53		
Others*	.59	.41		

Table 3: Bivariate Correlation coefficients of the Pre-IPO Ownership Structure

This table provides bivariate correlations between the different groups of shareholders.

	Venture Capitalists	Executives	Friends&Family	Firms	Banks
Executives	-.230	-	-	-	-
Friends&Family	-.154	-.325	-	-	-
Firms	-.212	-.402	-.291	-	-
Banks	-.073	-.118	-.079	-.075	-
freefloat	-.102	-.136	-.152	-.084	.012

Table 4: The determinants of venture capital

This table provides estimates of equation (3) and (6). The dependent variable in the probit model is 'VC_backed', a dummy variable indicating whether venture capitalists are involved in the investment or not. The dependent variable in the (left censored) tobit model is 'Ownership Venture Capital', the amount of equity ownership of venture capitalists. Standard deviations are in parentheses. The stars *, **, and *** indicate significance at the 10-percent, 5-percent, and 1-percent level, respectively. The definitions of the explanatory variables are given in table 1. The Likelihood ratio (LR) chi-square test statistics is statistically significant at one percent in both estimations.

	Probit	Tobit
Debt	-.0125 (.00475)***	-.2125 (.1145)**
Firm Patents	-.0021 .0121	.1018 (.2564)
Human Capital Executives	-.0701 (.1236)	.4443 (2.7890)
Human Capital Directors	.2225 (.08925)**	4.647 (1.9656)**
Size	-.0463 (.09140)	-1.960 (2.1843)
Age	-.0623 (.0712)	-.9069 (1.7455)
Ownership Banks	-.0027 (.0160)	-.5942 (.3894)
Ownership Executives	-.0143 (.0033)***	-.5362 (.0796)***
Ownership Firms	-.0215 (.0041)***	-.6918 (.1035)***
Germany	-.6808 (.2565)***	-10.1883 (5.8667)*
IAS	-.6443 (.1968)***	-11.6730 (4.6231)**
Software	.1389 (.1857)	4.0451 (2.8400)
Service	.3372 (.3108)	5.1019 (7.1853)
Computer&Hardware	.4602 (.4021)	16.0843 (9.4894)*
Telecommunication	.4261 (.4020)	19.152 (9.5081)**
Biotechnology	1.1627 (.5865)**	21.7168 (10.8641)**
LifeScience&Medicine	.6135 (.5749)	25.1667 (12.3155)**
Entertainment	.1261 (.3588)	8.3305 (8.5682)
Technology	.6708 (.4159)*	19.8960 (9.0206)**
IPO 2000	1.1034 (.6028)*	20.374 (15.359)
IPO 1999	.4844 (.5932)	8.6645 (15.1496)
LL	-137.586	-672.439
LR Chi square	92.85***	121.69***
Pseudo Rsquare	.2523	.0830

Table 5: Performance of venture-backed firm

This table provides estimates of the equation (7) and (8). The dependent variable in all specifications is GROWTH, as measured by the difference of the log of employees before and after the IPO. The second column reports the results from the OLS regression. The results from the quantile regressions are presented in column 3 - 4. To limit the number of columns, we report the results for the 0.20, the 0.80 and the median quantile. Standard deviations are in parentheses. The stars, *, **, and *** indicate significance at the 10-percent, 5-percent, and 1-percent level, respectively. HC stands for 'Human Capital', and VC for 'Venture Capital'. The definitions of the explanatory variables are given in table 1.

	OLS	0.20 Quantile	.50 Quantile	.80 Quantile
Ownership VC	.0072 (.0041)*	.0139 (.0075)*	.0098 (.0027)***	.0022 (.0038)
Debt	.0002 (.0006)	.0009 (.0008)	.0001 (.0002)	-.0003 (.0003)
Firm Patents	-.0045 (.0080)	-.0128 (.01857)	.0091 (.0048)*	.0011 (.0050)
HC Executives	-.1132 (.0987)	.1017 (.1282)	.1715 (.1385)	-.0245 (.0831)
HC Directors	.0626 (.0678)	-.1633 (.1763)	.0633 (.0048)*	.0848 (.0554)
Size	-.8583 (.0695)***	-.8637 (.1350)***	-.8498 (.0479)***	-.8187 (.0639)***
Age	.0070 (.0577)	.03464 (.1016)	.0350 (.0398)	-.0300 (.0467)
Ownership Banks	-.0016 (.0090)	-.01039 (.0150)	-.0001 (.0055)	.0088 (.0071)
Ownership Exec.	.0078 (.0029)**	.0083 (.0059)	.0086 (.0020)***	.0122 (.0026)***
Ownership Firms	.0059 (.0031)**	.0068 (.0061)	.0046 (.0021)**	.0056 (.0025)**
Germany	-.5081 (.2093)**	-.4233 (.3808)	-.4657 (.1425)***	-.6450 (.1636)***
IAS	-.07929 (.1553)	-.2583 (.2787)	-.0745 (.1080)	-.1619 (.1317)
Software	-.1245 (.1142)	-.1012 (.0684)	-.1639 (.0279)***	-.1950 (.0303)***
Service	.1086 (.2491)	.2902 (.4372)	.1641 (.1630)	.2160 (.2018)
E-Commerce	-.3221 (.3563)	-.0436 (.6360)	-.4716 (.2419)*	.4109 (.2735)
Computer	.1836 (.3437)	.0090 (.5880)	.0215 (.2204)	.3189 (.2398)
Telecom	-.3980 (.3408)	-1.007 (.6264)*	-.0738 (.2204)	-.2457 (.2783)
Biotechnology	.1289 (.4065)	-.0709 (.7119)	-.5678 (.2743)**	.3985 (.2688)
Medtech	.2300 (.4491)	.2584 (.9291)	-.3459 (.3014)	.5573 (.2445)**
Entertainment	-.0511 (.2958)	-.3198 (.5203)	.0483 (.1948)	.2711 (.2464)
Technology	-.0002 (.3310)	.2180 (.6485)	-.0864 (.2204)	.0738 (.2817)
IPO 2000	.9911 (.5528)*	.0540 (1.1282)	.0098 (.0027)***	1.2333 (.2480)***
IPO 1999	-.1175 (.1554)	-.3165 (1.1168)	.8799 (.3121)***	1.4154 (.2314)***
Pseudo R square		.2895	.2982	.3609
Adj. R square	.4501			

References¹⁵

- Admati, A. and P. Pfleiderer (1994): Robust Financial Contracting and the Role of Venture Capitalists, *Journal of Finance* 49 (2), 371-402.
- Aghion, Philip and Patrick Bolton (1992): An Incomplete Contracts Approach to Financial Contracting, *Review of Economic Studies* 59, 473-494.
- Audretsch, David and Erik Lehmann (2002): Does the New economy need New Governance? Ownership, Knowledge, and Performance, *working paper Indiana University*.
- Audretsch, David and Paula Stephan (1996): Company-Scientist Locational links: The case of Biotechnology, *American Economic Review* 86 (3), 641-652.
- Baker, Malcolm and Paul A. Gompers (1999): Executive Ownership and Control in Newly Public Financed Firms: The Role of Venture Capitalists, *Discussion paper Harvard Business School* (*).
- Bascha, Andreas, and Uwe Walz (2001): Financing Practices in the German Venture capital Industry. An Empirical Assessment, *working paper, University of Tuebingen* (*).
- Bates, Timothy (1990): Entrepreneurial Human Capital Impacts and Small Business Longevity, *The Review of Economics and Statistics* 72, 551-559.
- Becker, Ralf and Thomas Hellmann (2001): The Genesis of Venture Capital - Lessons from the German Experience, *working paper Stanford University*.
- Bergemann, Dirk and Uli Hege (1998): Venture Capital Financing, Moral Hazard, and Learning, *Journal of Banking and Finance* 22, 703-735.
- Berger, Allan N. and Greg Udell (1998): The Economics of Small Business Finance: The Role of Private Equity and Debt Markets in the Financial Growth Cycle, *Journal of Banking and Finance* 22, 613-673.
- Bergloef, Eric (1994): A Control Theory of Venture capital Finance, *Journal of Law, Economics, and Organization* 10, 247-267.
- Black, Bernard S. and Ronald J. Gilson (1997): Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets, *Journal of Financial Economics* 47, 243-277.
- Blair, Margaret; Hoffman, Gary M. and Salvatore P. Tamburo (2001): Clarifying Intellectual Property Rights for the New Economy, *Working paper No. 274038, Georgetown University Law Center* (*).

¹⁵ Discussion papers marked with an asterix (*) are downloadable under: www.ssrn.com

- Bottazzi, Laura and Marco Da Rin (2002): Venture Capital in Europe and the Financing of Innovative Companies, *Economic Policy*, 231-269.
- Brander, James A., Amit, Raphael and Werner Antweiler (2002): Venture-Capital Syndication: Improved Venture selection vs. the Value-Added Hypothesis, *Journal of Economics and Management Strategy* 11 (3), 423-452.
- Buchinsky, M. (1998): Recent Advantages in Quantile regression Models, *Journal of Human Resources* 33(1), 88-126.
- Cumming, Douglas, and Jeffrey G. MacIntosh (2002): A Cross Country Comparison of Full and Partial Venture Capital Exits, *Journal of Banking and Finance* (forthcoming).
- Diamond, Douglas (1984): Financial Intermediation and delegated Monitoring, *Review of Economic Studies* 51, 393-414.
- Dittmann, Ingolf; Maug, Ernst G. and Johannes Kemper (2001): How Fundamental are Fundamental Values? Valuation Methods and their Impact on the Performance of German Venture Capitalists, *working paper, Humboldt University of Berlin* (*).
- Franzke, Stefanie A. (2001): Underpricing of Venture-Backed and Non Venture-Backed IPOs: Germany's Neuer Markt, working paper *Center of Financial Studies No. 2001/01*.
- Gale, Douglas and Martin Hellwig (1985): Incentive-compatible debt contracts: The one-period problem, *Review of Economic Studies* 52, 647-663.
- Gohrman, M. and W. Sahlman (1989): What Do Venture Capitalists Do?, *Journal of Business Venturing* 4, 231-248.
- Gompers, Paul A. (1995): Optimal Investments, monitoring, and the Staging of Venture capital, *Journal of Finance* 50 (5), 1461-1489.
- Gompers, Paul A. (1996): Grandstanding in the Venture Capital Industry, *Journal of Financial Economics* 42, 133-156.
- Gompers, Paul, and Josh Lerner (2001): The Venture Capital Revolution, *Journal of Economic Perspectives* 15 (2), 145-168.
- Griliches, Zvi (1990): Patent Statistic as Economic Indicators: A Survey, *Journal of Economic Literature* 28, 1661-1707.
- Hart, Oliver (2001): Financial Contracting, *Journal of Economic Literature* 39 (4), 1079-1100.
- Hart, Oliver and John Moore (1998): Default and Renegotiation: A dynamic Model of Debt, *Quarterly Journal of Economics* 113, 1-41.

- Hellmann, Thomas (1998): The Allocation of Control Rights in Venture Capital Contracts, *Rand Journal of Economics* 29, 57-76.
- Hellmann, Thomas and Manju Puri (2000): The Interaction between Product Market and Financing Strategy: The Role of Venture Capital, *Review of Financial Studies* 13 (4), 959-984.
- Inderst, Roman and Holger Mueller (2002): Competition and Efficiency in the Market for Venture Capital, *Journal of Finance* (forthcoming).
- Kaplan, Steven N. and Per Stroemberg (2000): Financial Contracting Theory meets the Real World: An Empirical Analysis of Venture Capital Contracts, *CEPR Discussion paper 2421*.
- Kaplan, Steven N. and Per Stroemberg (2002): Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analysis, *NBER working paper 8764*.
- Kortum, S. and Josh Lerner (2000): Assessing the Contribution of Venture Capital to Innovation, *Rand Journal of Economics* 31, 674-692.
- Lazear, Edward P. (2002): Entrepreneurship, *NBER working paper 9109*.
- Lehmann, Erik and Juergen Weigand (2000): Does the Governed Corporation Perform Better? Governance Structures and Corporate Performance in Germany, *European Finance Review* 4, 157-195.
- Lel; ugur and Gregory F. Udell (2002): Financial Constraints, Start-up Firms, and Personal Commitments, *working paper Indiana University*.
- Lerner, Josh (1994): Venture Capitalists and the decision to Go Public, *Journal of Financial Economics* 35, 293-316.
- Lerner, Josh (1995): Venture Capitalists and the Oversight of Private Firms, *Journal of Finance* 50 (1), 301-318.
- Luelfesmann, Christoph (2001): Start-Up Firms, Venture Capital Financing, and Renegotiation, University of Bonn, mimeo.
- Mayer, Colin (1988): New Issues in Corporate Finance, *European Economic Review* 32, 1167-1188.
- Modigliani, Franco and Merton H. Miller (1958): The Cost of Capital, Corporate Finance, and the Theory of Investment, *American Economic Review* 48 (4), 261-297.
- Myers, Stewart C. and Nicholas S. Maljuf (1984): Corporate Financing and Investment Decisions when Firma have Information Investors do not have, *Journal of Financial Economics* 13, 187-221.

- Myers, Stewart C. (2001): Capital Structure, *Journal of Economic Perspectives* 15 (2), 81-102.
- Pfarrmann, Oliver, Wupperfeld, Udo, and Josh Lerner (1997): *Venture Capital and New Technology Based Firms. An US-German Comparison*, Springer:Heidelberg.
- Rajan, Rhaguram, and Luigi Zingales (2000): The Governance of the New Enterprise, in: Vives, Xavier (ed.): *Corporate Governance*, Cambridge University Press.
- Stiglitz, Joseph and Andrew Weiss (1981): Credit Rationing in Markets with Imperfect Information, *American Economic Review* 71, 393-410.
- Ueda, Masako (2000): Bank versus Venture Capital, *CEPR Discussion paper No.*
- Zucker, Lynne G., Darby, Michael R., and Marilyn B. Brewer (1998): Intellectual Human Capital and the Birth of U. S. Biotechnology Enterprises, *American Economic Review*, 88 (1), 290-306.