Discussion Papers on Entrepreneurship, Growth and Public Policy

1904

Financing High-Tech Growth: The Role of Debt or Equity

by

David B. Audretsch

Erik E. Lehmann

Number of Pages: 28

The *Papers on Entrepreneurship, Growth and Public Policy* are edited by the Group Entrepreneurship, Growth and Public Policy, MPI Jena.
For editorial correspondence, please contact: egppapers@mpiew-jena.mpg.de

ISSN 1613-8333

Max Planck Institute for Research into Economic Systems
Group Entrepreneurship, Growth and Public Policy
Kahlaische Str. 10
07745 Jena, Germany
Fax: ++49-3641-686710

Financing High-Tech Growth:

The Role of Debt or Equity

David B. Audretsch*

Max-Planck Institute, Indiana University and CEPR

Erik E. Lehmann**

University of Konstanz

5/21/04

Abstract

Using a data set 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 enhance the growth rates of firms positively.

Key Words: Venture Capital, New Economy, Entrepreneurship, Corporate Governance

JEL-Classification: G32, L11, M13

* David B. Audretsch is Director of the Entrepreneurship, Growth and Public Policy Group at the Max-Planck-Institut, Jena; Professor at the School of Public and Environmental Affairs, Indiana University, Bloomington, and CEPR, London. Address Max-Planck Institute for Research into Economic Systems, Kahlaische Strasse 10, D-07745 Jena; audretsch@mpiew-jena.mpg.de

** Erik E. Lehmann, University of Konstanz, Department of Economics. Box D-144, 78457 Konstanz. E-mail: erik.lehmann@uni-konstanz.de. We are grateful to Stephen Bond, Peter Welzel, Mark Wahrenburg, and Peter Witt for helpful comments and suggestions. The paper also benefited from presentations at the European Meeting of the Econometric Society 2003 (Stockholm), the CEPR conference on Entrepreneurship, Financial Markets and Innovation (2003, Barcelona), and the German Association of Business and Administration (2003, Frankfurt).

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 taxes[2] and incentive problems. Since taxes could not be the main reason explaining the bias of small business financing in favor of debt over equity, 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).[3] 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.

Gompers and Lerner (2001) have identified the important role that venture capital plays in financing young and innovative firms in the U.S. However, virtually nothing is known

[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.

whether this role is the same or different in a bank-based country such as Germany. In fact, there are some reasons casting doubt that the role of venture capital is invariant between countries with bank-based systems and those with more specialized markets (Black/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 analyze empirically the role of venture capitalist in promoting young and innovative firms. In particular, we examine whether debt and equity are complements or rather substitutes in financing young and high-tech firms. We then examine the impact of the mode of finance on firm performance as measured by growth rates. 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 from 1997 until march 2003.

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

[3] Dybwig and Wang (2002) show that the choice between debt or equity depends on the relative severity of the induced incentive problems.

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. The paper concludes in Section 5.

2. The impact of venture capitalist in financing innovative firms

In their seminal paper, Aghion/Bolton (1992) show that the double moral hazard problem in financing young entrepreneurs arises in innovative industries. As the relationship between the financer and the entrepreneur develops over time, eventualities arise that could not easily have been foreseen or planned for in an initial contract. Due to the disutility of effort neither the entrepreneur nor the venture capitalist may 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 (2003, 2004) describe the complexity of venture capital contracts.

Double moral hazard, however, 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). Thus, optimal contracts between start-ups and financiers differ between venture capitalists and banks. First, venture capitalists take an equity linked stake in the firms they finance, sharing in both upside and downside risks. Secondly, 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 2003). This creates the double moral hazard problem. Banks, however, can not credibly commit themselves to run the firm instead of the entrepreneur. In contrast, venture capitalists with their experts frequently replace the original founders as CEOs (Hellmann/Puri 2000, Gorman/Sahlman 1989, Lerner 1994).

Thirdly, 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. 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/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).[4] Becker and Hellmann (2003) 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 Black/Gilson (1997) may be a necessary condition but by no mean sufficient. 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/Walz (2002) 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. The underperformance of public venture capitalists compared to independent venture capitalists is shown by Tykvová/Walz (2003). Dittmann et al. (2001) focus on the different evaluation methods used by venture capitalists and their different impact on performance. Also Tykvova´ (2003) points on the differences of venture capitalists on firm performance. Franzke (2001) shows that venture capital backed IPOs appear to be more underpriced than non venture capital backed IPOs.

[4] However, financing high-tech start-ups and bringing them to public are high 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 be more explained by *waves* instead of a continuous process (Gompers/Lerner 2001).

Schefczyk/Gerpott (2001) analyze the relationship between experience and education aspects of manager qualifications and performance measures for a sample of portfolio companies in Germany. They find that manager qualification significantly correlates with the performance of the portfolio companies. Finally, Bottazi/Da Rin (2002) analyze the role of venture capital in several European countries. Their results show that venture-backed companies do not grow faster than do non-ventured-backed companies. However, their study suffers from the aggregation problem.[5]

3. Hypotheses, Data, and Measurement

In this section we briefly outline the hypotheses that underlie our empirical analyses. An important question is, whether young and innovative firms differ in their ability to attract equity by venture capitalists. In particular we examine in the next sub-section the interrelationship between firm characteristics and the type of financing - venture capital or some other mode of finance. Then, in subsection 3.2 we analyze the impact of venture capitalists on firm growth.

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

[5] 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).

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 monitoring[6] 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 2003). 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 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/Maljuf 1984), we formulate the alternative hypothesis that the choice of a venture capitalist to invest depends on a firm´s amount of debt. If a bank as the outside financier is more protected by law than the equity holders, 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 lost in the case of firm failure. The first alternative hypothesis is that the higher the amount of debt, the lower the likelihood of receiving venture capital. In this case, debt and equity are substitutes in that the firm receives either equity or debt.

[6] The effect of decreasing costs of monitoring is one explanation of the intermediation of banks.

The second alternative hypothesis refers to the complementary argument presented by Lel/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 and then invest in the company.

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 high-tech markets, competitive advantage largely comes from non-physical assets including human capital, ideas and intellectual property rights (see Audretsch/Stephan 1996, Rajan/Zingales 2000, Fabel 2003). Since human capital is assumed to play a dominant role in founding new firms in the high technology sector (Audretsch/Stephan 1996, Bates 1990) one could assume that human capital and intellectual property also play a decisive role in the decision making process of venture capitalists (Demougin/Fabel 2003).

3.2 Performance of venture-backed firms

Our fourth null hypothesis is that the performance of firms, as measured by growth, is not influenced by the mode of finance (see Bottazzi/Da Rin, 2002). Otherwise, as Brander et al. (2002) argue, venture capitalists not only provide financial resources but also value enhancing advice to the firm. If this holds, venture-backed firms should outperform non-

venture backed firms. Also, banks may be reluctant in financing fast growing firms with a higher risk and thus a higher likelihood of failure, since they could not participate from the higher expected returns.

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 capitalists (*venture-backed*) and the amount of equity held 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 held by banks on those firms (*bank equity ownership*). 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 possess a doctoral degree (Ph.D) or are professors[7]. 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.

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*. Thus, 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 further 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.

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 table 1 for the definitions of the variables).

The descriptive statistics presented in table 2 indicate that venture-backed firms 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 controlling high-tech firms compared to traditional firms. The descriptive statistics also

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

provide first evidence that on average, venture-backed firms are younger, smaller, and have significantly 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 two different estimations to analyze the determinants of receiving venture capital. First, we use a probit approach with a dummy variable indicating whether the firm is venture-backed or not. Assume that there is a an underlying variable y_i^* defined by the regression relationship

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

and y_i^* is unobservable. Only the dummy variable

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

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) *Prob (y=1) = f(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) $$y_i^* = \beta' x_i + u_i$$

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

$$(5) \qquad y_i = \begin{cases} \underline{c}_i & if\ y_i^* \le \underline{c}_i \\ y_i^* & if\ \underline{c}_i < y_i^* < \overline{c}_i \\ \overline{c}_i & if\ \overline{c}_i \le y_i^* \end{cases}$$

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

(6) *y (amount of equity held by venture capitalists)* = f (*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: Debt holders are stronger protected by the law than equity holders. If an entrepreneur is financed by both, by banks and venture capitalists, it is the bank which first gets the money back from selling assets or collaterals owned by the entrepreneur or the firm. Thus, debt reduces the incentive of a venture capitalist to invest in such firms.

Both results support the basic hypothesis that debt and equity are rather substitutes than complements in financing high-tech 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.

Summing up, the likelihood of receiving equity and the amount of equity invested by venture capitalists depends negatively on the amount of debt and positively on the degree of human capital incorporated in the board of management. However, the results also show that German firms are more restricted in receiving equity by venture capitalists compared to foreign firms.

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/Da

Rin (2002). Applying the same estimation method ensures some comparability of the results.

(7) *y (growth rate)* = f (*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 distinction of the dependent variable. Thus, quantile regressions reveal asymmetries in the data, which could not be detected by simple OLS estimations. [8]

Let (y_i, x_i), *i=1,...,n* , be a sample of firms, where x_i is a *Kx1* vector of regressors. Assume that $Quant_\theta(y_i, x_i)$ devotes 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

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

$Quant_\theta(u_{\theta i}, x_i) = 0$. Thus, we estimate $y_i = Quant_\theta(y_i, x_i) + \mu_{\theta i}$, 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.[9] 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 shown in table 5. The positive and statistically significant coefficient on venture capital ownership indicates that growth rates are in general 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, /Stroemberg 2004). There is at least 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 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.

[9] 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 firms have higher growth rates.

5. Conclusion

The findings summarized by Gompers/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, 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 former *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 high-tech firms. 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.

However, one drawback of this study is the lack of information of the investment decisions in the founding time of the firm. This restricts our results to the pre and post IPO year. 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 & 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

	Mean		Std. Deviation	
Variable	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. The variables are explained in table 1.

Ownership by...	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			

References

Aghion, Philip/Bolton, Patrick (1992), An Incomplete Contracts Approach to Financial Contracting, Review of Economic Studies 59, 473-494.

Audretsch, David/ Stephan, Paula (1996), Company-Scientist Locational links: The case of Biotechnology, American Economic Review 86 (3), 641-652.

Baker, Malcolm/ Gompers, Paul A. (1999), Executive Ownership and Control in Newly Public Financed Firms: The Role of Venture Capitalists, Discussion paper Harvard Business School (*).

Bascha, Andreas/Walz, Uwe (2002), Financing Practices in the German Venture capital Industry. An Empirical Assessment, CFS working paper, No. 2002/08

Bates, Timothy (1990), Entrepreneurial Human Capital Impacts and Small Business Longevity, The Review of Economics and Statistics 72, 551-559.

Becker, Ralf/ Hellmann, Thomas (2003), The Genesis of Venture Capital - Lessons from the German Experience, in *Keuschnigg/Kanniainen* (eds)., Venture Capital, Entrepreneurship, and Public Policy, MIT Press (forthcoming).

Bergemann, Dirk/ Hege Uli (1998), Venture Capital Financing, Moral Hazard, and Learning, Journal of Banking and Finance 22, 703-735.

Berger, Allan N./ Udell Greg (1998), The Economics of Small Business Finance: The Role of Private Equity and Dept 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./ Gilson, Ronald J. (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./Tamburo, Salvatore P. (2001), Clarifying Intellectual Property Rights for the New Economy, Working paper No. 274038, Georgetown University Law Center (*)

Bottazzi, Laura/Da Rin Marco (2002), Venture Capital in Europe and the Financing of Innovative Companies, Economic Policy, 231-269.

Brander, James A./Amit, Raphael/Antweiler, Werner (2002), Venture-Capital Syndication: Improved Venture selection vs. the Value-Added Hypothesis, Journal of Economics and Management Strategy 11 (3), 423-452.

Buchinsky, Moshe (1998), Recent Advantages in Quantile Regression Models, Journal of Human Resources 33(1), 88-126.

Cumming, Douglas/MacIntosh Jeffrey G. (2002), A Cross Country Comparison of Full and Partial Venture Capital Exits, Journal of Banking and Finance (forthcoming).

Demougin, Dominique/Fabel, Oliver (2003), Searching for Matching Partners: The Venture Capitalist's Value-Added, working paper Humboldt University Berlin and University of Konstanz, mimeo. s

Diamond, Douglas (1984), Financial Intermediation and delegated Monitoring, Review of Economic Studies 51, 393-414.

Dittmann, Ingolf/Maug, Ernst G./Kemper, Johannes (2001), How Fundamental are Fundamental Values? Valuation Methods and their Impact on the Performance of German Venture Capitalists, working paper, Humbold Unoiversity of Berlin (*).

Dybwig, Philip H./Wang, Yu (2002), Debt and Equity, working paper, Washington University in Saint Louis (*).

Fabel, Oliver (2003), The Emergence of a New Economy: An O-Ring Approach, Journal of Institutional and Theoretical Economics (forthcoming).

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/Hellwig, Martin (1985), Incentive-compatible debt contracts: The one-period problem, Review of Economic Studies 52, 647-663.

Gohrman, Michael/Sahlman, William (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/Lerner, Josh (2001), The Venture Capital Revolution, Journal of Economic Perspectives 15 (2), 145-168.

Hart, Oliver (2001), Financial Contracting, Journal of Economic Literature 39 (4), 1079-1100.

Hart, Oliver/ Moore, John (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/ Puri, Manju (2000), The Interaction between Product Market and Financing Strategy: The Role of Venture Capital, Review of Financial Studies 13 (4), 959-984.

Inderst, Roman/Müller, Holger (2002), Competition and Efficiency in the Market for Venture Capital, Journal of Finance (forthcoming).

Kaplan, Steven N./Stroemberg, Per (2003), Financial Contracting Theory meets the Real World: An Empirical Analysis of Venture Capital Contracts, Review of Economic Studies 70, 281-318.

Kaplan, Steven N./Stroemberg, Per (2004), Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analysis, Journal of Finance (forthcoming)

Kortum, S./Lerner, Josh (2000), Assessing the Contribution of Venture Capital to Innovation, Rand Journal of Economics 31, 674-692.

Lel, Ugur/Udell, Gregory F. (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.

Modigliani, Franco/Miller, Merton H. (1958), The Cost of Capital, Corporate Finance, and the Theory of Investment, American Economic Review 48 (4), 261-297.

Myers, Stewart C./Maljuf, Nicholas S. (1984), Corporate Financing and Investment Decisions when Firms 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.

Rajan, Rhaguram/Zingales, Luigi (2000), The Governance of the New Enterprise, in: Vives, Xavier (ed.): Corporate Governance, Cambridge University Press.

Schefczyk, Michael/Gerpott Torsten J. (2001), Qualifications and Turnover of Managers and Venture Capital-Financed Firm Performance. An Empirical Study of German Venture Capital-Investment, Journal of Business Venturing 16 (2), 145-163.

Stiglitz, Joseph/Weiss, Andrew (1981), Credit Rationing in Markets with Imperfect Information, American Economic Review 71, 393-410.

Tykvová, Theresa (2003), Is the Behavior of German Venture Capitalists Different? Evidence from the Neuer Markt, CFS working paper No. 2003/24.

Tykvová, Theresa/Walz, Uwe (2003), Are IPOs of Different Venture Capitalists Different? Working paper University of Frankfurt.

Ueda, Masako (2003), Bank versus Venture Capital, Journal of Finance (forthcoming).