DIW Berlin

German Institute
for Economic Research

Discussion Papers

411

Dorothea Schäfer
Axel Werwatz
Volker Zimmermann

The Determinants of Debt and (Private-) Equity Financing in Young Innovative SMEs: Evidence from Germany

Berlin, March 2004

Opinions expressed in this paper are those of the author and do not necessarily reflect views of the Institute.

DIW Berlin

German Institute
for Economic Research

Königin-Luise-Str. 5
14195 Berlin,
Germany

Phone +49-30-897 89-0
Fax +49-30-897 89-200

www.diw.de

ISSN 1619-4535

The Determinants of Debt and (Private-) Equity Financing in Young Innovative SMEs: Evidence from Germany[χ]

Dorothea Schäfer,[♣] Axel Werwatz,[♦] Volker Zimmermann[♠]

First Draft: September 2003

This Draft: February 2004

Abstract

Financial theory creates a puzzle. Some authors argue that high-risk entrepreneurs choose debt contracts instead of equity contracts since risky but high returns are of relatively more value for a loan-financed firm. On the contrary, authors who focus explicitly on start-up finance predict that entrepreneurs are the more likely to seek equity-like venture capital contracts, the more risky their projects are. Our paper makes a first step to resolve this puzzle empirically. We present microeconometric evidence on the determinants of debt and equity financing in young and innovative SMEs. We pay special attention to the role of risk for the choice of the financing method. Since risk is not directly observable we use different indicators for financial and project risk. It turns out that our data generally confirms the hypothesis that the probability that a young high-tech firm receives equity financing is an increasing function of the financial risk. With regard to the intrinsic project risk, our results are less conclusive, as some of our indicators of a risky project are found to have a negative effect on the likelihood to be financed by private equity. (JEL: G32)

Keywords: Debt and equity financing, financial risk und project risk, venture capital and bank financing

---

[χ] We would like to thank three anonymous referees, Dirk Engel, Joachim Heidebrecht, Norbert Irsch, Andreas Kemmerer, Erik Lehmann, Uwe Walz, Mark Wahrenburg and participants of the workshop of the Center of Financial Studies Workshop "Venture Capital and New Markets" in Glashütten and of the DIW-workshop "Sustaining innovation and Growth: Public Policy Support for SMEs – Conception and Evaluation" for helpful comments. We also acknowledge the valuable research assistence of Justus Henke. We are responsible for all errors.

[♣] Corresponding author, German Institute for Economic Research (DIW) Berlin, Königin-Luise-Straße 5, 14195 Berlin, Phone: 49 30 89789162, email: dschaefer@diw.de.

[♦] German Institute for Economic Research (DIW) Berlin, Königin-Luise-Straße 5, 14195 Berlin, Phone: 49 30 89789157, email: awerwatz@diw.de.

[♠] KfW Group, Palmengartenstraße 5-9, 60325 Frankfurt/Main, Phone: 49 69 74313725, email: volker.zimmermann@kfw.de.

1 Introduction

Recently the CEO of a large German public bank noted that German start-ups should be financed almost exclusively with equity, since debt financing is not appropriate to bear the huge risks that newly founded firms entail. In this paper we investigate whether young, small and medium-sized companies (henceforth SMEs) that belong to the class of innovative firms indeed favour equity financing, and explore the factors that determine their choice of financing mode. Financial theory discusses the optimal financial structure of firms extensively. But empirical evidence on the choice of the financing mode in young high-tech SMEs is rather limited. Our paper contributes to closing this gap.

Much of the literature on financial contracting focuses on debt contracts, which are often assumed rather than derived as the optimal financing method. However, as de Meza/Webb (1987) point out, some distortionary phenomena like rationing (Stiglitz/Weiss 1981) may simply disappear if equity contracts are allowed. Despite the clear-cut results on the relation between the type of asymmetric information and the preferred financial instrument in de Meza/Webb (1987), the theoretical results on financing decisions is far from being conclusive. In particular the impact of both the intrinsic and the financial risk on selecting either debt or equity financing remains an unresolved issue.

Only recently have contradictory results been derived. On the one hand Hellmann/Stiglitz (2000) show that high-risk entrepreneurs choose debt contracts whereas low-risk entrepreneurs select equity contracts. On the other hand the literature on financing start-ups predicts that high-risk projects are associated with venture capital rather then with bank financing (for example Ueda 2002). In these models the venture capitalist has superior expertise in screening, monitoring and providing managerial support for the founder. This expertise seems to be of more value for high-risk projects. Explicit reference to equity contracts is rare. But as venture capitalists usually offer equity or equity-like contracts, these findings imply a close tie between highly risky entrepreneurs and equity financing. Venture capitalists themselves consider it as the core of their own business model that they select high-risk/high-return ventures and contribute to improving their prospects during the period of investment (Manigart/Sapienza 1999).

In this paper we examine empirically whether and how the market for financing young German high-tech companies is divided between credit financiers, usually banks, and equity financiers,

usually venture capitalists. We rely on a data set that contains detailed financial and project information sampled from firms whose investors are refinanced by KfW group (henceforth KfW).[1] KfW is a government-owned support bank that manages most national programmes for promoting SME. The main focus of our study will be to explore whether entrepreneurs pre-select financing modes according to their project's characteristics. In particular we ask, "What is the role of risk for choosing debt and equity financing? What is the relationship between the provision of informed capital, risk and the financing mode? Finally, what lessons for start-up finance can be derived from the evidence?" Regarding the indicators of financial risk in our data, the results are clear-cut: risky enterprises with a low cash flow (price cost margin) or a low ratio of equity to total assets tend to receive equity financing. Also, equity financing is more likely the bigger the size of the project. The latter result is not surprising, given that the costly screening and coaching activities of equity financiers favour larger deal sizes. Moreover, in order to control their exposure to risk, banks may ration their high tech clients with respect to investment size.

Regarding the variables measuring the intrinsic risk of a project or an enterprise we find ambiguous results. Surprisingly, most indicators for the intrinsic project risk either fail to significantly influence the choice of financial mode or affect the probability of being equity financed negatively. In particular investing in a true R&D-project significantly decreases the likelihood of receiving equity finance. This result is quite robust. It also emerges if only the choice between equity investment with management or technical support and debt is analyzed. On the other hand, if we measure an enterprise's intrinsic risk by whether it regularly performs R&D then a positive relation between intrinsic risk and the propensity to receive equity financing emerges.

Recent studies show that start-up finance in Europe and Canada hardly resembles the picture drawn from empirical studies in the U.S. (e.g. Bascha/Walz 2001, Schwienbacher 2002 and Cumming 2000a). We share with these papers the aim to filter out particularities of a market for start-up finance embedded in a financial system that is less market-based than the U.S. system. Nonetheless our approach is novel in many respects. First, we examine a sample that con-

[1] Formerly Kreditanstalt für Wiederaufbau.

tains information about the financing practices of the two most important financial intermediaries for high-tech SMEs: banks and venture capitalists. Second, we use project- and financing-related micro-data that are mostly drawn from the entrepreneurs' balance sheets and, in addition, from questionnaires that the investors answer when they approach KfW for refinancing. Thus we do not rely exclusively on self-reporting from financiers. Third, our analysis is the first one that explicitly focuses on the role of credit and equity financing in young non-listed high-tech firms in Germany. By concentrating on this type of firms we avoid two biases, the survivor and the "high-flyer" bias.[2] Both biases come naturally with studies that investigate listed firms. Fourth, our sample is unique as it contains direct information on whether high-tech firms receive informed capital. We observe directly whether private equity financiers also support their client with managerial or technical advice. Fifth, and most importantly, by explicitly referring to the theoretical evidence on the choice between the two standard financial instruments we provide new evidence about the impact of risk on the financing decision. Knowing this impact is important. The potential of different financing modes (of different types of financiers) to contribute to the young firms' development can only be estimated correctly if the role of both the financial and the project risk for the pre-selection of a specific financing method is clarified.

However there is also a drawback. Since in many cases complete information is not available on all relevant firm and project characteristics we face a trade off between sample size and capturing the relevant risk factors. We try to resolve this problem by estimating different models but are aware of the fact that the problem of missing values forces us to be very cautious when interpreting the results.

We proceed as follows. Section 2 gives an overview of the relevant theoretical and empirical literature and states the hypotheses. Section 3 briefly compares the German market for financing high-tech firms with other European and the U.S. market. Section 4 lays out the institutional details of the KfW refunding programmes and describes the data set. Section 5 explains

[2] The most promising companies in a venture capitalist's portfolio are called "high-flyers". Clearly only such firms can be brought to the stock market.

the empirical method. Section 6 derives the main results. Section 7 discusses the findings and concludes.

2 Review of the literature and hypotheses

Under both symmetric information and complete contracting, neither agency conflicts nor control problems arise. In such a world, only taxes allow room for an optimal choice of financing mode (Modigliani/Miller 1958). In the absence of taxes, however, the financing decision would have no impact on the firm's value. In contrast, in the real world, asymmetric information prevails and – due to both an indefinite number of future states and unverifiable information[3] – contracts are incomplete and moral hazard occurs (Aghion/Bolton 1992). In such an environment even if taxes are neglected financing decisions matter (Hart 2001).

Ex ante, being paid back depends primarily on the investor's exposure to risk. Thus risk is a crucial determinant for the type of financial contract offered. The investor's risk exposure is a function of the intrinsic project risk, the implied financial risk and the availability of risk mitigating devices. The literature is divided about how these risk components affect the choice between debt and equity contracts. The bank versus venture capital literature predicts an equilibrium in which high-risk projects are equity-financed and entrepreneurs with saver projects apply for loan financing. Ueda (2002) develops a model in which the venture capitalist (henceforth VC) is informed whereas banks suffer from informational disadvantage and a lack of business expertise. The VC's superior expertise enables him to detect unprofitable projects and to take over the control of the project. Given these differences between the two types of financiers the project and the financial risk are decisive for the choice of contracts. A lower success probability and a higher cash flow work in favour of informed venture capital (equity) financing whereas higher amounts of collateral and lower upfront investments support debt financing. A fairly similar conclusion is reached by Landier (2002). Note that in both models the demand side determines the choice of the financing mode since venture (equity) capital is a voluntary choice driven by higher profits gained from that source.

[3] Being unverifiable means that a third party, let's say a court, is unable to prove that the information is true. Writing a contract on observations that are unverifiable is difficult or even impossible since such contracts could not be enforced in front of a court.

Bolton/Freixas (2000) take a different approach. In their model the supply side determines how an entrepreneur is financed. Debt is the preferred mode for any entrepreneur. But since dilution costs are huge for high-risk entrepreneurs this type is rejected by banks and has to stick involuntarily to equity financing. Bolton/Freixas consider the high-risk equity segment as the "last resort" where venture capital firms would offer their services.

The literature on collateralization implies supply-side restrictions, too. Pledging collateral reduces the creditor's financial risk. Because of this property collateral is said to enable entrepreneurs circumventing the rationing in the loan segment partly or even totally (Bester 1985, 1987, Besanko/Thakor 1987). Of course, for high-risk entrepreneurs lacking collateral, this route of returning to the preferred loan market is not open and equity may appear as the only remaining option.

Unfortunately the reason for taking on a specific financing mode is not observable. But independently of whether the financing mode is driven by the demand or the supply side the literature mentioned above leads us to

Hypothesis 1: *Investments with a high intrinsic and financial risk are more likely to be equity than debt-financed. Investments with a low intrinsic and financial risk are more likely to be debt than equity financed*.

Ueda (2003) and Landier (2002) argue that informed equity is of particular importance for high-risk entrepreneurs. Although not obvious at first glance such a conjecture follows also from the literature on moral hazard and collateral. Suppose entrepreneurs have an incentive to manipulate returns or report them falsely (Bester/Hellwig 1989, Bester 1994, Boot/Thakor/Udell 1991) because investors are unable to observe or verify the true cash flows. In such a scenario debt is the optimal financial instrument since it minimizes the cost of lying (Gale/Hellwig 1985, Townsend 1979). If a high-risk entrepreneur is denied a loan and lacks collateral, investors would even be more reluctant to finance when offered just a proportional sharing rule. Then equity financing is only feasible if it is informed in the sense that it develops a similar disciplining effect as collateral does. Only if appropriate control rights enable the investor to detect false reporting and to stop manipulation equity financing will be available for the entrepreneur. Since powerful execution of ownership and control rights can only be expected from a highly concentrated ownership, moral hazard induced equity financing is com-

patible with informed private equity financing but less so with equity financing via public offerings. By taking these considerations into account we arrive at

Hypothesis 1a: *If equity is informed the relation between risk and the financial mode predicted in H1 is more pronounced.*

Note that both conjectures coincide with conventional wisdom about the impact of risk on the nature of segmentation in the market for financing high-tech firms. Nonetheless, a second strand of literature argues differently. By generalizing the models of Stiglitz/Weiss (1981) and De Meza/Webb (1987) Hellmann/Stiglitz (2000) show that high-risk entrepreneurs choose debt in equilibrium whereas saver entrepreneurs opt for equity. A similar conjecture is derived by Boadway/Keen (2002). The rationale behind this result is simple. A debt-financed high-risk/high-return entrepreneur who is successful owns the entire surplus above the fixed face value calculated from the bank's break-even condition for the average entrepreneur. In contrast, an equity-financed entrepreneur of that type would have to share his high cash flow with the investor. For any present value a risk-return threshold exists that leaves the entrepreneur indifferent between debt and equity financing. Although rationing may occur in both markets in principle, entrepreneurs with success probabilities below and returns above this threshold select a debt contract. Founders with opposite risk/return characteristics receive equity financing. If this suggestion meets reality we should observe the opposite to Hypothesis 1:

Hypothesis 2: *Investments with a high intrinsic and financial risk are more likely to be debt-financed than equity-financed. Investments with a low intrinsic and financial risk are more likely to be equity than debt financed.*

To our knowledge to date, only three papers analyze the determinants of debt and equity financing in high-tech SMEs. Carpenter/Petersen (2002) study the financial behaviour of high-tech companies in the U.S. prior and after their IPO. These firms usually have low debt-to-assets ratios prior to the IPO, but increase debt after their listing. Moreover, especially in small firms, debt is secured at nearly 100 %. According to Carpenter/Petersen, these findings suggest that high-tech firms suffer in particular from severe credit constraints as long as the firms represent huge risks for financiers. Only when high-tech firms gain access to the public equity market and are thus able to establish reputation as a mature firm, are credit constraints lifted.

Audretsch/Lehmann (2003) analyze the determinants of the financial structure of firms listed between 1997 and 2002 in Germany's Neuer Markt. They show that small and innovative firms are more likely to be equity (venture capital) financed. Moreover intangible assets like R&D investment, which consists mainly of staff costs, increase the likelihood of obtaining venture capital finance. A listed firm that has obtained venture capital experiences a higher employment growth rate than a firm that is debt-financed. This latter suggestion stands in stark contrast to Bottazi/Da Rin (2002). Exploring European growth bourses including the Neuer Markt they find no significant impact of venture capital on the firms' performance.

Cumming (2002b) explores whether the financing behaviour of the Canadian venture capital industry reflects adverse selection among entrepreneurial firms. To this end he analyzes the determinants of entrepreneurs' (relative) preferences for six distinct financial instruments used by the Canadian VC-industry, including straight debt and common equity. Following Hellmann/Stiglitz (2000), Cumming hypothesizes that straight debt will attract the riskier firms and common equity will attract low-risk/low-return firms. Moreover he assumes that attraction follows the "lemons principle", which states that the worst possible types are attracted to a specific form of finance. Given this assumption he finds considerable evidence for self-selection (adverse selection) among Canadian entrepreneurial firms with respect to both standard financial instruments.

In our own empirical research we focus exclusively on non-listed high-tech companies. We do not treat those firms as belonging to one risk class, as Carpenter/Petersen (2002) do, but aim to find out what theoretical prediction fits best into the empirical reality of the heavily bank-based German financial system. To this end we construct several measures for both the intrinsic and the implied financial risk from balance sheets and structured descriptions of the planned project, and analyze their impact on the likelihood of being debt or equity financed.

3 Financing innovative SMEs in Germany

While banks are a rather established source for financing SMEs in Germany, private equity financing is still in a state of development (Fischer/Zimmermann 2003). The private equity industry is fairly young. The first German venture capital firm was founded only in 1965. Business angels are an even newer phenomenon. Experience with the complete venture cycle (funding, investing, and exiting) is limited among German VCs (Bascha/Walz 2001). Table 2

shows the domestic classic venture capital invested as a percentage of GDP. Despite the boom in the last decade the German VC industry is still far behind the U.S.-industry the latter usually being considered the role model for a well-developed VC industry. Compared to other European countries Germany lies in a medium range. In 2000 the German figure represented the fifth highest level. In 2001 Germanys VC investment/GDP dropped to the fourth lowest level of all European countries shown in table. Unfortunately comparable information about business angels or other types of private investors is not available.

Table 1: Domestic classic venture capital invested as a percentage of GDP

Country	1999	2000	2001
Belgium	0,146	0,120	0,062
Italy	0,042	0,100	0,072
France	0,084	0,189	0,077
Germany	0,097	0,151	0,091
UK	0,138	0,271	0,092
Ireland	0,079	0,172	0,099
Norway	0,066	0,165	0,104
Finland	0,084	0,135	0,120
Spain	0,074	0,122	0,130
Denmark	0,043	0,065	0,140
Netherlands	0,000	0,183	0,161
USA	0,527	1,020	0,398

Source: Reynolds, P.D. et al. (2002), Global Entrepreneurship Monitor 2002

The exact share of outside equity finance for innovative SMEs, whether from VCs or other shareholders is unknown. For the total of all SMEs, however, bank debt is by far the largest source of external finance. Estimates for the U.S. show that at most 5% of SMEs' external finance comes from equity sources (Berger/Udell 2002). For most European countries this figure is likely to be smaller. On the one hand the private equity industry is less strong and on the other hand banks play in general a larger role in corporate financing than U.S. banks. For Germany in particular relationship-based financing for SMEs is traditionally the core business of most banking institutions. Hackethal/Schmidt (1999) estimated for the period of 1970 to 1996 that more than 80 % of the gross amount of external finance for German corporations came from banks. This figure was only 44 % for the United States.

4 Data description

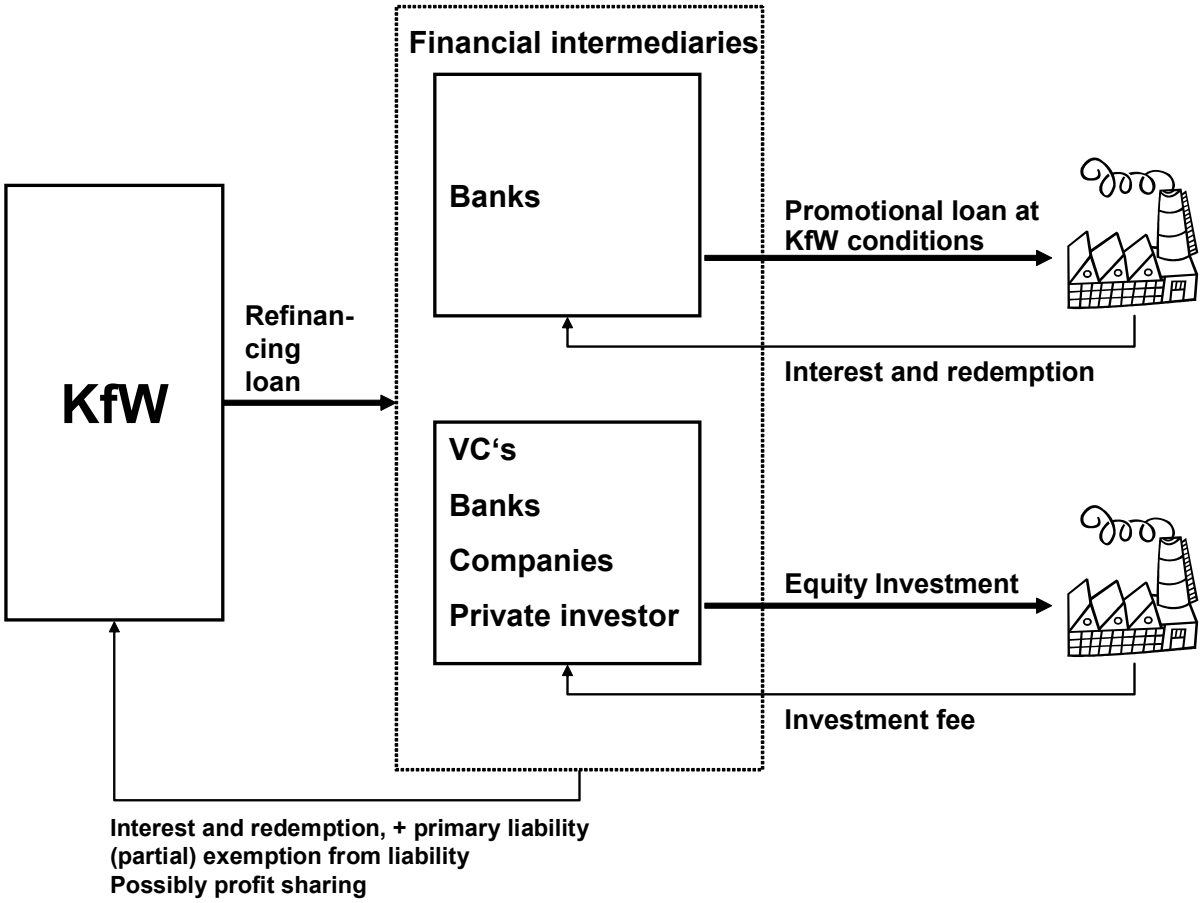
The rate of innovative firms depends on the availability of outside finance, as most young firms do not have enough cash flow to finance their own growth opportunities. To increase this availability most governments have launched specific programmes that should induce intermediaries to provide financing for this type of firm. KfW manages Germany's most important national programmes in this respect. Basically KfW runs two models when promoting innovative SMEs, the co-investment model and the refinancing model. Within the co-investment model the public bank invests jointly with a private lead investor directly into the firm by taking on silent equity. In contrast within the refinancing model financial intermediaries that have invested into a high-tech firm are refunded. Since only the refunding model addresses both private equity and loan financing our data comes only from KfW's refunding programmes.

4.1 The KfW refunding programmes for promoting innovative firms

Within the refunding programmes any intermediary whose application is accepted receives a loan by KfW (see Figure 1). These loans are meant to compensate the intermediary for the liquidity drain caused either by equity or by a loan investment. Intermediaries that make an equity investment have to apply for refinancing under the KfW/BMWA Technology Participation Programme (henceforth BTU) or the ERP Innovation Programme (equity variant) (henceforth ERPB).[4] The BTU-programme has been offered since 1995 and is geared particularly to encourage investments in technology-oriented start-up companies, while the ERPB was set up in 1999 and refinances equity investments in SMEs of any age.

Figure 1: Patterns of promotion in equity and loan programmes

[4] ERP is an abbreviation for European Recovery Programme.



Intermediaries that invest via loans are refinanced under the ERP Innovation Programme (loan variant) (henceforth ERPK), which started in 1996. This programme is equally open to loan investments into SMEs of any age.

A major prerequisite for being eligible to receive a refinancing loan within these programmes is that the underlying venture is innovative. That means that intermediaries can only apply if their portfolio firm uses the money to develop either a new product or technique or to introduce a new product or new technique into the market. The portfolio firm must spend significant parts of the investment money for R&D, and must conduct an essential part of the R&D on its own. An intermediary can only receive refinancing for those parts of its investment into the

portfolio firm that are directly attributable to the particular innovation project.[5] Any programme defines its own upper limit for the proportion of the intermediary's total investment (maximum funding share) that can be refinanced by the KfW.

To encourage investments KfW offers favourable contractual terms. In all three programmes the accepted intermediaries receive long-term loans at favourable conditions. Moreover, KfW assumes part of the intermediaries default risk against payment of an appropriate risk premium by the intermediary. That is, if the portfolio firm defaults the intermediary has to pay back his KfW loan only partly. The percentage that KfW forgives depends on the programme itself and on particular features of the investment. The exemption from liability ranges from 40% for innovation projects in SMEs under the ERP Innovation Programme (loans) to 100% for innovation projects in technology-oriented start-up companies under the BTU Programme (see Appendix 2). The intermediary's total release from default risk is determined by the exemption from liability and the maximum refunding share defined in the programmes. Let's say for example, an equity investor puts 2 million Euro into a portfolio firm that wants to develop a completely new bio-tech product. Suppose in the equity programme the share that can be refinanced is fixed at a maximum of 50 %, and the exemption from liability is 70 %. In this case the equity investor receives a loan from KfW of 50 % of its own investment, that is 1 million Euro. During the lifetime of the long-term loan contract the intermediary pays interest to KfW according to the specific programme's condition, and - if the firm survives until the loan contract expires - the intermediary also pays pack the principal of 1 million Euro to KfW. However, if the portfolio firm defaults the intermediary has to pay back only 30 % of the principal, that is 0.3 million Euro. Thus the intermediary's total release from default risk for this particular investment of 2 million Euro amounts to 35 %.[6]

Allthough considerable parts of the risk connected with the investment still remain with investors these programme features make the KfW's refinancing programmes attractive for all

[5] The eligible refunding share includes all innovation-related investments in real and human capital. Investments in machinery or equipment are refundable, but also so-called "soft investments", such as personnel costs for R&D staff; costs of training, external consultative advice, and business information acquisition. In addition all overheads directly attributable to the innovative project are refundable.

[6] 0.7 million Euro (forgiven by KfW) divided by 2 million Euro (entire investment into the portfolio firm) equals 0.35.

intermediaries that consider to invest into a high-tech firm. This attraction leaves us confident that our samples does not consist of specific investor groups that are for some reasons close to public support banks but contains a broad range of private equity and loan investors.

We use the information sampled from firm's whose financiers successfuly applied for refinancing. Of course, since the degree of release from default risk varies among and within programmes we have to deal with the fact that the release itself may be a major determinant for the observed financing mode. While we do not incorporate the different levels of reducing the financier's risk exposure explicitly into our estimation, we note that the release from default risk in the loan programmes is usually below the release in the equity programmes up to the year 2003 (see Appendix 2). Since the overwhelming majority of observations falls into the period 1999-2002 we can exclude the possibility that the nature of risk sharing creates a bias in favour of loan financing.[7]

At first glance KfW's screening procedure could be another source of systematic sample distortion. However, given that public programmes aim primarily to initiate more equity financing it is unlikely that applications from equity financiers are more thoroughly screened than applications from lenders. Thus our sample should also not be biased in the sense that it entails only relatively save equity investments.

4.2 The risk variables

To capture the investor's risk exposure we construct several classes of risk indicators.[8] First of all we employ *age* as a general risk indicator. This follows from the fact that firms in their very early phases of development do not possess a track record for management. Moreover, investors cannot rely on signals produced by the product market, when assessing the future prospects of the firm. Thus at this stage, the degree of asymmetric information between investor and firm is extremely high. With increasing maturity though, the general level of uncertainty about future prospects should ease.

[7] Note that the overwhelming majority of observations falls into the period before 2003. In that period, the BTU-programme provided a release from default risk of 70% (see also Appendix 1).

[8] For an overview of the explanatory variables see also appendix 3.

The investor's financial risk depends on the size of the transaction and the degree of insurance against losses in the event of default. In some cases a low total equity to total assets ratio and a lack of seizable assets may not only be interpreted by potential lenders as an indicator for a low insurance of claims but also as a sign for a lack of commitment to the firm on the entrepreneur's side. Thus we suggest that entrepreneurs are more likely to be rejected by lenders if the investment is large, seizable assets are scarce, and lenders would become almost a residual claimant to the firm. To capture the size effect we employ the amount of investment relative to total assets (*size-assets*). The lender in case of default can take material assets and receivables away but human capital fails to be seizable as the law prohibits slavery. We count for these distinctions by using the ratio of fixed assets plus current assets relative to staff expenses (*tangible-nontangible)* as proxies for the availability of collateral. Total equity to total assets reflects the degree to which a potential lender would be residual claimant (*totalEquity-assets*)**.** Finally, annual turnover minus staff costs minus cost of material (*price cost margin)* is taken as an indicator for the firm's ability to service debt.

To capture the intrinsic risk we start by constructing four dummy variables for the venture's degree of novelty and the firm's ambition. On the one hand demand is extremely uncertain for projects with a high degree of novelty and a high ambition. On the other hand such highly innovative projects promise a greater return potential, as success would generally imply that either a monopoly position or at least a first-mover advantage is achieved. We suggest that the intrinsic risk is higher if the intermediary's money is spent for developing a new product or process (*inno-process-product*) than if it is spend to introduce an already developed product/process into the market. We also conjecture that risk is higher if the firm invests in developing a product that is entirely new (*inno-and-newproduct*) than if it invests in improving an already known product. We consider an investment made to introduce a product into the market as more risky if the product is a novelty (*introduct-product-new*) instead of being only a variant of an already known product. Finally, the investment should carry more risk if the project is ambitious, that means the firm uses the money for developing an entirely new technological and business field (*newfield*) instead of using it to maintain an already achieved technological lead or to adapt to a new technological development.

In addition to novelty and ambition we consider the R&D content as being closely related to the risk/return potential of a specific venture. First, we conjecture that a large ratio of R&D-expenses to annual turnover (*R&D-intensity-firm*) reflects a high intrinsic risk. Second, an investment that is classified as a true R&D-investment (*classified R&D-project)* is riskier than an investment that fails to receive that label. The loan officer at KfW classifies the specific investment as a true R&D-investment if the money serves to finance the research and development phase of a new product or technology. The label is not granted if the intermediary finances the introduction of an already developed product into the market. Since only the loan department determines the nature of this variable we consider *classified R&D-project* as a particularly strong indicator for the intrinsic risk of the venture. Finally, we construct a further dummy variable that reflects how regularly the firm carries out R&D. An investment should be more risky if it is made in a firm that exerts R&D on a regular basis (*R&D-regular*).

We explored some more indicators for the intrinsic risk such as R&D expenses to staff costs or whether or not external research units such as universities have contributed to the original project idea. However since these indicators are badly observed and, if estimated, they also fail to have explanatory power we do not comment on them any further. Note that we observe most intrinsic risk variables on the project but not on the firm level. However, the project size is huge on average compared to the firm size (see summary statistics, where the variable *size-assets* reflects the ratio of project size to firm size). Thus, we do not pay special attention to the distinct levels when interpreting the results.

4.3 The Sample

Our sample is based on investments promoted by KfW in the period from 1999 to mid 2003. Equity financing comprises common equity, silent equity and a loan granted from a shareholder. Common equity defines a proportional sharing rule and gives the holder voting rights. In contrast silent equity obliges the firm to fulfill a pre-specified claim regularly and carries only conditional voting rights. Only if the firm fails to service the pre-specified claim the holder of a silent equity claim is allowed to exert his voting rights. In addition to these two instruments we take a shareholder loan as equity financing. This is justified for two reasons. First, the loan is subordinated to all other debt claims. This makes the lender a residual claim-

ant, as it is the case with equity financing. Second, the loan's interest directly reduces the return of the shareholder's claims from equity. Thus we interpret loan-related payments to the shareholder as part of his overall claim that results from shareholding.

To deal with the problem of "hidden" loan collateralization via unlimited liability of the entrepreneur we exclude investments in firms with unlimited liability. We restrict our analysis to firms whose annual turnover is below 125 million euros and define an upper limit for the firm's age of 5 years. Moreover we exclude applications in both a debt as well as in an equity programme and applications with inconsistent information. Multiple observations coming from one firm are possible but occur very rarely. They are left in the sample since the observations stem from different stages of the firm's life. After completing these steps we are left with 903 observations.

Table 2: Summary statistics - Basic specification

Variable	Obs.	Mean	Std-Dev	Min	Max	Mean	Std-Dev	Min	Max
		Debt				**Equity**			
totalEquity-assets	228	0,27	0,21	-0,28	0,91	0,16	0,36	-0,94	1,00
tangible-nontangible	228	7,89	50,35	0,28	508,00	2,40	2,89	0,18	22,00
size-assets	228	0,95	2,50	0,02	21,99	5,18	11,90	0,01	93,18
price cost margin	228	0,25	0,23	-0,41	1,00	0,11	0,40	-0,94	0,99
age	228	2,72	1,58	0,00	5,00	3,11	1,49	0,00	5,00
manuf. metal	228	0,16	0,37	0,00	1,00	0,02	0,15	0,00	1,00
manuf. - engeneering, vehicle	228	0,17	0,37	0,00	1,00	0,06	0,23	0,00	1,00
manuf. - equip.,.. Optical industry	228	0,27	0,45	0,00	1,00	0,25	0,43	0,00	1,00
manuf. - other.	228	0,06	0,24	0,00	1,00	0,03	0,18	0,00	1,00
services - Software, data processing	228	0,14	0,35	0,00	1,00	0,37	0,49	0,00	1,00
services - B2B	228	0,05	0,22	0,00	1,00	0,10	0,31	0,00	1,00
services - other	228	0,04	0,20	0,00	1,00	0,10	0,29	0,00	1,00
other	228	0,04	0,20	0,00	1,00	0,02	0,13	0,00	1,00
year2000	228	0,27	0,45	0,00	1,00	0,21	0,41	0,00	1,00
year2001	228	0,18	0,38	0,00	1,00	0,11	0,32	0,00	1,00
year2002	228	0,11	0,31	0,00	1,00	0,04	0,20	0,00	1,00
year2003	228	0,05	0,22	0,00	1,00	0,02	0,13	0,00	1,00
Annual turnover	228	16,09	25,61	0,06	119,67	1,28	2,28	0,03	14,83

As mentioned above we suffer from a problem of missing values. This problem is particularly severe for the financial risk variables. Facing a tradeoff between completeness and sample size we decided to test several models. Our basic specification includes sets of sectoral and year dummies, *age*, and the complete set of financial risk indicators. Due to the missing value

problem the sample size for this basic specification is reduced to 228 observations. Table 2 shows the summary statistics for the basic specification.[9]

To this basic specification the intrinsic risk variables are added one at a time. Of course, as the number of observation for the specific risk variable is the limiting factor, size and structure of the sample change with each specification. Table 3 presents the summary statistics of the intrinsic risk variable for each specification.

The percentage of equity investments in the samples is higher than 50 % (see in Table 5). This sample structure implies that private equity financing is of much higher importance for Germany's young high-tech firms than for SMEs in general. Nonetheless it is possible that the fraction of equity-financed firms is too high compared with their true share in the whole population of externally financed young high-tech firms. We take this problem into account when estimating our results.

Table 3: Summary statistics - intrinsic risk indicators

Variable	Model	Mean	Std-Dev	Min	Max	Mean	Std-Dev	Min	Max
		Debt				**Equity**			
inno-process-product	1	0.89	0.32	0	1	0.72	0.45	0	1
inno-and-newproduct	2	0.41	0.50	0	1	0.31	0.46	0	1
introduct-product-new	3	0.68	0.47	0	1	0.63	0.49	0	1
newfield	4	0.28	0.45	0	1	0.22	0.42	0	1
R&D-intensity-firm	5	18.31	21.49	2	100	36.78	28.39	3	100
classified R&D-project	6	0.85	0.36	0	1	0.52	0.50	0	1
R&D-regular	7	0.77	0.42	0	1	0.88	0.33	0	1

5 Method of Analysis

We study how the propensity to receive equity financing depends on explanatory variables characterizing the project and financial risk of a particular innovative SME by fitting Logit models to the KfW data. Basically, we distinguish between equity and debt financing, as revealed by an intermediary's admission to one of the KfW programmes. The binary dependent variable is defined as

[9] Annual turnover is given in million Euro.

$$Y = \begin{cases} 1 & \text{if} \quad \text{equity financed, i.e. admitted to BTU or ERPB programme} \\ 0 & \text{if} \quad \text{debt financed, i.e. admitted to ERPK programme.} \end{cases}$$

for testing Hypothesis 1 and 2 and

$$Y = \begin{cases} 1 & \text{if} \quad \text{equity plus mangerial or technical support by financier.} \\ 0 & \text{if} \quad \text{debt financed.} \end{cases}$$

for testing Hypothesis 1a. To estimate the effects of both the continuous explanatory variables (denoted as $x_1, x_2, \ldots$) and the dummy explanatory variables (denoted as $z_1, z_2, \ldots$) on the propensity to receive equity financing we fit both the popular Logit model in its standard form but also the following "non-linear" version:

$$P(Y = 1 \mid x_1, x_2, \ldots, z_1, z_2, \ldots) = [1 + \exp(\alpha + \text{polynomial in } x_1 + \text{polynomial in } x_2 + \ldots + \gamma_1 z_1 + \gamma_2 z_2 + \ldots)]^{-1}$$

where the continuous explanatory variables, such as the project size, enter the model as fractional polynomials (Sauerbrei/Royston 1999, Ambler/Royston 2001). These polynomials are of the form $\beta_1 x_j^p + \beta_2 x_j^p \log(x_j)$, where the second term is optional, the powers p are restricted to the set $\{-2, -1, -.5, 0, .5, 1, 2, 3\}$ and p=0 is synonymous with $\log(x_j)$. Note that these polynomials are linear in the coefficients β_1 and β_2, which are estimated by standard Logit maximum likelihood algorithms, along with the coefficients $\gamma_1, \gamma_2, \ldots$ of the discrete (dummy) explanatory variables $z_1, z_2, \ldots$. The powers p are determined by successively comparing models with different values of p according to their fit (deviance).

Apart from the ease with which it can be estimated and interpreted, the Logit model has a feature that makes it particularly attractive for our empirical analysis: the estimates of its slope coefficients are robust to deviations from random sampling referred to as "choice-based-sampling" in the econometrics literature (Anderson 1972, Scott/Wild 1986). That is, if the sample at hand can not be considered as a random sample from the distribution of the dependent variable Y (because, say, equity financed firms have been oversampled) then the Logit es-

timates of the slope coefficients (the β and γ coefficients) can still be consistently estimated from the choice-based sample. Only the Logit estimate of the intercept coefficient α will be inconsistent.[10]

The fractions with which equity-financed and debt-financed firms enter into our sample is a function of the application behaviour of the financial intermediaries and the admission rules of the KfW. The fraction of, say, equity financed firms in our sample may thus be higher than their population share because the KfW may have chosen to expand its equity programmes to achieve certain policy aims. For this reason, we view our sample as possibly being choice-based – which suggests the advisability of using the Logit model for the reasons given in the previous paragraph.

6 Results

Table 4 presents the estimation results for the test of Hypotheses 1 and 2. Although the Logit models that allowed for non-linear effects (via fractional polynomials) fit the data significantly better than their linear counterparts, we still report the results from the latter. This is because both types of models yield qualitatively similar results but the estimates of the standard Logit model are easier to communicate. To make the table easy to understand we omit to report the coefficients of the controls. For any model, size and structure of the sample are presented. For example, the sample defined by the basic specification contains 228 investments. Loan investment count for 45 % and equity investments for 55 % of the sample.

Our general risk indicator age is weekly significant in the basic specification but looses any explanatory power if an intrinsic risk indicator is included (Model 1 - 7). In contrast, most indicators for a high financial risk increase the likelihood of receiving equity finance. In all specifications shown in Table 4 the coefficient for the relative investment size is positive and significant at the 1% level. A high price cost margin and a high ratio of equity to assets decrease the likelihood (increase the likelihood) of equity finance (debt finance). The significance levels of these indicators are also quite robust across specifications. Hence, the results for most of the financial risk variables confirm Hypothesis 1. Only the ratio of tangible to nontangible

[10] This, however, means that we may not use our estimates to infer the *level* of the probability that a firm is equity financed. This is because the level of the probability depends on the intercept coefficient α .

assets which is an indicator for the availability of inside collateral fails to have explanatory power.

However, this latter result may be due to the fact that our sample includes private and state-owned venture capital firms. The latter type of equity investor is usually less profit-oriented and is said to behave often more like a bank than a venture capital firms. To test the effect of state-owned venture capital firms on the overall results we excluded their investments from the sample in a further specification which is not reported here. Then the variable *tangible-nontangible* gained statistical significance and the coefficient was negative.

Table 4: Estimates of Hypothesis 1 und Hypothesis 2

	Basic Specification		Model 1		Model 2	
Sample-size Structure	228	45% 55%	138	45% 55%	131	45% 55%
Explanatory Variables	coefficient	t-value	coefficient	t-value	coefficient	t-value
age	*0,21	1,77	-0,01	-0,08	-0,02	-0,14
totalEquity-assets	*-2,04	-2.71	*-2,20	-1,86	-1,86	-1.52
tangible-nontangible	0,00	-0.21	-0,03	-0,30	0,00	-0,01
size-assets	***0,28	3,79	***0,50	3,61	***0,53	2,23
price cost margin	***-2,32	-3,66	***-3,63	-3,36	***-3,73	-3,55
inno-process-product			**-1,60767	-2.09	-	-
inno-and-newproduct			-	-	*-1,01	-1,74
	Model 3		**Model 4**		**Model 5**	
Sample-size Structure	131	45% 55%	108	46% 54%	117	42% 58%
Explanatory Variables	coefficient	t-value	coefficient	t-value	coefficient	t-value
age	-0,01	-0,04	-0,06	-0,26	0,04	0,17
totalEquity-assets	*-1,98	-1,66	-2,32	-1,60	**-4,17	-2,33
tangible-nontangible	0,01	0,18	0,03	0,54	0,06	1,05
size-assets	***0,51	3,50	***0,90	3,03	***0,80	3,05
price cost margin	***-3,80	-3,69	***-4,54	-3,21	***-5,36	-3,37
introduct-product-new	-0,33	-0,58	-	-	-	-
newfield	-	-	-0,36	-0,46	-	-
R&D-intensity-firm	-	-	-	-	0,01	0,99
	Model 6		**Model 7**			
Sample-size Structure	212	48% 52%	134	46% 54%		
Explanatory Variables	coefficient	t-value	coefficient	t-value		
age	0,18	1,49	-0,11	-0,59		
totalEquity-assets	**-2,03	-2,51	**-2,75	-2,35		
tangible-nontangible	-0,02	-0,55	-0,05	-0,44		
size-assets	*** 0,28	3,86	***0,50	3,37		
price cost margin	*** -2,00	-2,87	***-3,85	-3,66		
classified R&D-project	***-1,25	-2,88	-	-		
R&D-regular	-	-	**2,16	2,47		

***Significance (1%-level),
**Significance (5%-level),
*Significance (10%-level)

The results for the intrinsic risk are less straightforward. Regular R&D activities in a firm (instead of R&D activities every now and then) increases the likelihood of equity finance but the results with respect to novelty and ambition are contrary to Hypothesis 1. Developing a new product or technique (*inno-process-product)* induces a lower probability of receiving equity than introducing an already developed product or technique into the market. The same is true if the firm wants to invest in developing an entirely new product (*inno-and-newproduct*) instead of investing in improving an already known product. The most surprising result with regard to

the subgroup of R&D variables is the significantly negative impact of the variable *classified R&D-project.*[11] Hence, conducting a true R&D-project significantly lowers the odds of receiving equity financing.[12]

Since many records in our data have missing values for one or several key explanatory variables we loose many observations when estimating larger multivariate models such as those shown in Table 4. In particular, very young firms are eliminated from the estimation samples because they have missing entries especially for the variables describing the financial risk of a project or an enterprise. We try to address and alleviate this problem by estimating additionally specifications in which we reduce the number of explanatory variables (besides the time and sectoral dummies) to only four: *age*, *annual turnover, size-asset* and one intrinsic risk indicator at a time. Moreover, we assume that -if not reported- annual turnover is zero. The results for these alternative specifications are reported in Appendix 1. It turns out that sign and significance of the estimated coefficients are quite robust to specification changes and usually agree with the corresponding estimates of the "more variables/fewer observations" models reported in Table 4. We take this robustness as a hint that our results are not mainly driven by the specific composition of the sample that results from a particular specification.

[11] Note that the variable *inno-process-product* and *classified R&D-project* capture similar features of the venture. Since the data for the two variables comes from different ankles the result on *classified R&D-project* may be interpreted as a constistency check for the result on *inno-process-product.*

[12] Since financing a true R&D project lifts the lenders' release from default risk above the level attached to equity investment promoted under the EPRB-program, we were suspicious that the negative coefficient of *classified R&D-project* could be due to a pure programme effect. To explore this possibility we estimated, as a robustness check, an unreported specification in which we only included equity investments with a release from default risk above the loan investment's release. However, both the significance level and the sign of the coefficient remained unchanged.

Table 5: Estimates of Hypothesis 1a

	Basic Specification		Model 1		Model 2	
Sample-size Structure	157	64% 36%	115	53% 47%	107	36% 64%
Explanatory Variables	coefficient	t-value	coefficient	t-value	coefficient	t-value
age	0,03	0,19	-0,08	-0,42	-0,12	-0,61
totalEquity-assets	**-2,06	-2,21	-1,95	-1,55	-1,52	-1,15
tangible-nontangible	0,00	-0,10	-0,05	-0,42	0,00	0,06
size-assets	***0,26	3,38	***0,45	3,12	***0,46	3,04
price cost margin	***-2,72	-3,39	***-3,16	-2,79	***-3,24	-2,92
inno-process-product			*-1,50	-1,86	-	-
inno-and-newproduct			-	-	-1,13	1,74
	Model 3		**Model 4**		**Model 5**	
Sample-size Structure	107	54% 46%	86	52% 48%	96	36% 64%
Explanatory Variables	coefficient	t-value	coefficient	t-value	coefficient	t-value
age	-0,10	-0,51	-0,03	-0,13	-0,10	-0,39
totalEquity-assets	-1,83	-1,40	-2,41	-1,54	**-4,18	-2,04
tangible-nontangible	0,01	0,23	0,02	0,33	0,04	0,67
size-assets	***0,42	2,94	**0,74	2,30	**0,61	2,11
price cost margin	***-3,52	-3,20	***-3,86	-2,67	***-5,32	-3,09
introduct-product-new	-0,62	-1,03	-	-	-	-
newfield	-	-	-0,35	-0,44	-	-
R&D-intensity-firm	-	-	-	-	0,01	1,02
	Model 6		**Model 7**			
Sample-size Structure	155	36% 64%	112	53% 47%		
Explanatory Variables	coefficient	t-value	coefficient	t-value		
age	0,03	0,17	*-0,39	-1,65		
totalEquity-assets	**-2,23	-2,18	*-2,69	-1,95		
tangible-nontangible	-0,01	-0,20	-0,17	-0,95		
size-assets	***0,22	2,85	***0,44	3,19		
price cost margin	***-2,35	-2,75	***-3,89	-3,22		
classified R&D-project	***-1,67	-3,09	-	-		
R&D-regular	-	-	***3,85	2,96		

***Significance (1%-level),
**Significance (5%-level),
*Significance (10%-level)

Table 5 gives the results for the test of Hypothesis 1a. Note that for testing the informed capital hypothesis (Hypothesis 1a) only equity engagements combined with managerial or technical support and loans are taken into account. Thus the estimation samples are subsets of those shown in Table 4. For reasons of space we omit showing the summary statistic for these specification. Obviously, focusing on informed equity has hardly any specific impact on our estimates.

Again the relative project size and price cost margin are highly significant and show the expected sign. Moreover having a high R&D-content (*classified R&D-project*) reduces the project's likelihood of being financed with equity and regular R&D activities in a firm increase it. Hence, the estimated impact of risk on the likelihood of equity finance leads to similar results if only informed equity is taken into account. That is, we cannot find evidence in favour of Hypothesis 1a.

7 Discussion and conclusions

The private equity industry is often considered as a resolution to the financing problems of high-risk entrepreneurs. Little is known, however, about whether this common wisdom is true to the reality of high-tech financing in heavily bank-based financial system such as the German system. Are more risky high-tech firms indeed more likely to receive equity than debt financing?

This study explores the so far neglected relation between the degree of risk embedded in high-tech projects and the way of financing these projects. We find that the indicators describing the financial risk of a project or an enterprise are important predictors for the choice of the financing mode: as expected, (financially) risky projects tend to receive equity financing. In particular, firms with a low price cost margin and a low ratio of equity to assets (prior to the financing stage observed and analysed in this paper) possess a significantly higher chance of receiving equity finance. The same is true for firms with a large project size - a particularly powerful predictor for whether the project is equity financed. This is most likely due to the considerable cost associated with the screening and coaching activities of many equity financiers that may be justified and recouped only for large deals. Whether this is also a sign that banks implicitly restrict their financial risk by limiting the amount of loan granted to the high-tech firm (rationing with respect to the project size) or whether this result simply reflects the fact that banks – contrary to conventional wisdom – stage their financing more than private equity financiers (and grant further credits in the course of the venture's development process) remains to be investigated using (presently unavailable) information on follow-on finance.

Regarding the measures of the intrinsic risk of a project or an enterprise our results are less conclusive. On one hand, if regular R&D activities are taken as an indicator for a risky

enterprise, then high intrinsic risk tends to increase the propensity to receive equity financing. On the other hand, our qualitative indicators of the novelty or the ambitiousness (and therefore the riskiness) of a project often have no significant impact or even a significantly negative impact on the tendency of a project to be financed by private equity. Several explanations for this rather surprising results are possible. First, our qualitative indicators may simply fail to properly measure the intrinsic risk associated with a particular project. If they, however, do pick up the intrinsic risk effects then this result may reflect the prevalence of a more conservative business model in the German private equity industry than common wisdom suggests. VCs and other sources of private equity may focus less intensively on the highly risky stages in the process of developing a new product or process and instead select ventures that have already succeeded in finishing these steps.[13] At the same time, German banks, who traditionally play a big role in financing more conventional SMEs, may also engage in financing high-tech industries and be willing to take on the associated high intrinsic risks – albeit on a small (project) scale.

Although our data stem from public promotional programmes, we are confident that the specific conditions of these programmes do not influence our results in a systematic way. Since some of our findings are contrary to common wisdom they are an urgent call for more empirical research into the mechanism of financing high-tech firms. More research is needed to identify differences in attitudes towards risk within the broad categories of debt and equity financiers and to explore the consequences of a specific financing mode (specific type of intermediary) for the firm's performance. In addition, given that in many European countries the private equity industry is in a similar stage of development as in Germany it would be interesting to know whether in these countries comparable results would emerge.

[13] This latter explanation would be consistent with Engel/Keilbach (2002), who find that possessing a patent significantly increases the firm's likelihood of receiving venture capital, but conflicts somewhat with our result concerning the role of the firm's turnover.

Appendix 1

Basic specification				**Sample structure**[1]		**26.74**	**73.26**
Logit estimates				Number	of obs =		546
				LR chi2	(15) =		204,21
				Prob >	chi2 =		0,00
Log likelihood	-214,94			Pseudo	R2 =		0,32
	Coef.	Std. Err.	t-value	p-value	[95% Conf.	Interval]	
size-assets	0,14	0,04	3,45	0,00	0,06	0,22	
age	-0,03	0,08	-0,30	0,77	-0,19	0,14	
turnover-imputed	0,00	0,00	-4,38	0,00	0,00	0,00	
Model 1				**Sample structure**		**26.18**	**73.82**
Logit estimates				Number	of obs =		337
				LR chi2	(15) =		122,22
				Prob >	chi2 =		0,00
Log likelihood	-130,30			Pseudo	R2 =		0,32
	Coef.	Std. Err.	t-value	p-value	[95% Conf.	Interval]	
size-assets	0,13	0,05	2,63	0,01	0,03	0,22	
age	-0,10	0,11	-0,97	0,33	-0,31	0,11	
turnover-imputed	0,00	0,00	-3,08	0,00	0,00	0,00	
inno-process-product	-0,46	0,39	-1,18	0,24	-1,22	0,30	
Model 2				**Sample structure**		**25.93**	**74.07**
Logit estimates				Number	of obs =		321
				LR chi2	(15) =		127,81
				Prob >	chi2 =		0,00
Log likelihood	-117,43			Pseudo	R2 =		0,35
	Coef.	Std. Err.	t-value	p-value	[95% Conf.	Interval]	
size-assets	0,14	0,05	2,67	0,01	0,04	0,24	
age	-0,10	0,11	-0,93	0,35	-0,32	0,11	
turnover-imputed	0,00	0,00	-3,32	0,00	0,00	0,00	
indrud-product-new	-0,85	0,38	-2,23	0,03	-1,60	-0,10	
Model 3				**Sample structure**		**25.93**	**74.07**
Logit estimates				Number	of obs =		321
				LR chi2	(15) =		133,60
				Prob >	chi2 =		0,00
Log likelihood	-114,53			Pseudo	R2 =		0,37
	Coef.	Std. Err.	t-value	p-value	[95% Conf.	Interval]	
size-assets	0,14	0,05	2,77	0,01	0,04	0,24	
age	-0,15	0,11	-1,32	0,19	-0,37	0,07	
turnover-imputed	0,00	0,00	-3,48	0,00	0,00	0,00	
inno-and-newproduct	-1,23	0,38	-3,27	0,00	-1,97	-0,50	
Model 4				**Sample structure**		**25.27**	**74.73**
Logit estimates				Number	of obs =		278
				LR chi2	(15) =		111,67
				Prob >	chi2 =		0,00
Log likelihood	-98,83			Pseudo	R2 =		0,36
	Coef.	Std. Err.	t-value	p-value	[95% Conf.	Interval]	
size-assets	0,20	0,07	2,62	0,01	0,05	0,34	
age	-0,19	0,13	-1,53	0,13	-0,44	0,06	
turnover-imputed	0,00	0,00	-3,49	0,00	0,00	0,00	
newfield	-0,84	0,43	-1,96	0,05	-1,69	0,00	

Model 5					**Sample structure**		**27.41**	**72.59**
Logit estimates					Number	of obs =		258
					LR chi2	(15) =		102,74
					Prob >	chi2 =		0,00
Log likelihood	-99,45				Pseudo	R2 =		0,34
	Coef.	Std. Err.	t-value	p-value	[95% Conf.		Interval]	
size-assets	0,10	0,05	2,00	0,05	0,00		0,20	
age	-0,08	0,12	-0,67	0,51	-0,32		0,16	
turnover-imputed	0,00	0,00	-2,80	0,01	0,00		0,00	
R&D-intens	0,01	0,01	0,88	0,38	-0,01		0,02	
Model 6					**Sample structure**		**46.95**	**53.05**
Logit estimates					Number	of obs =		261
					LR chi2	(13) =		183,86
					Prob >	chi2 =		0,00
Log likelihood	-79,75				Pseudo	R2 =		0,54
	Coef.	Std. Err.	t-value	p-value	[95% Conf.		Interval]	
size-assets	0,04	0,04	0,98	0,33	-0,04		0,12	
age	-0,03	0,14	-0,19	0,85	-0,31		0,25	
turnover-imputed	0,00	0,00	-3,18	0,00	0,00		0,00	
R&D/staff^2	-1,99	0,45	-4,38	0,00	-2,88		-1,10	
Model 7					**Sample structure**		**30.23**	**69.77**
Logit estimates					Number	of obs =		483
					LR chi2	(16) =		211,46
					Prob >	chi2 =		0,00
Log likelihood	-190,24				Pseudo	R2 =		0,36
	Coef.	Std. Err.	t-value	p-value	[95% Conf.		Interval]	
size-assets	0,14	0,04	3,44	0,00	0,06		0,22	
age	-0,04	0,09	-0,52	0,61	-0,22		0,13	
turnover-imputed	0,00	0,00	-3,73	0,00	0,00		0,00	
classified R&D-project	-1,04	0,29	-3,54	0,00	-1,61		-0,46	
Model 8					**Sample structure**		**26.15**	**73.85**
Logit estimates					Number	of obs =		322,00
					LR chi2	(15) =		130,58
					Prob >	chi2 =		0,00
Log likelihood	-117,41				Pseudo	R2 =		0,36
	Coef.	Std. Err.	t-value	p-value	[95% Conf.		Interval]	
size-assets	0,19	0,06	2,90	0,00	0,06		0,32	
age	-0,08	0,11	-0,67	0,50	-0,30		0,14	
turnover-imputed	0,00	0,00	-2,95	0,00	0,00		0,00	
regular-R&D	0,88	0,45	1,95	0,05	0,00		1,76	
Model 9					**Sample structure**		**25.41**	**74.59**
Logit estimates					Number	of obs =		121,00
					LR chi2	(15) =		55,00
					Prob >	chi2 =		0,00
Log likelihood	-40,27				Pseudo	R2 =		0,41
	Coef.	Std. Err.	t-value	p-value	[95% Conf.		Interval]	
size-assets	0,21	0,16	1,33	0,18	-0,10		0,53	
age	-0,19	0,20	-0,92	0,36	-0,59		0,21	
turnover-imputed	0,00	0,00	-2,12	0,03	0,00		0,00	
spill-over research^2	1,35	1,27	1,06	0,29	-1,14		3,84	

Notes:

[1] The first number gives the percentage of loan investments in the sample.

[2] *R&D/staff* represents R&D expenses to staff costs. *Spill-over research* reflects that external research units such as universities have contributed to the original project idea.

Appendix 2: Current Programme Criteria

Programme	Addressee	Max. funding share in %	Max. amount refinancing loan in € million	Exemption from liability in %	Total release from default risk in %
Equity Programmes					
KfW/BMWA-Technology Participation Progr.	Technology-oriented Start-up [1)]	50 %[2)]	1.4	100 %	50 %[3)]
ERP-Innovation Progr. (Equity)	Innovating SME [4)]	Old federal states: 75 % New federal states: 85 %	5.0	60 %	Old federal states: 45 % New federal states: 51 %
Loan Programmes					
ERP-Innovation Progr. (Loans)	Innovating SME [5)]	R&D-Phase:100% Market introduction: old federal states: 50 % new federal states: 80 %	R&D-Phase: 5.0 Market introduction: old federal states: 1.0 new federal states: 2.5	Depending on sales up to € 5 million: 60 % € 5 to 50 million: 50 % € 50 to 125 million: 40 %	R&D-Phase: 40/50/60% Market introduction: old federal states: 20/25/30% new federal states: 32/40/48%

Notes:

[1)] not older than 5 years, less than 50 employees, balance sheet total up to € 10 million; annual turnover up to € 9 million.

[2)] before 2003: 70%.

[3)] The last column of the table shows the extent of release from risk that can be achieved, given the current conditions, through the combination of refinancing shares and exemption from liability in the different programmes.

[4)] Annual turnover up to € 125 million.

[5)] R&D-Phase: Annual turnover up to € 125 million; Market introduction: annual turnover up to € 40 million, balance sheet total up to € 43 million less than 250 employees.

[6)] From 1999 to 2003 KfW granted for the loans in the ERP Innovation Programme the following total releases from default risk (density in parentheses): 0% (17.4%) 25% (5.3%) 30% (8.2%) 40% (15.8%) 48% (1.8%) 50% (30.0%) 60% (21.5%).

Appendix 3: List of important explanatory variables

Variable	Description
age	Age of the firm
inno-process-product	dummy variable; =1 if the project is aimed at developing a new product or process
inno-and-newproduct	dummy variable; =1 if the project is aimed at developing a product that is entirely new
introduct-product-new	dummy variable; =1 if the project is aimed at introducing a product into the market that is a novelty
newfield	dummy variable; =1 if the project is aimed at developing an entirely new technological and business field
R&D-intensity-firm	R&D-expenses as a fraction of annual turnover
classified-R&D-project	dummy variable; =1 if the project is classified by the loan officer of KfW as being a true R&D-project (early stage or development)
R&D-regular	dummy variable; =1 if the firm regularly carries out R&D
size-assets	Amount of investment/Total assets
tangible-nontangible	Fixed assets plus current assets/staff expenses
totalEquity-assets	Total equity/Total assets
price cost margin	annual turnover minus staff costs minus cost of material

Literature

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

Ambler, G./Royston, P. (2001), Fractional polynomial model selection procedures: investigation of Type I error rate. J. Statistical Simulation and Computation, 69, 89-108.

Anderson, J.A. (1972), Separate sample logistic discrimination, Biometrika, 59, 19-35.

Audretsch, D.B./Lehmann, E. E. (2003), Financing High-Tech Growth: The Role of Debt and Equity, Working Paper, Indiana University, CEPR und Universität Konstanz.

Bascha A. /Walz, U. (2001), Financing Practices in the German Venture Capital Industry, An Empirical Assessment. Working Paper, Economic Department, University of Tübingen.

Bester, H. (1985), Screening vs. Rationing in Credit Markets with Imperfect Information, American Economic Review, 75, 850–855.

Bester, H. (1987), The Role of Collateral in Credit Markets with Imperfect Information, European Economic Review, 31, 887–899.

Bester, H. (1994), The Role of Collateral in a Model of Debt Renegotiation, Journal of Money Credit and Banking, 26, 72–86.

Bester, H./Hellwig, M. (1989), Moral Hazard and Equilibrium Credit Rationing: An Overview of the Issues, in: Bamberg, G. und Spremann, K., Agency Theory, Information, and Incentives, Springer, Berlin, Heidelberg, New York, 135–166.

Berger, A.N./Udell, G.(2002), Small business credit availability and relationship lending: the importance of bank organisational structure, The Economic Journal 112, F32-F64.

Besanko, D./Thakor, A.V. (1987), Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets, International Economic Review 28, 671-689.

Boadway, R./Keen, M. (2002), Imperfect Information and Public Intervention in Credit Markets, mimeo.

Boot, A.W.A./Thakor, A.V./Udell, G.F. (1991), Secured Lending and Default Risk: Equilibrium Analysis, Policy Implications and Empirical Results, Economic Journal 101, 458–472.

Bottazi, L./Da Rin, M. (2002), Venture Capital in Europe and the Financing of Innovative Companies, Economic Policy 34, 229-269.

Bolton, P./Freixas, X. (2000), Equity, Bonds, and Bank Debt: Capital Structure and Financial Market Equilibrium under Asymmetric Information, Journal of Political Economy 108, 324-351.

Carpenter, R.E./Petersen, B.C. (2002), Capital market imperfections, high-tech investment, and new equity, The Economic Journal 112, F34-F72.

Cumming, D. (2002a), The Convertible Preferred Equity Puzzle in Canadian Venture Capital Finance, Working paper, University of Alberta.

Cumming, D. (2002b), Adverse Selection and Capital Structure: Evidence from Venture Capital, Working paper, University of Alberta.

de Meza, D./Webb D.C. (1987), Too Much Investment: A Problem of Asymmetric Information, Quarterly Journal of Economics 102, 281-292.

Dietz, M. (2002), Risk, Self-Selection and Advice, Banks versus Venture Capitalists, Working Paper, Universität von St. Gallen, IFF WP 0201.

Engel, D./Keilbach, M., (2002), Firm Level Implications of Early Stage Venture Capital Investment– An Empirical Investigation – ZEW-Discussion Paper No. 02-82.

Fischer, J./Zimmermann, V. (2003), Beteiligungskapital in Deutschland. Anbieterstrukturen, Verhaltensmuster, Marktlücken und Förderbedarf, KfW.

Gale, D./Hellwig, M. (1985), Incentive compatible debt contracts: the one period problem, Review of Economics Studies 52, 647-63.

Hackethal, A./Schmidt, R.H. (1999), Financing Patterns: Measurement Concepts and Empirical Results. Working Paper, Universität Frankfurt/M.

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

Hellmann T./Stiglitz, J.E. (2000), Credit and equity rationing in markets with adverse selection, European Economic Review 44, 281-304.

Kaplan, S.N./Strömberg, P. (1999), Financial contracting theory meets the real world: an empirical analysis of venture capital contracts, working paper, University of Chicago.

Landier, A. (2002), Financial institutions and entrepreneurship: Banks vs. Venture Capitalists, mimeo, MIT.

Manigart, S./Sapienza, H. (1999), Venture capital and growth, in: Sexton, D.L./ Landström, H. (eds), International State of the Art in Entrepreneurship Research Blackwell Publishers, Oxford, 240-258.

Modigliani, F./Miller, M.H. (1958), The cost of capital, corporation finance, and the theory of investment, American Economic Review 48, 261-297.

Reynolds, P.D/Bygrave, W.D./Autio, E./Cox, L.W./Hay, M. (2002), Global Entrepreneurship Monitor 2002 Executive Report.

Sauerbrei W./Royston, P. (1999), Building multivariable prognostic and diagnostic models: transformation of the predictors by using fractional polynomials, Journal of the Royal Statistics Society, Series A, Statistics in Society, Volume 162, part 1, 71 – 94.

Schwienbacher, A. (2002), An Empirical Analysis of Venture Capital Exits in Europe and in the United States, Working Paper, University of Namur (FUNDP), Center for Research in Finance and Management

Scott, A.J./Wild, C.J. (1986), Fitting logistic models under case-control or choice based sampling. Journal of the Royal Statistics Society, Series B, 48, 170-182

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

Townsend, R. (1979), Optimal contracts and competitive markets with costly state Verification, Journal of Economic Theory 21, 265-93.

Ueda, M. (2002), Banks versus Venture Capital, Working Paper University of Wisconsin – Madison