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Venture Capital versus Bank Financing in Innovative German Firms

Abstract

The paper investigates young firms' choice of capital source. Our theoretical model hypothesizes a positive (negative) relation between riskiness of the project (price of venture capital) and receiving informed equity. We test our predictions by employing a unique data set collected by KfW group. The theoretical framework is largely confirmed for the sample of bank financing and independent VC financing. However, the picture is less clear if the sample includes also public and bank-dependent VCs. In this case, empirical evidence is less compatible with theory, in particular the evidence on intrinsic project risk is inconclusive.

Keywords: Equity financing, debt financing, innovation firms.

JEL: M13, G32

1 Introduction

In the seminal paper Modigliani and Miller (1958) have established that financing decisions are irrelevant to a firm's market value and investment. In the world without information asymmetries, transaction costs, or taxes, and with perfect capital markets, funds are always available for positive net present value projects, firm value is independent of its financial structure, and internal and external finance are viewed as perfect substitutes. However, the real world is far from being perfect and investors may ration capital. As a result of this, positive net present value projects might be either rejected, or only able to obtain certain types of funding.

The role played by financial constraints on investment decisions has long interested economists. Starting with Fazzari, Hubbard and Petersen (1988) many studies have investigated the importance of capital market imperfections on investment.[1] Without perfect information about the characteristics of the borrower's investment projects, the adverse selection problem might lead to a financing gap as firms are restricted to their internal funds.

Venture capital (VC) companies are considered as one of the solutions for closing this funding gap. For instance The Economist reported in November 2004: "Investors poured their money into the industry, certain that venture capitalists had discovered a corporate alchemists's stone, a quick and reliable way of turning bright ideas into valuable firms."[2] This quotation suggests that VC firms might be one of the main sources of financing for young innovative firms. Recent literature also argue that the role of VCs is essentially to screen, contract, and monitor investments for minimization agency and moral hazard costs or for reducing information asymmetries.[3] This allows VC companies to invest profitably in projects rejected by uninformed outsiders. Thus, investments of VC backed companies are less constrained by internal funds generation compared to similar non-VC backed companies.

In the United States venture capital has proven to be able to fill an important gap by providing funds and guidance for promising, yet relatively high-risk, start-up companies, which lack sufficient access to credits from banks. Venture capital has increased both

[1] See Hubbard (1998), Bond and Meghir (1994), Bond, Harhoff and Reenen (1999)

[2] Citation: The Economist, "Once burnt, still hopeful", November 27th, 2004.

[3] See Manigart, Baeyens and Verschueren (2002), Amit, Brander and Zott (1998).

the founding of new businesses and the growth of promising high-tech firms. US-venture capitalists commonly exert corporate control functions and monitor their portfolio firms closely. Since such activities have a positive impact on the firms' corporate governance, VC-backing also strengthens the confidence of outside investors in the portfolio firm. Moreover, VCs are also successful in bringing their portfolio firms to the capital markets.

While the VC industry is firmly established and sophisticated in the US, Germany face a different institutional environment. The German financial system includes an old and well-developed banking sector, while "... Venture Capital and mezzanine finance — essentially, debt with equity-like features — are still rare in Germany."[4]. In order to stimulate domestic venture capital industry German government started numerous programs.[5] The important question is though whether venture capital is able to play in Germany a similar role as in the US.

Why is private equity financing so weakly developed in Germany? What affects the demand, i.e. the firm's decision for a particular financial mode? What factors determine the decision on the supply side, i.e. the private equity firm's selection of portfolio companies. There exist some empirical studies that try to explain what determines the occurrence of specific financial modes in Germany. Audretsch and Lehmann (2004) find that small and innovative firms are more likely to be financed by venture capitalists instead of banks. Engel and Keilbach (2002) suggest that firms with higher innovative output and with a higher educated management have a larger probability of being venture funded. Similarly, Schäfer, Werwatz and Zimmermann (2004) argue that the probability that a young high-tech firm receives equity financing is an increasing function of the financial risk. Our paper goes beyond these studies. We analyze theoretically which factors promote or hinder the choice of equity financing by innovative start-ups. Then we test our predictions by exploring how small and medium sized young innovative German companies choose debt or equity modes of financing. Thereby we focus in particular on the question of how this decision is influenced by the type of VC and the local availability of different types of VC financing.

Based on recent theoretical developments (e.g. Ueda 2002 and Leshchinskii 2002), we model the decision of choosing the financial mode using a simple game-theoretic framework. Risky and safe firms compete for external financing, which can be provided

[4]Citation: The Economist, "The loan factory", April 16th, 2005

[5]Citation: The Economist, "Once burnt, still hopeful", November 27th, 2004.

by credit banks or by equity financiers. As in earlier papers (Cooley and Smith, 1998), we consider an economy in which firms finance their investment entirely either by debt or equity. VC firms have technological expertise that allows them to gain more precise information on the venture than banks.[6] VCs and banks set the price of financing based on available information about overall financial exposure, return and intrinsic riskiness of the project, demand for external financing, and the cost of being informed. The derived mixed strategy equilibrium gives us the opportunity to investigate directly the effects of project characteristics on the probability of selecting a particular financial mode. The model predicts that safer projects and those which need smaller amounts of money are likely to get debt-financing. Moreover, competition in both debt- and equity-financing markets also affects firm's decision of financial mode.

We base our analysis on a data set collected by KfW Group. The data cover the period 1999–2004, and consist of a sample of about 1000 projects, whose investors applied for a refinancing credit with KfW Group. We establish that if asymmetric information is weaker on the VC's side, firms' characteristics indeed affect the choice of the financial mode. There is a positive relationship between both the financial risk and the intrinsic project risk and choosing informed equity financing for the project. In addition, lower compensation requirements for "smartness" work in favor of VC financing.

The data confirm the model's results if the analysis includes commercial VCs and banks only. However, the picture is less clear if the VC sample comprises also public and bank-dependent VCs. In this latter case, a higher financial risk still results in a increased likelihood of equity financing. However, not all the proxies for the intrinsic project risk point in the expected direction. This latter non-conclusiveness may account for distinct strategies of bank-dependent and public VC on the one hand and commercial VCs on the other hand. In any specification, larger firms in terms of turnover are more likely to get debt financing. This result is in line with theory as a high turnover implies a relatively low intrinsic risk of the firm. In addition low compensation requirements by VCs – proxied by the availability of cheap equity sources such as public VC financing – work in some specifications in favor of equity financing.

The rest of this paper is organized as follows. Section 2 presents the theoretical framework. Section 4 describes the data and illustrates econometric model. Finally,

[6] For example Ueda (2002) argues that the technological expertise received through the industry specialization might help VC to assess profitability of projects more accurately than banks.

Section 5 concludes.

2 Theoretical Part

2.1 Model setup

In order to have a consistent framework for the impact of firm- and financier-specific factors we develop a simple stylized model for the financing choice.[7] All agents in the economy are risk neutral. Each entrepreneur has a positive net present value (NPV) project with a one-period time horizon. They compete for "idea development" funding by playing a "financing" game. Because the entrepreneurs have no internal financial resources, they must obtain the amounts necessary for investment, B, from financial intermediaries. If financed the project produces a payoff RB in case of success, and zero payoff otherwise. We denote the gross return on investment as R. There are two types of firms $t \in T = \{H, L\}$, that differ in their success probability. Type H firm succeeds with probability p_h, and type L firm with probability p_l, where $p_h > p_l$.

Financing can be obtained either from a private equity firm (e.g. a VC firm) or from a loan supplier (e.g. a commercial bank). Asymmetric information enters into the model through the fact that banks do not know the type of firm. Equity, however, is informed, in the sense that VCs perfectly observe their client's type. Note, that we assume that the refinancing markets for VCs and banks are completely separated.

To cover the costs of refinancing and project expertise the VC-firm wants to receive at least Ω_y. The expertise is necessary to identify the firm's type perfectly and it is assumed to be scarce. This assumption reflects the notion that the cost per screening procedure, c_y, increases with the number of firms.[8] Consequently, if all entrepreneurs apply to VC, then VC charges more than if the demand for financing is split between banks and VCs: $\Omega_2 > \Omega_1$. The payoff of the entrepreneur is equal to

$$\pi_{vc}^{x,y} = p_x \, \delta_y^x \, B \, R \tag{1}$$

where $x \in \{h, l\}$ and $y \in \{1, 2\}$. $1 - \delta$ is the VC's share of the gross return. The VC's

[7] We follow models by Ueda (2002), Leshchinskii (2002).

[8] Ω_y may also include the VC's mark-up which changes with the VCs bargaining power against the entrepreneur.

participation constraint is

$$p_x BR(1-\delta_y^x) \geq i^{vc}B + c_y = (1+z^{vc})B + c_y \tag{2}$$

with c_y as screening costs and $z^{vc}B$ as the net refinancing cost. The VC's required compensation is the sum $\Omega_y = z^{vc}B + c_y$. We assume that the participation constraint is binding. The share of the firm is then

$$\delta_y^{x*} = 1 - \frac{B+\Omega_y}{p_x BR}, \tag{3}$$

which is positively associated with the probability of success and the return in case of success. Note, there is a negative relationship of δ_y^{x*} with the VC's required compensation, Ω_y. Inserting δ_y^{x*} into (1) yields

$$\pi_{vc}^{x,y} = p_x BR - B - \Omega_y. \tag{4}$$

The situation with bank financing is slightly different. The bank does not know the type of the firm, but it has developed in the past (for example from rating) an a priori belief about the type of the firm that applies for financing. It believes that the firm is of type H with probability θ, and is of type L with probability $1-\theta$. The bank lends the same B, and faces gross refinancing costs i per unit of capital. For simplicity we assume a perfectly elastic supply and perfect competition in the banking sector.

There are two crucial features in this game. First, only the bank faces the risk associated with asymmetric information and second, firms compete for finance with the effect that more demand increases the price of equity financing. We assume that the risk effect associated with asymmetric information dominates the competition effect:

$$\Omega_2 < B(\frac{i}{p_l} - 1) \tag{5}$$

$$\Omega_1 > B(\frac{i}{p_h} - 1). \tag{6}$$

The story behind inequalities (5) and (6) is simple. If the bank faced only a demand of high risk types, the required compensation would be higher than the VC's required compensation if every firm in the economy applies for equity financing. In contrast, if the bank financed only low risk types its required compensation would be smaller than the VC-firm's required compensation in case of a low demand for equity financing.

In order to derive the optimal choice, suppose for a moment that the H-type (L-type) approaches the bank only with a certain probability λ (μ). The bank's participation constraint is given by

$$\frac{\lambda\,\theta}{\lambda\,\theta+\mu\,(1-\theta)}\,p_h\,rB+\frac{\mu\,(1-\theta)}{\lambda\,\theta+\mu\,(1-\theta)}p_l\,rB \;\;\geq\;\; i\,B$$

where r is the gross interest rate the bank charges for financing the firm. With a binding constraint we have

$$r^*=i\,\frac{\lambda\,\theta+\mu\,(1-\theta)}{\lambda\,\theta p_h+\mu\,(1-\theta)p_l}=i\,s.$$

Then the firm's payoff is equal to

$$\pi^{x,y}_{bank}=p_xBR-r\,B=B\,(p_xR-i\,s). \tag{7}$$

The following table represents the payoffs of the "financing game":

	L, bank - probability λ	L, VC, probability $1-\lambda$
H	$\pi^{h,2}_{bank}=B(p_hR-i\,s)$	$\pi^{h,1}_{bank}=B(p_hR-i\,s)$
bank μ	$\pi^{l,2}_{bank}=B(p_lR-i\,s)$	$\pi^{l,1}_{VC}=p_lBR-B-\Omega_1$
H	$\pi^{h,1}_{vc}=p_hBR-B-\Omega_1$	$\pi^{h,2}_{vc}=p_hBR-B-\Omega_2$
VC $1-\mu$	$\pi^{l,1}_{bank}=B(p_lR-i\,s)$	$\pi^{l,2}_{vc}=p_lBR-B-\Omega_2$

In equilibrium, the riskier firm chooses the probability of going to the bank, λ, by making the safe firm (the second firm in this game) indifferent between going to the bank and choosing VC. This strategy implies that the L-firm solves

$$\lambda\pi^{h,2}_{bank}(\mu,\lambda)+(1-\lambda)\pi^{h,1}_{bank}(\mu,\lambda)=\lambda\pi^{h,1}_{vc}+(1-\lambda)\pi^{h,2}_{vc}. \tag{8}$$

Respectively, the safe firm H chooses its probability of demanding finance from the bank according to

$$\mu\pi^{l,2}_{bank}(\mu,\lambda)+(1-\mu)\pi^{l,1}_{bank}(\mu,\lambda)=\mu\pi^{l,1}_{vc}+(1-\mu)\pi^{l,2}_{vc}.$$

Solving both equations for s yields

$$s(\lambda,\mu)=\frac{B+\Omega_1\lambda+\Omega_2(1-\lambda)}{i\,\lambda\,B}\text{ and }s(\lambda,\mu)=\frac{B+\Omega_1\mu+\Omega_2(1-\mu)}{i\,\mu\,B}.$$

Since these expressions are completely symmetric, $\mu = \lambda$. Inserting this equality into (8) and solving for λ gives

$$\lambda = \frac{\Omega_2 \widetilde{p} - B(i - \widetilde{p})}{(\Omega_2 - \Omega_1)\widetilde{p}}$$

where $\widetilde{p} = \theta p_h + (1 - \theta) p_l$. We interpret λ as the probability of the high risk firm to choose bank financing.

Lemma 1: There exist three ranges of θ. In the lowest range $\theta \in [0, \theta_1]$ (banks are very pessimistic about the quality of their borrowers) $\lambda \leq 0$, i.e. only VC-financing occurs. In the highest range $\theta \in [\theta_2, 1]$ (banks are very optimistic about the quality of their borrowers) $\lambda \geq 1$, i.e. firms go exclusively to banks. In a medium range of $\theta \in]\theta_1, \theta_2[$ (believed quality is mediocre) $\lambda \in]0, 1[$ and firms choose either bank or VC financing.
Proof: see appendix

In reality both financing modes occur. So it is reasonable to concentrate in the further analysis on the medium range. The theoretical predictions of the model can be written as

$$\frac{\partial \lambda}{\partial B} = \frac{i - \widetilde{p}}{(\Omega_2 - \Omega_1)\widetilde{p}} < 0 \tag{9}$$

$$\frac{\partial \lambda}{\partial \Omega_1} = -\frac{B(i - \widetilde{p}) - \Omega_2 \widetilde{p}}{(\Omega_2 - \Omega_1)^2 \widetilde{p}} > 0 \tag{10}$$

$$\frac{\partial \lambda}{\partial p_l} = \frac{Bi(1 - \theta)}{(\Omega_2 - \Omega_1)\widetilde{p}^2} > 0. \tag{11}$$

The inequalities (9) - (11) apply also to safe firms as it is symmetric. The derivatives of the probability for bank financing provide us with the following hypotheses:

1. Ceteris paribus a large project size/low equity ratio increases the likelihood of (external) equity finance (decreases the chance of bank financing).

2. Higher minimum compensation requirements of equity financiers decrease ceteris paribus the probability of equity financing (increases the chance of bank financing).[9]

[9]Note, that we assume a complete lack of own resources for the entrepreneur. Thus, B represents

3. An increase in the intrinsic project risk increases the likelihood of equity finance (decreases the probability of bank financing).

2.2 Econometric Model Specification

In order to investigate the determinants of financial mode we employ a logit model. For the combined sample of projects that are equity and debt financed it is expressed as follows:

$$equity_{it} \quad = \quad \Lambda(\alpha_1 \log(size)_{it} + \alpha_2 \Omega_{it} + \alpha_3 risk_{it} + X_{it} + \varepsilon_{it})$$

where

$equity_{it}$ = a dummy variable equal to one if project j at time t has chosen equity-financing or equity like financing and zero if it has chosen credit;
$size_{it}$ = a logarithm of size of a project i with which firm applies for financing at time t,
Ω_{it} = a proxy for the compensation required by a venture capitalist;
$risk_{it}$ = a measure for riskiness of project i at time t;
X_{it} = a set of industry, region and time dummy variables;
Λ = the c.d.f. of the logistic distribution.

Note, that both the coefficient of $\log(size)_{it}$ and its negative value (effect of a change in

both the financial exposure of the intermediary and the project size. However, this is no longer the case if we drop that assumption and let the entrepreneur invest own resources E in the venture. In this case VC-financing yields a gross profit of

$$\pi_{vc}^{x,y} = E + I(Rp_x - 1) - \Omega_y.$$

and bank financing results in

$$\pi_{bank}^{x,y} = p_x I\, R - (I - E) i\, s.$$

The intermediary's financial exposure is $B = I - E$. Thus the equlibrium probability of bank financing for the high-risk entrepreneur changes to

$$\lambda \quad = \quad \frac{-(I-E)(i-\tilde{p}) + \Omega_2 \tilde{p}}{\tilde{p}(\Omega_2 - \Omega_1)}. \qquad (12)$$

Obviously the derivative with respect to I, given that E remains constant, is the negative derivative with respect to E. An increase of $\Delta\, I$ decreases the equity ratio to $E/(I + \Delta I)$. Thus, the negative sign of the derivative with respect to I can be interpreted as the change of the probability of bank financing with respect to the equity ratio.

the equity ratio, see footnote 9) reflect the financial risk. As stated in our hypotheses we expect that if the financial risk goes up the proclivity for equity financing increases.

We proxy the minimal compensation requirement of VCs, Ω_{it}, by a set of dummy variables measuring prevalence of a certain VC type in intersect of industry, region and year. In the KfW-dataset four main types of VC are identifiable: public VCs (include publically owned equity financiers), bank-dependent VCs (include banks and financial institutions plus VCs that are subsidiaries of banks and saving banks), independent VCs (independent Venture Capital firms) and other VCs (includes incubators, other private equity investors that are not VCs, business angels, insurance companies and pension funds). The VC type is called prevailing if the sum of all application to this VC, n_{type}, in a specific region, industry and year is the largest among all four types or close to the largest.[10] For $type \in \{Public, Bank, Indep, Other\}$, prevalence is defined as[11]

$$\begin{aligned} \Omega^{type} &= 1, \text{ if } \max(n_{Public}, n_{Bank}, n_{Indep}, n_{Other}) - n_{type} \leq 3 \\ &\quad \text{or } 0, \text{ otherwise} \end{aligned}$$

We denote prevalence of public, bank-dependent and independent VCs by Ω_{it}^{Public}, Ω_{it}^{Bank}, Ω_{it}^{Indep}, respectively. The other type of VCs is not prevailing in any of regions/industries/ years. We assume that required minimum compensation is low if the prevailing type is public,[12] and it is high if the prevailing type is an independent VC.[13] For bank-dependent VCs required compensation should range between the other two. This assumption is mainly due to the fact that this category also includes subsidiaries of public saving banks which may resemble public VCs with respect to their compensation behavior.

To check robustness of our results with respect to intrinsic project risk $risk_{it}$, we use several proxies: turnover of the firm, $\log(turnover)_{it}$, age of the company, age_{it}[14] and three measures that reflect the innovativeness of the firm or/and the project as risk

[10] The difference between the largest and almost the largest sums does not exceed three.

[11] Lets assume for example

$$\max(n_{Public} = 7, n_{Bank} = 9, n_{Indep} = 2, n_{Other} = 2) = 9$$

then $\max(\cdot) - n_{Bank} = 0 \leq 3$, that is $\Omega^{Bank} = 1$, $\max(\cdot) - n_{Public} = 2 \leq 3$, that is $\Omega^{Public} = 1$, $\max(\cdot) - n_{Indep} = 7 > 3$, that is $\Omega^{Indep} = 0$, etc.

[12] See Achleitner, Tchouvakhina, Zimmermann and Ehrhart (2006) for expected minimum rates of returns for different types of German VCs.

[13] See Bottazzi, Rin and Hellmann (2004) for the effects of investor heterogeneity on investment style.

[14] The age varies from 1 to 10 years

indicators.[15] We set new_{it} equal to one if the project is aimed at developing an entirely new technological and business field and zero otherwise. Another dummy variable, $R\&D_{it}$, is one if the project is in the R&D phase and zero if it is already in the market launch phase. Finally, we consider a firm as particularely risky if it carries out R&D on a regular basis: $R\&Dreg_{it}$. Our theoretical model predicts a positive signs for α_1 and α_3 and a negative one for α_2.

3 Empirical implementation

The theoretical model developed in the previous section suggests several firm and project characteristics that might affect the choice of financing. In this section, we test the theoretical predictions for a panel of German firms.

3.1 Data description

The data for the study are taken from the KfW firm database for 1999–2004. KfW manages Germany's most important national programmes for promoting innovative young firms. Within the programmes in our samlpes KfW refinances intermediaries that have invested into an innovation project of a firm by granting a loan.[16] These loans are meant to compensate default riskiness for financial institutions. Intermediaries that invest apply for refinancing under the KfW/BMWA Technology Participation Programme (henceforth BTU) or the ERP Innovation Programme (equity variant) (henceforth ERPB). The BTU-program was offered from 1995 to 2004 and is geared particularly to encourage equity investments in technology-oriented start-up companies, while the ERPB has been set up in 1999 and refinances equity investments in SMEs at any stage. Intermediaries that invest via loans are refinanced under the ERP Innovation Programme (loan variant) (henceforth ERPK), which started in 1996 and is equally open to loan investments into any SME. Furthermore, BTU program has 1.4 million EUR as the maximum amount of refinancing loan per firm comparing to 5 million per innovation project in the other programs. The BTU-program before 2000 applies a ten year restriction on age. After 2000 the restriction has been changed to five years.

[15]We employ Consumer Price Index (CPI) for turnover and project adjustment, taken from Bundesbank website, www.bundesbank.de

[16]See Schäfer et al. (2004) for a detailed description of KfW database.

Our main sample contains financial information on about 4,000 projects. Any firm could have more than one project in which intermediaries have invested and are therefore entitled to apply for refinancing with KfW. The firms are classified by 2-digit NACE code. We apply a number of sample selection criteria. In order to alleviate the influence of extreme observations, investment size and turnover variables are winsorized at the most extreme (top and bottom) one percent level of the distribution on an annual basis.[17] In order to increase comparability of the remaining data set we keep only those debt financed firms that are younger than ten years before 2000 or younger than five years after 2000. These screens collectively reduced the sample to about 1000 firms.

Table 1 presents a first look at the data. We report descriptive statistics of the variables used in our regression analysis for the all project sample and by regions. For convenience we merge data for the German federal states Bremen, Hamburg, Schleswig-Holstein and Lower Saxony into North region; Saarland, Rhineland-Palatinate and Hesse into West region; Mecklenburg-Western Pomerania, Brandenburg and Saxony-Anhalt into East region; Saxony and Thuringia into Center region. Such states as North Rhine-Westphalia, Baden-Wurttemberg, Bavaria and Berlin are left without any aggregation. From the mean of the all projects statistics we see that about 58 percent of projects on average receive equity financing. This number varies dramatically by region: from 82 percent in Berlin to only 35 percent in Baden-Wurttemberg. The oldest and largest firms by turnover are also located in the latter region.

Industries are grouped into 3 main groups: metal manufacturing (includes metallurgy, metal processing and electronics), non-metal manufacturing and services. 81 percent of projects in services on average receive equity financing while 51 percent of project in metal manufacturing receive debt financing. However, the oldest and largest firms belong to non-metal manufacturing industry. In our analysis we also consider distribution of firms by year. The highest percentage of projects that receive equity financing is observed in 2000 and is equal to 77 percent. After that this number steadily decreases to 46 percent in 2004. We place firms into "small firms" and "large firms", defining firms as above and below the median of the average turnover distribution, respectively. Similarly, we construct the data sets of "small project" and "large project" firms based on project size.

[17] As a sensitivity check, we winsorize pooled data and perform all of our tests. Our results are not affected by this specification.

3.2 Results discussion

The first part of the empirical study investigates the factors affecting decisions of innovative firms regarding the mode of financing. The four columns of Table 2 show the results of the logit regressions on the probability of getting equity financing for all firms. In each column we report marginal effects around means. In all our regressions we use Huber-White robust standard errors. As any firm could have more than one project we specify projects of the same firm as a cluster. Every regression includes also year, industry and region dummy variables.

Consistent with our theoretical prediction, the coefficient on the project size variable is positive and strongly significant, indicating that size of the investment project matters. Equity financed projects are likely to be larger compared to debt financed ones. Considerable cost associated with the screening and coaching activities of many equity financiers may only be justified and recouped for large deals. Given that this coefficient multiplied by -1 can be interpreted as the marginal effect of a change in the equity ratio, this result clearly signals that equity investors are prepared to take on more financial risk than debt financiers. Credit financier may avoid a too large risk exposure and implicitly restrict their financial risk by two measures. First, they limit the amount of loan granted to the high-tech firm (rationing with respect to the project size), and second they stick to firms with fairly large equity ratios. There is negative relationship between turnover of the applying firm and likelihood of getting equity financing for the project. The variable displays a statistically significant coefficients at 1 % and 5 % confidence level. The result is also compatible with our theoretical prediction given that turnover reflects intrinsic risk (low turnover = high risk). Note that the findings on project size and turnover hold for almost all specifications.

The prevailing types of VC have a significant effect, but the sign is as expected only in case of the public VC dummy. In those industry-region-years, where the public VC type dominates, firms are likely to choose equity financing. However, in some regions and sectors public VCs may provide the only external equity-based financing. Thus, the positive sign could simply reflect the fact that appearence of public VCs opens up the possibility to realize latent demand for venture capital. The coefficient for the independent VC-type dummy in a specific industry-region-year is also positive and weakly significant in some specifications. The latter result may indicate that apart from the price effect there is also a clustering effect that is not covered by the model. The possibility of efficiency enhancing spill-overs between clustered independent VCs may make equity financing particularly attractive.

The regression results from including a series of project risk characteristics are reported in columns 1-4. We find a negative effect of $R\&D_{it}$, which indicates that being in the $R\&D$ phase of a innovation project would decrease the chance for equity financing. At the same time the chance for equity financing increases with the fact that a firm carries out $R\&D$ on a regular basis. Being aware of the heterogeneity of the German VC industry an explanation could arise from different business models within the VC group. The public VC type might not be prepared to deal with high intrinsic project risk and prefers to play safe. Second, the bank-dependent VCs may have inherited a conservative strategy from their mother companies. If a lack of homogeneity of VC firms is responsible for the inconclusive evidence then results should be different if we split up the VC sample into more homogenous subgroups.

Indeed, with commercial VC as the only type in the VC sample the contradictory results vanish (Table 3). The variable $R\&Dreg$ has a positive coefficient that is significant at the 1 % level. For all other risk indicators the zero hypothesis of no impact can not be rejected. In those industry-region-years, where the bank-dependent VC type dominates, firms are likely to choose credit financing. The coefficients for the independent VC-type dummy is positive and significant in most specifications. This result points again at important clustering effects. Table 4 illustrates that adding public VCs to the group of commercial VCs changes the picture, a fact that supports the hypothesis of strong heterogeneity among business models of German VCs. In particular it renders the evidence with respect to the project risk again inconclusive. Finally, Table 5 reveals that in a comparison of credit financing and equity financing by banks the intrinsic project risk seem to play no role. In sum commercial VCs seem to fit best into the framework provided by financial theory.

For examining further the robustness of our result with respect to the intrinsic project risk we investigate more homogenous subsamples of firms. Results are reported in Table 6. The common finding for large/small firms and large/small project size is that the proxy $R\&Dreg$ is positive and significant. The significant coefficients in the specifications for large firms/project sizes confirm the model while the significant risk variables in the specifications for the mirroring sub-samples play an ambiguous role. As a third check we exclude initial stage equity financing but in this specification none of the risk indicators turn out to be significant. This finding implies a low importance of risk as a determining factor for following financing rounds.

The second part of our empirical examination goes beyond the theoretical model. It digs deeper into the relation of the capital provider's smartness and the sharing rule imposed by a specific financial instrument. For that purpose we consider VC financing exclusively. Using a multinominal logit model, we estimate the probability that the VC type determines the financial mode used. Three financial modes are distinguished: mezzanine/silent equity, credit provided by an incumbent equity financier (credit (incumbent equity) in the Table), and common equity. The specifications (1)-(3) with three different risk measures are reported in Table 7. The reported slope coefficients tell us how the log-odds of falling into the given category (e.g. common equity) vs. the base category (mezzanine/silent equity) changes with a unit change in the explanatory variables. Our main variables of interest are the dummy variables VC_2 and VC_3 corresponding to bank-related and independent (commercial) VCs, respectively.[18] The results suggest that independent VCs prefer common equity and - if they are already equity financier - debt to mezzanine/silent equity financing. Provided that independent VCs have on average the highest degree of smartness this result implies a close tie between informed capital provision and common equity for German young high-tech firms. There is also some evidence that bank-dependent VC - given that they are equity provider already - prefer debt to any other financial modes. Interestingly, larger projects are more likely to get common equity than mezzanine/silent equity.

4 Conclusions

This paper examines the determinants of choosing financing mode, that is, equity or debt financing. In line with the game-theoretical model we expected that larger projects and projects with a relatively high financial risk exposure for the external investor are more likely to get equity than debt finance. In addition, likelihood of equity financing (debt financing) should the more increase the lower the intermediary's required compensation

[18] Public VC is a benchmark category.

is. Finally the theoretical model predicts that the intrinsic project risk will stimulate more VC financing.

We test our hypothesis using project level data during 1999–2004 of KfW group – one of the largest public support banks in Germany. We are allowed to use the database due to a wide-ranging cooperation with KfW. The data suggest that independent (commercial) VCs correspond the most to the informed equity provider that is assumed in the theoretical model. Three results are fairly stable in all of the specifications of the regression model. First, the size of the particular investment project the intermediary finances increases the likelihood of equity financing. This finding indicates that private equity suppliers are more prepared to take on a high financial risk exposure than credit banks. Second, a large turnover works in favor of credit financing. The latter may show that credit institutions care less about the project risk but more about the firm's intrinsic risk and stay away from firms that carry a high intrinsic risk signalled by a low turnover. Third, regression results strongly support the prediction that the price of external funds matters. The availability of cheap public funds seem to have a positive impact on equity financing. Surprisingly, being located in a surrounding where equity financing by independent VCs is prevailing does not decrease the probability of equity financing relative to credit financing, although these sources provide presumably fairly expensive capital. But there may be clustering effects that overcompensate the price effect. Commercial German VCs seem to have a high affinity for common equity. Forth, our intrinsic risk measures indicate that carrying out $R\&D$ on a regular basis increases the chance for equity financing. However, the picture concerning the other proxies for the project is less clear, a fact that supports the hypothesis of strong heterogeneity among business models of German VCs.

Some caveats should also be noted. First, our data stem from public promotional programmes. This might cause self-selection bias if VCs and banks deny applying for public refinancing programmes. Second, we do not consider explicitly the syndication of investments among VC-firms. In particular more research is needed to explore the interaction between syndication and the risk of the venture. Finally, our research reveals that public VCs play an important role in the German VC industry. As part of the state-based column of the German financial system the specific role of public VCs deserves more examination than has been done so far.

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Appendix 1: Proof of Lemma 1

Recall that $\lambda = \mu$. Thus we prove the existence of three distinct ranges of θ only for λ. We establish at first θ_1 from the inequality

$$B(p_x R - s\,i) < p_x BR - B - \Omega_2. \tag{13}$$

and

$$\theta < \frac{B(i - p_l) - \Omega_2 p_l}{(B + \Omega_2)(p_h - p_l)} = \theta_1.$$

Substituting θ by 0 and solving for Ω_2 gives (6). Thus $\theta_1 > 0$ which implies that (13) is satisfied in the range $\theta \in [0, \theta_1]$. $\lambda > 1$ requires

$$B(p_x R - s\,i) > p_x BR - B - \Omega_1. \tag{14}$$

This yields

$$\theta < \frac{B(i - p_l) - \Omega_1 p_l}{(B + \Omega_1)(p_h - p_l)} = \theta_2.$$

Substituting θ by 1 and solving for Ω_1 gives (5). Thus $\theta_2 < 1$. This inequality ensures that (14) is satisfied in the range $\theta \in [\theta_2, 1]$. Finally, $\theta_1 < \theta_2$ is satisfied if $\Omega_2 - \Omega_1 > 0$. The right hand side is negative. Thus this inequality always holds, meaning that a medium range $\theta \in]\theta_1, \theta_2[$ exists. In this medium range $B(p_x R - s\,i) > p_x BR - B - \Omega_2$ and $B(p_x R - s\,i) < p_x BR - B - \Omega_1$ yielding $0 < \lambda < 1$. $\triangle$

Appendix 2: Construction of the data

The following variables are used in the study:

equity: a dummy variable equal to one if the project gets equity financing or equity like financing and zero if it has chosen credit financing

Log(*project size*): Log of the size of the project in which the intermediary takes a stake and applies for refinancing with KfW;

Log(*turnover*): Log of the firm's turnover

Ω^{Public}: a dummy variable with value 1 if public VCs are prevalent and zero otherwise,

Ω^{Bank}: a dummy variable with value 1 if bank-dependent VCs are prevalent and zero otherwise,

Ω^{Indep}: a dummy variable with value 1 if private independent VCs are prevalent and zero otherwise.

age: age of the firm, risk indicator, varies from 1 to 10 years;

new: a dummy variable, that is 1 if the project is aimed at developing an entirely new technological and business field and zero otherwise;

R&D: a dummy variable with value 1 if the project is in the R&D phase and zero if it is already in the market launch phase;

$R\&Dreg_{it}$: a dummy variable with value 1 if the firm carries out R&D on a regular basis and zero otherwise.

Bundesbank: Consumer Price Index (CPI)

Table 1: Descriptive Statistics for all firms and by regions

	All		Region East		Center	
	μ	σ^2	μ	σ^2	μ	σ^2
$equity_{it}$	0.589	0.492	0.643	0.483	0.636	0.484
Log($project\ size$)$_{it}$	13.564	1.252	13.534	1.160	13.708	1.248
Log($turnover$)$_{it}$	8.751	6.756	9.481	5.977	7.763	6.805
Ω_{it}^{Public}	0.143	0.351	0.214	0.413	0.057	0.233
Ω_{it}^{Bank}	0.099	0.299	0.000	0.000	0.057	0.233
Ω_{it}^{Indep}	0.170	0.376	0.129	0.337	0.057	0.233
age_{it}	2.481	2.578	2.557	2.465	2.341	2.669
new_{it}	0.375	0.485	0.385	0.496	0.297	0.463
$R\&D_{it}$	0.815	0.389	0.813	0.397	0.791	0.412
$R\&Dreg_{it}$	0.311	0.463	0.300	0.462	0.295	0.459
	North		North Rhine-West.		West	
	μ	σ^2	μ	σ^2	μ	σ^2
$equity_{it}$	0.755	0.432	0.529	0.501	0.525	0.502
Log($project\ size$)$_{it}$	13.346	1.330	13.559	1.083	13.454	1.161
Log($turnover$)$_{it}$	7.694	6.417	9.436	7.003	9.103	6.401
Ω_{it}^{Public}	0.415	0.495	0.000	0.000	0.000	0.000
Ω_{it}^{Bank}	0.000	0.000	0.000	0.000	0.000	0.000
Ω_{it}^{Indep}	0.151	0.360	0.000	0.000	0.129	0.337
age_{it}	2.387	2.517	2.544	2.561	2.515	2.419
new_{it}	0.310	0.468	0.404	0.495	0.306	0.467
$R\&D_{it}$	0.774	0.423	0.843	0.367	0.767	0.427
$R\&Dreg_{it}$	0.245	0.432	0.353	0.480	0.327	0.471
	Bad.-Wurttemberg		Bayern		Berlin	
	μ	σ^2	μ	σ^2	μ	σ^2
$equity_{it}$	0.352	0.479	0.593	0.493	0.821	0.385
Log($project\ size$)$_{it}$	13.304	1.362	13.927	1.359	13.736	1.121
Log($turnover$)$_{it}$	10.317	6.575	8.193	7.388	0.331	6.579
Ω_{it}^{Public}	0.254	0.437	0.073	0.261	0.158	0.367
Ω_{it}^{Bank}	0.211	0.410	0.146	0.355	0.347	0.479
Ω_{it}^{Indep}	0.254	0.437	0.285	0.453	0.347	0.479
age_{it}	2.901	2.822	2.276	2.536	2.168	2.508
new_{it}	0.436	0.501	0.400	0.495	0.424	0.502
$R\&D_{it}$	0.788	0.412	0.817	0.390	0.930	0.258
$R\&Dreg_{it}$	0.338	0.475	0.325	0.470	0.284	0.453

Note: σ^2 and μ represent distribution variance and mean respectively.

Table 2: Determinants of equity financing, logit regression, all firms

	Dependent variable, $equity_{it}$: equity = 1, debt =0			
	age	*new*	*R&D*	*R&Dreg*
Log$(project\ size)_{it}$	0.171***	0.135***	0.144***	0.168***
	(0.02)	(0.02)	(0.02)	(0.02)
Log$(turnover)_{it}$	-0.026***	-0.023***	-0.022***	-0.029***
	(0.00)	(0.00)	(0.00)	(0.00)
Ω_{it}^{Public}	0.149**	0.119*	0.235***	0.142**
	(0.06)	(0.07)	(0.05)	(0.06)
Ω_{it}^{Bank}	0.022	0.024	0.094	0.018
	(0.11)	(0.12)	(0.12)	(0.11)
Ω_{it}^{Indep}	-0.121*	-0.027	-0.009	-0.142**
	(0.07)	(0.11)	(0.11)	(0.07)
age_{it}	-0.008			
	(0.01)			
new_{it}		-0.098		
		(0.06)		
$R\&D_{it}$			-0.118**	
			(0.05)	
$R\&Dreg_{it}$				0.133***
				(0.04)
N. obs	652	336	410	652
Log-likelihood	-269.647	-130.186	-166.200	-265.906
Pseudo R2	0.37	0.37	0.37	0.38
Chi2	163.55	81.20	109.36	161.71

Note: Every equation includes constant and industry, region and year dummy variables. Robust standard errors are reported in the brackets. Marginal effects are calculated around mean points. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Determinants of equity financing, logit regression, commercial VC vs ERPK (= bank loans)

Dependent variable, *commercial VC-equity*$_{it}$: equity = 1, debt =0				
	age	*new*	*R&D*	*R&Dreg*
Log(*project size*)$_{it}$	0.158***	0.286***	0.195***	0.160***
	(0.02)	(0.06)	(0.04)	(0.02)
Log(*turnover*)$_{it}$	-0.017***	-0.039***	-0.022***	-0.021***
	(0.00)	(0.01)	(0.01)	(0.00)
Ω_{it}^{Public}	0.016	0.333	0.376	-0.007
	(0.08)	(0.21)	(0.23)	(0.07)
Ω_{it}^{Bank}	-0.112***	-0.329***	-0.170***	-0.117***
	(0.04)	(0.10)	(0.06)	(0.04)
Ω_{it}^{Indep}	0.459***	0.383	0.428*	0.551***
	(0.15)	(0.25)	(0.25)	(0.15)
age_{it}	-0.010			
	(0.01)			
new_{it}		-0.149		
		(0.13)		
$R\&D_{it}$			-0.087	
			(0.09)	
$R\&Dreg_{it}$				0.162***
				(0.05)
N. obs	337	157	207	337
Log-likelihood	-94.757	-53.534	-61.602	-90.202
Pseudo R2	0.53	0.50	0.53	0.56
Chi2	84.94	45.95	54.40	96.72

Note: Every equation includes constant and industry, region and year dummy variables. Robust standard errors are reported in the brackets. Marginal effects are calculated around mean points. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Determinants of equity financing, logit regression, bank independent vs ERPK (= bank loans)

Dependent variable, *bank-independent equity*$_{it}$: equity = 1, debt =0

	age	*new*	*R&D*	*R&Dreg*
Log(*project size*)$_{it}$	0.204***	0.166***	0.173***	0.201***
	(0.02)	(0.03)	(0.03)	(0.02)
Log(*turnover*)$_{it}$	-0.030***	-0.028***	-0.026***	-0.034***
	(0.00)	(0.00)	(0.00)	(0.00)
Ω_{it}^{Public}	0.186**	0.191**	0.310***	0.176**
	(0.08)	(0.08)	(0.06)	(0.08)
Ω_{it}^{Bank}	-0.101	-0.082	0.031	-0.133
	(0.14)	(0.19)	(0.20)	(0.15)
Ω_{it}^{Indep}	0.162**	-0.074	-0.027	0.203***
	(0.08)	(0.14)	(0.14)	(0.08)
age_{it}	-0.009			
	(0.01)			
new_{it}		-0.108		
		(0.07)		
$R\&D_{it}$			-0.153**	
			(0.06)	
$R\&Dreg_{it}$				0.184***
				(0.05)
N. obs	572	296	362	572
Log-likelihood	-243.457	-123.741	-154.729	-238.401
Pseudo R2	0.38	0.35	0.36	0.39
Chi2	148.80	66.99	92.81	145.15

Note: Every equation includes constant and region dummy variables. Robust standard errors are reported in the brackets. Marginal effects are calculated around mean points. * significant at 10%; ** significant at 5%;*** significant at 1%.

Table 5: Determinants of equity financing, logit regression, bank dependent vs ERPK (= bank loans)

Dependent variable, *bank-dependent equity*$_{it}$: equity = 1, debt =0				
	age	*new*	*R&D*	*R&Dreg*
Log(*project size*)$_{it}$	0.076***	0.238***	0.096***	0.077***
	(0.02)	(0.07)	(0.03)	(0.02)
Log(*turnover*)$_{it}$	-0.012***	-0.042**	-0.015***	-0.013***
	(0.00)	(0.02)	(0.00)	(0.00)
Ω_{it}^{Public}	-0.011	-0.410	-0.016	-0.014
	(0.10)	(0.25)	(0.38)	(0.10)
Ω_{it}^{Bank}	0.321	0.740**		0.323
	(0.21)	(0.29)		(0.21)
Ω_{it}^{Indep}	0.046	0.628**	0.166	0.062
	(0.11)	(0.28)	(0.22)	(0.12)
age_{it}	-0.006			
	(0.01)			
new_{it}		-0.265		
		(0.21)		
$R\&D_{it}$			-0.112	
			(0.10)	
$R\&Dreg_{it}$				0.039
				(0.04)
N. obs	322	97	135	322
Log-likelihood	-101.308	-26.661	-45.678	-101.088
Pseudo R2	0.44	0.59	0.41	0.44
Chi2	66.88	36.94	37.80	69.95

Note: Every equation includes constant and industry, region and time dummy variables. Robust standard errors are reported in the brackets. Marginal effects are calculated around mean points. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Determinants of equity financing, logit regression, sub-samples

Dependent variable, $equity_{it}$: equity = 1, debt =0

Panel A: SMALL TURNOVER

	age	*new*	*R&D*	*R&Dreg*
	0.008	-0.043	-0.053*	0.060**
	(0.01)	(0.04)	(0.03)	(0.03)
Pseudo R2	0.34	0.31	0.38	0.35
N	324	165	224	324

Panel B: LARGE TURNOVER

	age	*new*	*R&D*	*R&Dreg*
	-0.035**	-0.170	-0.130	0.151*
	(0.02)	(0.14)	(0.14)	(0.08)
Pseudo R2	0.36	0.39	0.38	0.36
N	326	149	182	326

Panel C: SMALL FINANCING SIZE

	age	*new*	*R&D*	*R&Dreg*
	-0.026	-0.206*	-0.202**	0.156**
	(0.02)	(0.12)	(0.10)	(0.07)
Pseudo R2	0.29	0.31	0.32	0.30
N	326	150	194	326

Panel D: LARGE FINANCING SIZE

	age	*new*	*R&D*	*R&Dreg*
	0.006	-0.040	-0.056	0.056**
	(0.01)	(0.04)	(0.04)	(0.03)
Pseudo R2	0.49	0.51	0.47	0.48
N	163	188	318	326

Note: Every equation includes constant and industry, region and year dummy variables. Robust standard errors are reported in the brackets. Marginal effects are calculated around mean points. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Multinominal logit results, relationship of VC type and financial mode

	(1)		(2)		(3)	
	credit (incumbent equity)	common equity	credit (incumbent equity)	common equity	credit (incumbent equity)	common equity
Log($project\ size$)$_{it}$	0.363	0.886***	0.248	1.189***	0.498*	1.058***
	(0.31)	(0.25)	(0.39)	(0.31)	(0.28)	(0.26)
VC_2	1.562	0.226	20.170***	0.644	2.187*	0.041
	(1.24)	(0.63)	(5.31)	(0.69)	(1.16)	(0.59)
VC_3	4.067***	2.297***	23.403***	2.493***	4.507***	2.513***
	(1.16)	(0.53)	(5.48)	(0.58)	(1.21)	(0.54)
$R\&D_{it}$	1.101	-0.442				
	(0.90)	(0.57)				
new_{it}			-0.567	-.0459		
			(0.87)	(0.58)		
$R\&Dreg_{it}$					-0.778	-0.685
					(0.56)	(0.45)
N. obs	184		161		215	
Log-likelihood	-118.221		-93.441		-137.650	
Pseudo R2	0.32		0.38		0.32	

Note 1: Robust standard errors are reported in the brackets. The slope coefficient are reported in terms of odds. * significant at 10%; ** significant at 5%; *** significant at 1%.
Note 2: We control for Ω_{it}^{Public}, Ω_{it}^{Bank} and Ω_{it}^{Indep}. The turnover variable is included into the specification but not reported as it lacks significance.