Differences in Public and Private Venture Capital Companies' Activities: Microeconometric Evidence for Germany*

by

Dirk Engel[1] and Diana Heger[2]

[1] Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI Essen), engel@rwi-essen.de
[2] Centre for European Economic Research (ZEW), heger@zew.de

First Draft August 2005, do not quote without the authors' permission

Abstract: The paper supports empirical evidence to the question whether public VC has the potential to crowd out private VC investments. In addition, we present new findings with respect to performance differences between firms funded by public venture capital companies and those funded by private ones. We use a multivariate probit estimation and a matching procedure for multiple treatments to assess both questions. Our empirical results suggest that public VCCs' selection profile differs slightly from that of private VCCs. Thus, we conclude that crowding out effects may occur. Furthermore, venture-backed firms funded by private VCCs seem to outperform those funded by public VCCs. Moreover, firms funded by public VCCs do not perform better than non-funded firms.

Keywords: *Venture Capital, Start-ups, Firm Performance, Matching*

JEL Classification: *G32, L21, C14, C35*

* Thanks to Georg Licht for valuable comments and discussion. All remaining errors and shortcomings are, of course, the responsibility of the authors alone.

1 Introduction

The presence of quite a large number of publicly owned venture capital companies (VCCs) and their provision of a large sum of funds are an outstanding specificity of the European venture capital market. However, it is an open question whether this kind of direct involvement may really provide benefits to close the financing gap of firms and to foster their growth. The presumption that public VCCs crowd out private investments with negative effects on market development and the fear that public VCCs provide insufficient management support are one of the most popular arguments against direct public involvement. Recently, Leleux and Surlemont (2003) analyze the relationship between sources of cumulative and new fund raising and the share of public funds in European countries between 1990 and 1996. Their empirical findings do not suggest that public money crowd out private investments.

This study provides first empirical evidence concerning the possible emergence of crowding out effects on the microlevel of German firms. Further, we provide insights in differences between public and private VCCs with respect to quality differences in the investment stage. Policymakers need to be well informed about the structure of the venture capital market and the role of publicly owned VCCs, particularly with respect to arguments against state intervention and the increasing role of public activity evaluation. The contribution of the paper is also linked to the fundamental question, whether VCCs' characteristics matter concerning firm performance. Many studies have contributed empirically to the relationship between VCC characteristics and firm performance (e.g. MacMillan 1987 and 1988, Sapienza 1992, Landstroem 1992, Rosenstein et al. 1993, Schefczyk 1999). These studies, however, do not explicitly take into account the differences between public and private VCCs.

In addition, we revise the findings of Engel and Keilbach (2005), who address performance differences between venture-backed and non-venture-backed firms. Empirical evidence suggests that venture-backed firms perform better than non venture-backed firms (e.g. Jain and Kini 1995, Kortum and Lerner 2000, Hellmann and Puri 2002, Bottazi and Da Rin 2002). The results emphasize that venture capital companies are able to select and support high quality projects successfully in the high-risk asset class. In addition, Engel and Keilbach (2005) try to separate the effect of financial and non-financial support and argue that positive effects occur.

As we look at crowding out effects of and the quality of VCCs' activities, we focus on early stage financing and differentiate between four states of VC funding: public VCCs only, private VCCs only, combined investment of public and private VCCs, non-VC-funding. At first, we estimate a multivariate probit model to analyze whether the characteristics of firms funded by public or private VCCs differ significantly. Second, we apply a matching procedure technique to construct pools of similar venture-backed firms. The matching procedure is applied both to analyze market segmentation and to emphasize performance differences between different states of VC-funding i.e. to highlight quality differences between public and private VCCs. Here we highlight employment growth and patent behavior as performance indicators.

The paper is structured as follows: Section 2 starts with the discussion of theoretical aspects and empirical evidence concerning the relationship between return-orientation, quality of value creation process and firm performance. Section 3 describes the methodology of our empirical analysis. Section 4 contains the estimation results and interpretation. The paper ends with a summary and discussion of main results in section 5.

2 Framework

The economic function of VCC and the contribution of public VCCs

Modern literature on capital market imperfection states problems of debt financing for firms with high-risk projects (see e.g. Carpenter and Petersen (2002) for a discussion of several reasons). New equity financing has some advantages compared to debt financing and is seen as a suitable source to overcome financing constraints of innovative firms. Carpenter, Petersen (2002: F60) point out that "equity finance does not require the firm to post collateral, investors' upside returns are not bounded, and additional equity financing does not increase the probability of financial distress".

Equity financing is still confronted with some imperfections. High-risk projects are characterized by high uncertainty about future outcomes, i.e., they are characterized by the potential to create extremely high profits and at the same time by a high uncertainty of failure. However, entrepreneurs may dedicate inefficient or insufficient effort for their venture and lack skills to handle technological and market risks. Finally, uncertainty about technological realization and market acceptance exists. As a result, significant information asymmetries about the individual risk of failure occur, and cause

agency costs to reduce the asymmetries. Venture capital companies are new players to deal with agency costs. They act as intermediaries between outside investors and equity seeking entrepreneurs. VCCs raise funds from investors, invest the money in selected projects, give hands-on management to funded firms and realize return on investment via selling their shares to other investors, particularly later stage oriented VCCs and corporate investors (see e.g. Sahlman 1990 for details).

A rich body of literature focuses on the description of venture capital contracts to handle agency costs (see e.g. Admati and Pfleiderer 1994, Gompers 1995, Hellman 1998, Kaplan and Stromberg 2000). From the viewpoint of the economic function of VCC, risk-pooling (Amit et al. 1998), risk-diversification (Diamond 1984, Norton and Tenenbaum 1993), specialization (Chan 1983) and better opportunity to syndicate investments (Lerner 1994) are the most popular arguments to derive advantages of VCCs over single investors to handle information asymmetries efficiently. As a result, VCCs can make a contribution to reduce the financing constraints of some high-tech firms with a high level of agency problems.

The commitment of public authorities to facilitate technology oriented firms to access funds is based on the assumption that private sector VCCs, namely, independent and private bank/corporate-owned VCCs, only finance high potentials. High potentials are characterized by a potential of high firm value growth on the one hand and only moderate uncertainty about the successful realisation of the business idea on the other hand. Firms with a moderate growth potential or with very high uncertainty about future outcomes are not likely to succeed in receiving venture capital by private VCCs. In addition, private VCC activity depends positively on the occurrence of radical innovations based on new technologies and the access and strength of stock markets (see Black and Gilson 1997, Gompers and Lerner 1998, Jeng and Wells 2000, Engel and Licht 2004). Stock market prosperity increases the chance to realize high returns on equity investment.

Related to that, a significant number of public VCCs are founded in the 1990s. Public VCCs include venture capital units of regional and national development banks, namely savings banks (“Sparkassen”), state banks (i.e. “Landesbanken”, “Investitionsbanken”) and federal government banks (i.e. KfW Bankengruppe). These institutions are owned by public authorities (municipalities or state as well as national government). Public VCCs are assumed to potentially contribute to close the funding gap of firms in two

regimes. The first one is characterized by low inflows from investors to the venture capital market. The second follows from the assumption that private VCCs avoid projects with a high level of uncertainty about future outcomes and a high level of uncertainty about growth potential of the firm and its market.

Hypotheses

Public VCCs and private VCCs differ within a lot of characteristics. These differences are assumed to matter for the project selection and management support of the funded firms. First, publicly owned VCCs emphasize employment creation and innovation instead of realizing a high return on investment. But they do not only focus on non-financial goals. Most of them formulate a minimum required return.

Second, the public fund managers often lack a industry-specific knowledge. Some of them were previously employed at public institutions or were politicians. The combination of both suggests that government emphasis of nonfinancial goals and the lack in management abilities are incompatible with portfolio-based thinking in the venture capital market.

Third, private VCCs compete in the market of investors in the high-risk asset class. They need to continuously demonstrate the successful realization of returns because private investors only invest money in successful private VCCs and owners of private VCCs, respectively. Especially, independent VCCs have to rapidly build up reputation to raise a sufficient level of funds. Outside investors require a relative high level of return to realize compensation for investments in the high-risk asset class. Banks and corporate firms are more tolerant concerning lower returns for their VCCs. Their success is, however, evaluated by their shareholders and hence, an acceptable return on equity is also necessary for the private captive VCCs. Unlike that, public VCCs are confronted with lower requirements to raise funds from public authorities. With respect to the second characteristic, fund raising is easier based on the strong linkages between public fund managers and public investors.

Fourth, fund managers of private VCCs have higher incentives to provide high efforts to deal successfully with the value creation process. Empirical evidence on the role of

carried interest[1] confirm this assumption. Weber and Dierkes (2002: 548) show that private VCCs have more frequently offered carried interest to portfolio managers than publicly owned VCCs.

Carried interest and competition on the VC market suggest a higher minimum required return for private VCCs to get sufficient compensation. In contrast, public VCCs have lower costs of refinancing and need lower minimum required return based on non-financial goals. Results of Manigart et al. (2002) and KfW (2003) quantify the expected differences in the minimum required return. The KfW (2003) study shows that 40 per cent of independent VCCs and 35 per cent of bank-owned/corporately owned VCC require a minimum annual return of more than 28 per cent. In contrast, only 11 per cent of publicly owned VCCs require such a high return on investment.

Because of the lower minimum required return, public VCCs are able to finance projects with lower growth potential. However, these firms can also offer cheaper prices for equity investments for firms with a high growth potential. Firms know about price differences and ask for funding by public VCCs. However, public fund managers avoid to finance uncertain projects. This expectation follows from the limitations in skills for identification of lemons and lower motives for the management to finance high-risk projects. It is assumed that the management of public VCCs finance certain projects, leaving only the uncertain ones for private VCCs. Following from this we derive our first hypothesis:

Hypothesis 1: Selection Profiles of public VCCs do not remarkably differ from private VCCs' ones. Thus, public VCCs may crowd out private sector activity.

The consequences of crowding out are obvious: Private investors can only select from the pool of less favourable projects (Lerner 2002, Leleux and Surlemont 2003, Gilson 2003). The entry and the development of established private VCCs is hindered. Accordingly, venture capital can be misallocated. In the result, direct state intervention is counter productive and do not help to overcome the financing gap of uncertain projects.

[1] Carried interest is well known as 80/20 rule. According to this, 80 percent of profits going to investors and 20 percent of profits mentioned as carried interest going to the portfolio management of VC-company (e.g. Schmidt and Wahrenburg, 2003: 14 with results for Europe).

Based on public VCCs' characteristics, it is easy to conclude that public VCCs provide a lower effort and quality of management support. According to the resource-based view (e.g. Barney 1991), higher efforts of VCCs in each stage of the process are assumed to increase the competitive advantage of the funded firm. Results of empirical studies show remarkable differences and hence, the distinction between VCC effort and venture-backed firm performance may depend on the specific activity under consideration (MacMillan, 1987 and 1988). For example, Sapienza (1992) and Rosenstein et al. (1993) derive empirical evidence for a positive effect of the quantity (frequency of contacts) and quality of efforts (VCCs count to the "top 20") on the one hand and venture-backed firm performance on the other hand. Under the assumption that management support is a crucial resource for firm growth, we formulate our second hypothesis as follows:

Hypothesis 2: Firms funded by public VCCs perform worse than firms funded by private VCCs.

3 Methodology

3.1 Database

We have generated the main information by using firm-specific data from the ZEW Foundation Panel. This data has been provided by the largest German credit rating agency "Creditreform" (see Almus et al. 2000 for further explanations). The identification of venture-backed firms is based on a computer-assisted search for names of venture capital companies as shareholders recorded by Creditreform up to January 2003. All venture capital companies that are private equity investors which have a full member status of European Venture Capital Association (EVCA) or German Venture Capital Association e.V. (BVK) are considered (EVCA 2000, BVK 2000). Additionally, members of U.S. National Venture Capital Association with activities in 1999 at the U.S. venture capital market (VentureOne 1999) and other well-known venture capital companies are considered. Finally, funds of venture capital companies are included in the database and a search for key words like "Venture Capital", "Private Equity" is done to identify firms with obvious venture capital activities.

One singularity of the German VC market is the occurrence of a special type of investment by public organizations. In this special case the relationship between the investor

and the entrepreneur is that of a silent partnership. In practice, exclusive silent partnerships do not play an important role in early stage financing of venture capitalists (BVK, 2002: 24, 31, 45). In this context one limitation of the study arises: ventures with a silent partner are very difficult to observe based on Creditreform data, because silent partnerships concern the relationship between two or more partners inside a firm and are not recorded in the trade register. But a comparison of the findings with information provided by BVK depicts the potential of the ZEW Foundation Panels for analyzing the impact of early stage financing by venture capitalists.

Our sample contains 135,797 firms founded between 1996 and 2000, of which 918 are venture-backed firms. To exclude derivative foundations (i.e., existing business units within a firm turned into a legally independent entity) we ignore companies with more than 250 employees at the time of the foundation. Within the group of venture-backed firms we differentiate between four types of funding.

- funding by public VCCs (N=168)
- funding by private VCCs (N=675)
- combined funding by public and private VCCs (N=75)
- non-funding (N=56786)

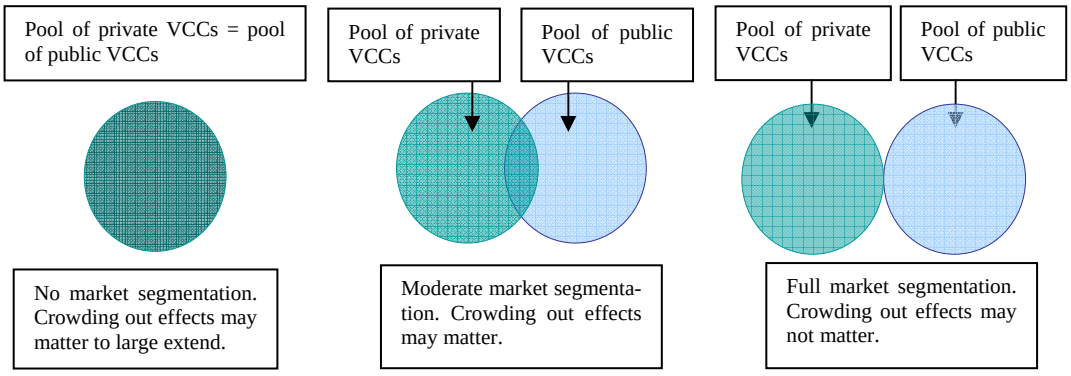
The definition of public and private VCCs follows the description in section 2. Again, private VCCs contains bank-owned VCCs, corporate VCCs and independent ones.[2] We have to decide, however, about the classification of venture capital units of corporate banks, the third pillar in the provision of formal venture capital finance. Only a few firms received venture capital from those units. Corporate banks show a very similar behaviour like public sector banks. Based on §51 Corporate Law (*Genossenschaftsgesetz*), the main purpose is the promotion of their owners and members, the small scale firms. Similar to savings banks, profit-maximization is not their main objective. Thus, our group of public VCCs also contains cooperative banks.

[2] We ignore differences within the group of private VCCs, meaning the differences between independent VCCs, corporate VCCs and bank-owned VCCs. For example Manigart et al. (2002a) discuss the differences explicitly.

3.2 Econometric Approach

Related to our first hypothesis, **Figure 1** introduce in concept of testing the market segmentation hypothesis. The basis idea behind our econometric approach is a test of similarity of the portfolio of funded firms. For the case on the left hand side, each venture-backed firm funded by public VCCs shows very similar characteristics compared to one venture-backed firms funded by private VCCs. Market segmentation is very low, thus, we conclude that crowding out effects may occur. For the case in the middle, there is a range where the selection profiles of public and private VCCs overlap. Market segmentation exists to a certain extent and crowding effects may occur and may be smaller than in the first case. Finally, the case on the right hand side, suggests completely different portfolio of firms and thus, crowding out effects may not matter.

Figure 1: Characteristics of firms funded by private VCCs and public VCCs



The starting point for analyzing if market segmentation occurs in the VC market is the multivariate probit model (MVP) (see e.g. Greene, 1997: 915f.). Typically, the MVP's starting point is the choice between alternatives conditional on a vector of exogenous variables (e.g. level of risk, founder's knowledge).[3] The parameter vector varies between the funding state, indicating how an exogenous variable affects the probability to realize this state and hence, to realize positive impacts through equity partner presence. As mentioned above, we differentiate between three states of funding whereas it is possible that public and private VC funding may occur simultaneously. This has consequences on the structure of the error term meaning that the covariance is not zero. Significant estimation results signalize that selection profiles of public VCCs and pri-

[3] Choice has to be interpreted as realized alternative, resulting from the supply and demand for equity funding. We consider a one stage game, because asking for equity or not is unobservable.

vate ones differ. Thus, market segmentation occurs and we cannot derive empirical evidence for crowding out hypothesis.

$$y_1^* = x_1\beta_1 + \varepsilon_1,\ \ y_1 = 1 \text{ if } \ y_1^* > 0,\ 0 \text{ otherwise}$$
$$y_2^* = x_2\beta_2 + \varepsilon_2,\ \ y_2 = 1 \text{ if } \ y_2^* > 0,\ 0 \text{ otherwise}$$
whereas
$$E(\varepsilon_1 \mid x_1, x_2) = E(\varepsilon_2 \mid x_1, x_2) = 0$$
$$Var(\varepsilon_1 \mid x_1, x_2) = Var(\varepsilon_2 \mid x_1, x_2) = 1$$
$$Cov(\varepsilon_1, \varepsilon_2 \mid x_1, x_2) = \rho$$

Then we apply a matching procedure to underline the results of MVP. The matching algorithm aims to construct a pool of 'twin' firms to compare the groups which only differ in their source of VC funding with respect to the outcome variable. Related to **Figure 1**, the ratio of the number of successful matches to all potential matches indicates the level of market segmentation. As we do not succeed in finding out a twin firm, we interpret the results in favour for market segmentation.

The actual sense of the matching procedure is to derive a statement about the impact of a difference in the VC funding source on outcome indicators. Given that the matching algorithm is an appropriate method to provide empirical evidence for both hypotheses we use it in order to identify the extent of market segmentation and the VCCs' influence on firm performance. Employment growth and patent behaviour, as indicators for firm performance, also serve as measures for quality differences in the support. To be able to compare the four different funding states we rely on the so called Average Treatment Effect (ATE). This measure shows the differences in the performance indicators (*Y*) between the different funding types (*F*) for a firm of group *m* to a firm in group *l* (Lechner, 2001), whereas *m* and *l* indicate a different VC funding type

$$E(Y^{m,l} \mid F = m) = E(Y^m \mid F = m) - E(Y^l \mid F = m). \qquad (1)$$

If the selection in the different funding groups was randomly, it would only be necessary to calculate the sample means of the performance indicators for each group and to compare them. Based on our argumentation in section 2 we expect that receiving funds from a specific VCC does not occur randomly. The assignment to the different VC funding types is characterised by the so called selection bias, which has to be eliminated in order to get reliable results for the comparison of the outcome variables. A survey of

different estimation strategies to correct for the selection bias is provided by Heckman, Lalonde and Smith (1999).

As methodology in this context we choose a matching procedure[4] for multiple treatments. This methodology has been applied by Imbens (2000), Lechner (2001) and Gerfin and Lechner (2002) for labour market evaluation. Czarnitzki, Ebersberger and Fier (2004) use this estimator in the context of industrial economics and examine the relationship between public R&D funding, R&D collaboration and innovative output with a sample of German and Finish firms. To get reliable results of the matching estimator for multiple treatments it must be assured that the different funding types are mutually exclusive, i.e. each firm exactly belongs to one funding type (Lechner, 2001).

The matching estimator corrects for the selection bias by comparing firms with two different VC funding profiles. In doing so, we draw best twin from group *l* for each VC-backed firms in group *m*. The similarity is attained via a set of a priori defined firm characteristics (X). These characteristics have to fulfil the condition that they influence selection as well as outcomes and that conditioning on them outcomes and selection are independent. This condition is called the conditional independence assumption (CIA)

$$(Y \perp S) \mid X.$$

The difference between the outcome variables shows the effect of VC funding by two different VCC types and can be interpreted as the impact of venture capital finance and support if and only if no difference between observables is detected and there is no selection on unobservables (see Heckman et al., 1998). Typically for the matching procedure, we cannot empirically test, whether the CIA holds or not, so that we can only derive plausible arguments. We argue that the CIA is supported under specific conditions. Concerning the selection on observables, we require that firms in group *m* are very similar to firms in group *l* in most of the important factors affecting the outcome variables and the selection into the different funding types. Unobservables like market potential of new ideas and technological risk may be less important as we consider factors which correlate with them. In addition, VC companies are not able to superiorly evaluate the individual project risk. It is only possible to select firms from a pool in

[4] Applications and discussions of the matching estimator for the binary case are provided by Angrist (1998), Dehejia and Wahba (1999), Heckman, Ichimura, Todd (1998), Heckman, Ichimura, Smith, Todd (1998) and Lechner (1999, 2000).

which is characterised by the same risk class, meaning to be aware that four of ten firms will fail on average. To our point of view, ex-post firm survival is an appropriate measure for the ex-ante risk class of a firm. Insignificant differences in firm survival between the funding types can be interpreted as selection of firms with similar level of risk. Firm survival is, however, potentially influenced by hands-on management of VCC. We expect that the impact of quality differences of the hands-on management on the survival seems to be very small. First, VCCs are more oriented to foster rapid growth of funded firms and their market value. Second, VCC may only marginally contribute to avoid the failure of the project because technological and market risks are most important in this context and unaffected from VCC involvement. The high share of write-offs indicates this fact clearly.[5] To sum up, we can interpret the differences in the outcome variables for group *m* and *l* as ATE if and only if, we detect no significant differences in observables in general.

If the CIA holds the Average Treatment Effect can be rewritten as follows

$$E(Y^{m,l} \mid F = m, X) = E(Y^{m} - Y^{l} \mid F = m, X) = E(Y^{m} \mid F = m, X) - E(Y^{l} \mid F = l, X).$$

The problem that may arise in this context is called the curse of dimensionality which says that if the number of criteria is large, an exact matching would be hardly possible. Rosenbaum and Rubin (1983) propose a method to adjust for these pre-treatment variables based on the propensity score. The propensity score, defined as the conditional probability of receiving a specific form of funding, removes all selection bias. The matching is based on the propensity score by creating a comparison group out of the control group (*l*) that have the same distribution of the propensity score than the group of examination (*m*). However, for the selection of the comparison group we impose additional restriction: The matched firms of group *l* must be in the same industry and must be located in the same region (East or West Germany). In order to calculate the propensity scores of all groups we use the information of the above mentioned multivariate probit model (see Train 2003 for a survey of discrete choice models). The calculated propensity scores reflect the probability to enter each financing status relative to the reference category. If the distribution of the characteristics is also balanced in the

[5] According to EVCA (2001, 2002), 36.5 percent of all divestments in Germany in 2001 and 44.1 percent in 2002 were write-offs.

two subsamples and the number of observation is large then the population mean for the two subsamples can be replaced by the sample mean (Gerfin and Lechner, 2002).

The procedure of the matching for multiple funding schemes is as follows:

(i) Estimation of the propensity score by means of a multivariate probit

(ii) Estimation of the expectations of the outcome variables conditional on the propensity score
- Choose one observation out of the subsample *m*.
- Find an observation in the subsample *l* that is as similar as possible to the observation of the subsample *m* . Do not remove this observation from the subsample *l*.
- Repeat the preceding steps until no observation in *m* is left.
- Compute the conditional expectations by the sample means.

(iii) Repeat (ii) for all combinations of *m* and *l*.

3.3 Description of variables

This section is dedicated to the description of variables and firm characteristics in order to clarify the matching procedure described above.

Variables for the calculation of the propensity scores

The propensity scores are calculated by estimating a multivariate probit. The dependent variable is the type of VC-funding.

$$\text{VC}-\text{Funding}_{\text{public}} = \begin{cases} 1 \text{ if public VCCs fund this firm} \\ 0 \text{ if no public VCC funds this firm} \end{cases}$$

$$\text{VC}-\text{Funding}_{\text{private}} = \begin{cases} 1 \text{ if private VCCs fund this firm} \\ 0 \text{ if no private VCC funds this firm} \end{cases}$$

So that the following combinations can occur:

$$VC-Funding_{public}=1 \text{ and } VC-Funding_{private}=0,$$
i.e., firm is funded by public VCC(s).
$$VC-Funding_{public}=0 \text{ and } VC-Funding_{private}=1,$$
i.e., firm is funded by private VCC(s).
$$VC-Funding_{public}=1 \text{ and } VC-Funding_{private}=1,$$
i.e., firm is funded by public and private VCCs.
$$VC-Funding_{public}=0 \text{ and } VC-Funding_{private}=0,$$
i.e., firm does not get any VC funding.

The exogenous variables can be separated in firm-specific variables, regional and sectoral variables. First, we consider **firm-specific variables** influencing the selection into the four different VC-funding types.

Related to the crucial importance of project risk, we try to explicitly measure it in different ways. Firms exhibiting sales within the first three years of business activities (*sales_3y*) may be less risky than firms without sales. 16 percent[6] of the firms in the sample and in the different groups representing the VC types have realised sales within the first three years. The availability of current information (*investig*) signalizes significant business activities, i.e. fast growing or fast declining firms. The share of firms that has been investigated within the last year is 61 percent.

Resource-based theories emphasize the importance of tangible and intangible resources to build up competitive advantages of the firm. Entrepreneurial ability and technological knowledge are crucial resources of innovative firms.[7] We take into account the highest educational degree of entrepreneurs, i.e., if there has been a graduate (*graduate*) or PhD (*phd*) in the foundation team. The share of firms with a graduate is 35 percent and a PhD 8 percent. Furthermore, we use the information, whether the new firms are founded by a team of persons (*teammore*). The share of firms with more than one founder is about 42 percent. Finally, we include the variable number of patent applications before the VCC entry (*patbeforevc*). Patent behaviour signalizes the property rights of specific

[6] All information is based on Table 3 of Appendix A.

knowledge and hence, business idea may characterize a unique selling position with high potential of value added.

In addition, the number of employees at the time of the firm foundation (*emp_found*) and firm's *age* are measures to consider the availability of resources and the level of risk in general. The older and larger a firm the less probable a failure is. The average firm has had 4.26 employees at the firm foundation time and the average firm is about four years old.

The second group of variables are **regional variables**. According to the literature linking VC funding theory and regional cluster theory, knowledge spillovers may be higher in urban areas and in the surroundings of R&D facilities. They may increase the probability to select firms generating and using these spillovers. These firms may differ in their potential of growth. Population density (*popdense*) at the county level measure this kind of selection. Moreover, the number of employees in business R&D affiliates and public research institutes (*emp_rnd*) are used to measure knowledge spillovers. Furthermore, a dummy variable is included indicating whether a region has applied at the BioRegio contest (*bioregio*) conducted by the Federal Ministry of Education and Research. This contest has tried to assign regions with a high potential of establishing new industries (in this context biotech industry). Engel (2003) finds that regions, which applied, exhibit a substantially higher amount of VC-backed firms. Participation then serves as a signal that in this region the entrepreneurial environment is convenient.

Finally, the commitment of the VCC funding types may differ if a firm is located in Eastern Germany (*east*). Since Eastern German firms are often subject of special public funding, we expect that the publicly owned VCCs get more involved in Eastern German firms than the other VC types. Looking at the descriptive statistics this may be correct: In the sample 20 percent are Eastern German firms.

Lastly we consider some **control variables** for the legal form and the business emphasis of the firm. With respect to VCC, the expectation of high financial returns is mainly correlated with the size and growth of markets targeted by young innovative firm. Hence, we consider the two-digit NACE codes. We have pooled the industries in four groups: low-tech manufacturing (*ind_1*), high-tech manufacturing (*ind_2*), research and

---

[7] For an extensive discussion of VC investment criteria see, among others, Tyebjee and Bruno's (1984)

development (*ind_3*) and services (*ind_4*). Furthermore, an indicator variable measures the choice of publicly listed company before venturing (*capcom*).

Variables indicating the success of VC funding

We have two variables that shall measure the success of VC funding. These variables account for the outcome variables of the matching procedure. We first consider firm growth. If VC funding has been successful and the firm has been established into the market then it should prosper. The most reliable indicator for firm growth in our sample is the growth of employment. It is measured in a linear (*growth*) and an exponential way (*growthold*). The second variable is a dummy variable indicating if there has been a patent application after the entry of a VCC (*pataftervc*). A patent is the result of a successful innovation so that in the context of VC funding it can be interpreted as a successful business idea.

4 Estimation results

4.1 Results of the MVP estimation

In this section we aim to verify if the market for VC is segmented or if public VCCs have the potential to crowd out private VC investments. Furthermore, the MVP serves as a first step for the subsequently supplied results of the matching procedure in that propensity scores can be calculated. The results are presented in Table 1 below.

If the results display differences this can be interpreted as a hint towards market segmentation. In contrast, similar values of coefficients and their significance indicate equal decision criteria for both public and private VCC. We interpret the result as a hint that public VCCs' potential to crowd out private VC funding. We cannot directly observe neither the crowding out itself nor its extent.

The results of MVP only show a few differences in factors affecting VC-funding between the two equations.

---

and MacMillan et al. (1987).

- Firm size at the foundation time is a critical characteristic for the decision of private VCCs to invest in a firm. The effect is significantly positive which means that the bigger a firm is at its foundation time the more probable a investment by a private VCC is. Firm size does not matter for the investment decision of public VCCs.

- A firm located in Eastern Germany rises its probability to get funds from a public VCC. This is what we expected and it is consistent with the behaviour of government in the allocation of public grants. Private VCCs are neutral against firm's location.

- Private VCC tend to invest funds in firms with a higher degree of risk. This is suggested by the negative sign of the variable *investig* which indicates if a firm has currently been investigated by Creditreform. Unavailable current signalizes a low level of market activity. This might be the reason for difficulties in the transformation of new business idea to the market.

- Surprisingly, the significance of the number of patent applications after the VCC entry is very weak. The probability value for the coefficient achieves only 7.7 per cent in the public funding equation. There seems to be no effect of patents with respect to the venturing decision of a private VCC.

For all other variables the coefficients have the same sign which can be interpreted as a hint that public VCCs may crowd out private VC investments. There are still a lot of characteristics which have an influence on the probability to provide funds to a firm.

- The age of a firm and its legal form influences the probability to get funds from public and private VCCs. The older a firm is the more probable a VC investment will be. Furthermore, if a firm is a capital company the probability is higher to be funded by a venture capitalist. These two firm characteristics suggest that VCCs prefer firms with a relatively low risk potential.

- There are some characteristics of the entrepreneur and the founder team that are crucial for the decision to provide funds. The entrepreneur's academic background is a factor that affects the investment behaviour of VCCs. The higher the degree attained the larger is the effect on the investment probability. Moreover, private and public VCCs prefer founder team compared to a single entrepreneur

since the effect of the indicator, if the team consists of more than one person, is positive on the probability to provide funds.

- Regional characteristics are also significant in the funding equations. The provision probability raises with the number of R&D affiliates in surrounding R&D institutions and with the participation of the region to the BioRegio Contest. Firms in these regions have easier access to tacit knowledge and thus, realize an knowledge advantage compared with other firms. This advantage is positively evaluated by VCCs.

Many effects suggest that private VCCs tend to minimize the risk of their portfolio more vigorously than public VCCs. Characteristics, which are supposed to indicate the level risk, are the firm size, firm age, patent behaviour before the investment, team foundation and the availability of current information. With the exception of the availability of current information these variables exhibit a sign that indicates that the risk to be taken is relatively low.

Table 1: Regression results for MVP

	Public VCC		**Private VCC**	
Variable	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
Emp_found	0.0046	0.0028	0.0151 ***	0.0015
patbeforevc	0.0008 *	0.0004	0.0003	0.0003
sales_3y	0.0697	0.0571	-0.0186	0.0392
investig	-0.0200	0.0604	-0.0988 ***	0.0380
ln(age)	0.1235 *	0.0664	0.0736 **	0.0291
capcom	0.1968 ***	0.0573	0.2481 ***	0.0349
graduate	0.1352 ***	0.0505	0.1712 ***	0.0319
phd	0.4002 ***	0.0550	0.4765 ***	0.0345
teammore	0.2926 ***	0.0480	0.2457 ***	0.0295
ln(emp_rnd)	0.1125 ***	0.0276	0.0688 ***	0.0219
ln(popdense)	0.0376	0.0233	0.0142	0.0170
bioregio	0.2446 ***	0.0527	0.3054 ***	0.0328
east	0.3387 ***	0.0497	-0.0006	0.0381
ind_1	0.4121 ***	0.0797	0.1918 ***	0.0646
ind_2	0.4431 ***	0.0785	0.4621 ***	0.0527
ind_4	0.5918 ***	0.0528	0.6152 ***	0.0339
year2	0.2703 ***	0.0962	0.1659 ***	0.0636
year3	0.4016 ***	0.0961	0.3777 ***	0.0602
year4	0.5017 ***	0.1004	0.5559 ***	0.0590
year5	0.4338 ***	0.1125	0.4609 ***	0.0640
constant	-4.5883 ***	0.2107	-4.0624 ***	0.1206
atrho21	0.2272 ***	0.0268		
rho21	0.2234 ***	0.0254		

Sample size	135,797
log-Likelihood	-5241.2294

* (**; ***) indicates a level of significance of 10% (5%; 1%)

4.2 Results of the Matching procedure

We consider nine different combinations of the group of interest (below: actual state) *m* and control group *l*.

Figure 2: Combinations of actual and counterfactual states

		Actual state *m*		
		pub	priv	pubpriv
Counterfactual state *l*	pub		(1)	(2)
	priv	(3)		(4)
	pubpriv	(5)	(6)	
	nonvc	(7)	(8)	(9)

Before starting the matching procedure we drop firms lacking the common support condition. The common support condition requires that the probability of matching a twin firm out of the comparison group is not zero.

Table 2 shows the attrition of observations due to common support condition and due to the fact that we impose two restriction upon the matching procedure (see section 3.2). The loss of observations is relevant for the assessment of the suitability of the matching estimator on the one hand and to derive further empirical evidence for the market segmentation hypothesis. Only a few cases are characterised by a remarkable loss of observations.

Concerning the market segmentation hypothesis, we succeed in finding a privately funded firm with similar characteristics for each publicly funded firm (case 1 of Table 2).[8] The same is true for the opposite case (case 3 in Table 2). Related to **Figure 1** in section 3.2, this result describes the case on the left hand side. Thus, we conclude that public VCCs choose similar firms than private VCCs. Market segmentation may not

[8] We renounce to display all t-tests of the observables before and after the matching and execute a visual inspection of their results because of the lack of space. Results of t-tests are available upon author's

occur for this case. The empirical evidence is in favour of our first hypothesis. In contrast to that, we find a significant number of publicly funded firms (case 2 in Table 2) as well as privately funded ones (case 4 in Table 2) drop out of the sample because no suitable twin firm could be found when matching firms funded by public and private VCCs contemporaneously. Just remember **Figure 1** again, our results address the case in the middle and thus, market segmentation may occur to a moderate extent in the case of a syndicated investment of public and private VCCs. These results suggest that crowding out effects may occur if a venture-backed firm has been funded exclusively by public VCCs.

Table 2: Differences between matched treated and unmatched treated

Case	Initial Sample Size	Loss due to common support condition	Differences in performance indicators		
			employment growth	patent behaviour	market exit
1	168	0,6%			
2	168	19,1%	+***		+***
3	675	5,3%			
4	675	20,1%	+***		
5	75	8,7%			
6	75	0,0%			
7	168	0,6%			
8	675	0,6%			
9	75	0,0%			

Grey colouring signalizes that selected group of treated firms is not representative for all treated firms. Differences in performance indicators are only presented for grey coloured combinations.

In the following, we focus on the second hypothesis, that differences in the performance depend on the funding source, i.e., public and private VCCs. Consistency of the matching estimator requires that funded firms of the actual state *l*, for which a similar match has been found out of the control group is representative for all funded firms of this group. Thus, the loss of observations due to the common support condition is negligible or matched funded firms do not differ concerning performance indicators from unselected treated firms.

Table 2 emphasizes, however, significant differences in some performance indicators between matched and unmatched treated firms in case 2 and case 4. Unmatched treated

request. Significant differences in factors affecting both the probability to be funded and the firm per-

firms perform better compared to matched treated firms. The group of matched treated is not representative for all treated firms. Thus, we conclude that performance differences between actual state and counterfactual state are not representative for the group of the treated firms in these cases.

A second limitation arises from the occurrence of the differences in firm characteristics after the matching procedure. Significant differences in factors affecting both the probability to be funded and the firm performance are only evident for case 9 in Figure 2. The group of firms simultaneously funded by public and private VCCs differs significantly from non-venture backed firms with respect to legal form and firms age. Therefore, we are able to test our second hypothesis concerning the firm performance on the basis of six combinations of actual and counterfactual state, i.e., the cases 1, 3, 5, 6, 7 and 8 (Figure 2).

Table 4 in Appendix B presents the treatment effects of the firm performance indicators of the different funding types. We consider exponential growth for survived firms, linear growth and patent application (yes or no) as well as market exit (yes or no) for all firms. Significant performance differences are very rare. In case 5 we detect a higher linear employment growth significant at five per cent level for treated firms. Under the assumption that the CIA holds, the difference suggests a higher impact of combined investment of public and private VCCs on firm performance compared to the counterfactual state of exclusive funding by public VCCs. We conclude that public VCCs should avoid stand alone investments. This conclusion is supported by the results of case 7 in Table 4. Exclusively publicly funded firms do not perform better compared with non-venture backed firms. Financial and non-financial involvement of public VCCs during the investment stage do not contribute to an outperformance of venture-backed firms.

The results for the cases 7, 8, 9 in Table 4 potentially allow to address the question, whether venture-backed firms outperform non-venture backed firms based on the involvement of VCCs. As mentioned above, an exclusive funding of public VCCs does not affect firm performance. Case 8 show that exclusively privately funded firms grow faster than non-venture-backed firms on the one hand. On the other hand, the share of firms failure is higher for the group of treated firms. We believe that the CIA does not

---

formance are only evident in the legal form and firm's age measure in case 9.

hold in this case. The higher share of market exit may result from both the VCC involvement and decisions[9] during the investment period and/or the selection process in the pre-investment stage. It is not possible to separate both impacts.[10] We expect, however, that the higher share does not only reflect the lack of VCCs' involvement. Thus, we have to interpret the performance difference carefully. The differences do not present the causal effect of private VCCs' involvement on firm performance.

It's worth to note that venture-backed firms do not achieve a significantly higher probability to apply at least one patent application after VCCs' entry. This result is in contradiction to the findings of Kortum and Lerner (2000), who used the number of patent applications to measure the innovation output. A plausible explanation for this finding could be that VCCs assist their funded firms mainly towards the commercialization of innovations, rather than in further innovation, to very quickly realise value added to their funded firms. Our findings confirm the results of Engel and Keilbach (2005), who observe a weakly significantly higher probability to apply for a patent of their 142 venture-backed firms.

5 Conclusion

We wanted to illustrate with the differences of public VCCs and private VCCs with respect to selection profiles and quality of involvement in the investment stage. We expect that public VCCs do not significantly contribute to fill the funding gap which arises due to risk minimization of private VCCs. Public VCCs compete with private VCCs and thus, crowding out effects may occur. A multivariate probit model and a matching procedure are applied to empirically test the market segmentation between public VCCs and private VCCs. The matching procedure also allows to answer the question, whether venture-backed firms funded by private VCCs perform better than those funded by public VCCs. In general, we are able to differentiate between a wide

[9] This suggests that VCCs do not give adequate managerial advice or provide sufficient financial resources. Maybe, VCCs tend to drop out the firm very quickly if the transformation of the business idea to the market suffers from serious difficulties. This (unexpected) drop out of the VCCs increases the probability for firm's failure rapidly. To the best of our knowledge, an empirical study which highlights the phenomen of an early drop out of VCCs and its consequences for venture-backed firm performance does not exist.

[10] Finance theory points out that the risk of an investment positively correlates with the return expectation.

range of combinations based on four VCC funding regimes: funding exclusively by private VCCs, funding exclusively by public VCCs, combined funding by private and public VCCs and no-funding. A unique dataset of about 136,000 German firms, derived from the ZEW Foundation Panel, represents the database for the empirical analysis.

Our analysis reveals that a remarkable market segmentation of public VCC and private VCC does not occur. The results of the MVP estimation suggest that selection profiles between both types of VCCs are very similar. Although we detect only in three of fourteen characteristics different estimates in public funding and private funding equations. The first impression of similar strategy is strengthened by the matching procedure itself because we succeed in finding a privately funded firm with similar characteristics for each firm had been exclusively funded by public VCCs. In contrast to that, a moderate market segmentation is obvious for combined funding by public and private VCCs. To our point of view, the results suggest that crowding out effects may occur in the case of exclusively funding by public VCCs only. Our findings may contradict the results of Leleux and Surlemont (2003). We believe that the level of aggregation induces the difference. Leleux and Surlemont provide empirical evidence at a high level of aggregation which does not allow to separate between exclusive funding by public VCCs and combined funding with private ones. Thus, the potential negative impact of an exclusive funding by public VCCs is compensated by the expected positive impact of combined funding.

With respect to quality differences during the investment period, the results of our matching procedure suggest an outperformance of firms backed by a combined funding of private and public VCCs compared with those funded exclusively by public VCCs. We conclude that public VCCs may support their funded firms to lower extent than private sector VCCs. Additionally, we confirm the results of Engel and Keilbach (2005) by finding that the involvement of VCCs helps to exploit growth opportunities based on a unique business idea. Similarly to their results, we find that VCCs' involvement does not increase the technological base of funded firms.

Our empirical results allow to derive some recommendations to public authorities. Our study emphasizes that crowding out effects may be relevant in the case of exclusive funding by public sector VCCs. Furthermore, exclusive funding by public VCCs does not contribute to firm performance. The contribution may be higher in the case of combined funding. We conclude that public VCCs should avoid to invest in startup

firms without an involvement of private VCCs. The combined funding helps to fill the financing gap of firms which had not been selected by private VCCs alone. Furthermore, private VCCs may support funded firms better than public VCCs alone.

Actually the empirical results are based on activities in a formative and booming period of the VC market. For a similar analysis in other stages one could expect to obtain some different results. In particular, smaller independent units are affected by the consolidation process. Market turbulences finally lead to an increase in quality, the indicated higher inefficiencies within the value chain process of VCCs will be reduced. We expect that advantages of private VCCs compared with public ones concerning the support for venture-backed firms may be in favour for private VCCs.

References

Admati, A. and P. Pfleiderer (1994), Robust Financial Contracting and the Role of Venture Capitalists, *Journal of Finance* 49, 371-402.

Almus, M., D. Engel and S. Prantl (2000), The Mannheim Foundation Panels of the Centre for European Economic Research (ZEW), *ZEW-Documentation 00-02*.

Amit, R., J. Brander and C. Zott (1998), Why Do Venture Capital Firms Exist? Theory and Canadian Evidence, *Journal of Business Venturing* 13, 441-466.

Barney, J.B. (1991), Firm resources and sustained competitive advantage, *Journal of Management* 17, 99-120.

Bottazzi, L. und M. da Rin (2002), Venture Capital in Europe and the Financing of Innovative Companies, *Economic Policy* 17, 229-269.

Brander J., R. Amit, and W. Antweiler (2002), Venture Capital Syndication: Improved Venture Selection versus the Value-Added Hypothesis, *Journal of Economics and Management* 11, 423-452.

Bundesverband deutscher Kapitalbeteiligungsgesellschaften – German Venture Capital Association e.V. (BVK, 2000), *Directory 2000*, Berlin.

Bundesverband deutscher Kapitalbeteiligungsgesellschaften – German Venture Capital Association e.V. (BVK, 2002), *BVK Statistik 2001: Das Jahr 2001 in Zahlen*, Berlin.

Bygrave, W. D. (1987), Syndicated Investments by Venture Capital Firms: A Networking Perspective. *Journal of Business Venturing* 2**,** 139-154.

Carpenter, R. and Petersen, B. (2002), Capital Market Imperfections, High-Tech Investment, and New Equity Financing, *The Economic Journal* 112, 54-72.

Chan, Y. (1983), On the Positive Role of Financial Intermediation in Allocation of Venture Capital in a Market with Imperfect Information, *Journal of Finance* 38, 1543-1568.

Czarnitzki, D., B. Ebersberger and A. Fier (2004), The relationship between R&D collaboration, subsidies and patenting activities: Empirical evidence from Finland and Germany, *ZEW Discussion Paper* 04-07.

Diamond, D.W. (1984), Financial Intermediation and Delegated Monitoring, *Review of Economic Studies* 51, 393-414.

Engel, D. (2003), Determinanten der regionalen Verteilung Venture Capital-finanzierter Unternehmen, *Jahrbuch für Regionalwissenschaft* 23 (2), 155-181.

Engel, D. and M. Keilbach (2005), Firm Level Implications of Early Stage Venture Capital Investments – An Empirical Investigation, *Papers on Entrepreneurship, Growth and Public Policy No. 2205*, Jena.

European Private Equity & Venture Capital Association (EVCA), *EVCA Yearbook*, verschiedene Jahrgänge, Zaventem.

Gerfin, M. and M. Lechner (2002), A microeconometric evaluation of the active labour market policy in Switzerland, *The Economic Journal* 112, 854-893.

Gilson, R.J. (2003), Engineering a Venture Capital market: lessons from the American Experience, *Stanford Law Review* 55, 1067-1104.

Gompers, P.A. (1995), Optimal Investment, Monitoring, and the Staging of Venture Capital, *Journal of Finance* 50, 1461-1489.

Gompers, P. A. und J. Lerner (1998), What Drives Venture Capital Fundraising?, *Brookings Papers on Economic Activity – Microeconomics*, 149-192.

Greene (1997), *Econometric Analysis*, 3rd edition, Prentice Hall, New Jersey.

Heckman, J.J, H. Ichimura and P. Todd(1998), Matching as an econometric evaluation estimator, *Review of Economic Studies* 65, 261-294.

Heckman, J.J., H. Ichimura, J.A. Smith and P. Todd (1998), Characterising selection bias using experimental data, *Econometrics* 66, 1017-1098.

Heckman, J.J., R.J. Lalonde and J.A. Smith (1999), The economics and econometrics of active labour market programs, in: Ashenfelter, A. and D. Card, *Handbook of labour economics*, Vol.3, 1866-2097.

Hellmann, T. and Puri, M. (2002), Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence, *Journal of Finance* 57, 169-197.

Hellmann, T. (1998), The allocation of control rights in venture capital contracts, *RAND Journal of economics* 29, 57-76.

Imbens. G.W. (2000), The role of propensity score on estimating dose-response functions, *Biometrika* 87, 706-710.

Jain, B. A. und O. Kini (1995), Venture Capitalist Participation and the Post-Issue Operating Performance of IPO Firms, *Managerial and Decision Economics* 6, 593-606.

Jeng, L. A. und P. C. Wells (2000), The Determinants of Venture Capital Funding: Evidence Across Countries, *Journal of Corporate Finance* 6, 241-289.

Kaplan and Stromberg (2001), Venture Capitalists As Principals: Contracting, Screening, and Monitoring, NBER Working Paper 8202.

Kortum, S. and J. Lerner (2000), Assessing the Contribution of Venture Capital to Innovation, *RAND Journal of Economics* 31, 674-692.

Kreditanstalt für Wiederaufbau (KfW, 2003), *Beteiligungskapital in Deutschland: Anbieterstrukturen, Verhaltensmuster, Marktlücken und Förderbedarf*, Mai 2003, Berlin.

Landström, H. (1992), The Relationship Between Private Investors and Small Firms: An Agency Theory Approach, *Entrepreneurship & Regional Development* 4, 199-233.

Leleux, B. and B. Surlemont (2003), Public versus private venture capital: seeding or crowding out? A pan-European analysis, *Journal of Business Venturing* 18, 81-104.

Lerner, J. (2002), When Bureaucrats Meet Entrepreneurs: The Design of the Effective Public Venture Capital Programmes, *The Economic Journal* 112, F73-F84.

Lechner, M. (2001), Identification and estimation of causal effects of multiple treatments under the conditional independence assumption, in: Lechner, M. and F. Pfeiffer (eds.), Econometric evaluation of labour market policies, *ZEW Economic Studies* 13, 43-58.

Lerner, J. (1994), The Syndication of Venture Capital Investments, *Financial Management* 23, 16-27.

Lockett, A. and M. Wright (2001), The Syndication of Venture Capital Investments, *Omega* 29, 375-390.

Mackewicz & Partner (2002), Venture Capital Panel 3. Quartal 2002, available at http://www.mackewicz.de/cgi-bin/vc-display.pl?topic=sonder&report=vcp-2002-3.

MacMillan, I. C., D. M. Kulow und R. Khoylian (1988), Venture Capitalists' Involvement in Their Investments: Extent and Performance, *Journal of Business Venturing* 4, 27-47.

MacMillan, I.C., L. Zemann and P.N. SubbaNarasimha (1987), Criteria Distinguishing Successful From Unsuccessful in the Venture Screening Process, *Journal of Business Venturing* 2, 123-137.

Manigart, S., K. D. Waele, M. Wright, K. Robbie, P. Desbières, H. Sapienza und A. Beekman (2002a), Determinants of Required Return in Venture Capital Investments: A Five-Country Study, *Journal of Business Venturing* 17, 291-312.

Norton, E. and B.H. Tenenbaum (1993), Specialization versus diversification as a venture capital investment strategy, *Journal of Business Venturing* 8, 431–442.

Rosenbaum, P.R. and D.B. Rubin (1983), The central role of the propensity score in observational studies for causal effects, *Biometrika* 70, 41-55.

Rosenstein, J., B. V. Albert, W. D. Bygrave, N. T. Taylor (1993), The CEO, Venture Capitalists, and the Board, *Journal of Business Venturing* 8, 99-113.

Sahlman, W. A. (1990), The Structure and Governance of Venture Capital Organizations, *Journal of Financial Economic* 27, 473-521.

Sapienza, H. J. (1992), When Do Venture Capitalists Add Value, *Journal of Business Venturing* 7, 9-27.

Schefczyk, M. (1999), Erfolgsdeterminanten von Venture Capital-Investments in Deutschland, *Zeitschrift für betriebswirtschaftliche Forschung* 51, pp. 1123-1145.

Train, K. (2003), *Discrete choice methods with simulation*, Cambridge.

Tyebjee, T. T. and A. V. Bruno (1984), A Model of Venture Capitalist Investment Activity, *Management Science* 30, 1051-1066.

VentureOne (1999), *The 1998 Venture Capital Industry Report*, San Francisco.

Weber, C. and M. Dierkes (2002), Strukturmerkmale klassischer Venture-Capital-Gesellschaften und Corporate-Venture-Capital-Gesellschaften in Deutschland im Vergleich, *Finanzbetrieb* 4, pp. 545-553.

Wright, M. and K. Robbie (1999), Venture capital and private equity: a review and synthesis, *Journal of Business Finance Accounting* 25, 521-570.

Appendix A

Table 3: Descriptive Statistics

Variable	Mean	Std. Dev.	min	max
pub	0.0018	0.0421	0	1
priv	0.0055	0.0739	0	1
emp_found	4.2550	6.2814	1	100
patbeforevc	0.0564	6.4082	0	1969
sales_3y	0.1622	0.3686	0	1
investig	0.6129	0.4871	0	1
age	4.3391	1.8229	0	8.5
capcom	0.1249	0.3306	0	1
graduate	0.3491	0.4767	0	1
phd	0.0827	0.2755	0	1
teammore	0.4198	0.4935	0	1
ln(popdense)	6.3324	1.2858	3.7136	8.2810
bioregio	0.3495	0.4768	0	1
east	0.2011	0.4008	0	1
ln(emp_rnd)	7.0696	1.5912	0.6921	10.3728
ind_1	0.0545	0.2270	0	1
ind_2	0.0477	0.2132	0	1
ind_3	0.8169	0.3868	0	1
ind_4	0.0809	0.2727	0	1
Observations		136676		

Appendix B

Table 4: Matching results for firm performance indicators

exponential growth of survived firms		Actual state *m*		
		pub	Priv	pubpriv
Counterfactual state *l*	pub		4.94 E10-4 (0.120)	0.045 (0.196)
	priv	0.046 (0.155)		0.0128 (0.175)
	pubpriv	0.134 (0.120)	-0.099 (0.157)	
	nonvc	0.113 (0.999)	0.145** (0.628)	0.583 (0.394)
linear growth of all firms		Actual state *m*		
		pub	Priv	pubpriv
Counterfactual state *l*	Pub		-0.122 (0.906)	0.257 (0.882)
	Priv	0.111 (0.900)		0.130 (0.971)
	pubpriv	0.900** (0.382)	-0.777 (1.507)	
	nonvc	0.652 (0.494)	0.532* (0.273)	1.615* (0.832)
Patent (1/0)		Actual state *m*		
		pub	Priv	pubpriv
Counterfactual state *l*	pub		0.030 (0.029)	-0.024 (0.083)
	priv	-0.008 (0.043)		-0.052 (0.085)
	pubpriv	0.058 (0.104)	0.060 (0.041)	
	nonvc	0.027 (0.025)	0.015 (0.010)	0.060 (0.754)
Market exit (1/0)		Actual state *m*		
		pub	Priv	pubpriv
Counterfactual state *l*	pub		-0.230 (0.081)	0.034 (0.153)
	priv	0.869 (0.102)		0.002 (0.152)
	pubpriv	-0.141 (0.297)	0.040 (0.106)	
	nonvc	0.084 (0.062)	0.147*** (0.031)	0.127 (0.250)

Standard errors in parentheses. *** (**; *) indicates a 1 %, (5%, 10%) significance level (two-sided test). Matching with replacement to draw one control observation. Standard errors are corrected by Lechner's (1999) asymptotic approximation correcting for replicated observations due to sampling with replacement.