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Sources of Funds and Specialization Patterns of European Venture Capital Investments

by

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SOURCES OF FUNDS AND SPECIALIZATION PATTERNS OF EUROPEAN VENTURE CAPITAL INVESTMENTS

Abstract

This paper analyses the link between venture capitalists' sources of funds, such as banks and pension funds, and the specialization pattern of venture capital investments in particular industries and particular stages of enterprises' development. Based on a panel data set of Western European countries, the results of the analysis show that sources of funds and investment specialization patterns are linked. For example, the specialization in the early stage of enterprises' development depends positively on the importance of pension funds and negatively on the importance of banks as sources of funds. These results reject models that assume independence of sources of funds and investment patterns.

Keywords: sources of funds, venture capital, Europe, panel data
JEL classification: G24, G32

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1 Introduction

Specialization patterns in Europe's venture capital markets differ substantially. In France, only about 21 per cent of all venture capital rounds has been in the early stage of enterprises' development, on average. In contrast, in Germany about 38 per cent, and in Finland even about 48 per cent has been in the early stage of enterprises' development. These data suggest that, in Germany and Finland, comparatively risky enterprises received a high percentage of venture capital, while in France these enterprises received comparatively little attention by venture capitalists.

This paper discusses whether the specialization patterns in Europe's venture capital markets and sources of funds are linked. As sources of funds, banks, pension funds, and corporations may act. In a frictionless financial market, one would expect that sources of funds do *not* affect the way in which capital is allocated across different types of enterprises. In a financial market with several frictions and rigidities, however, one can expect that sources of funds do affect the allocation of capital across different types of enterprises. This might be the case because sources of funds, which may differ with respect to their degree of risk aversion, may not only invest their capital in venture capital funds for risk-return considerations. For example, banks may provide capital only for enterprises in traditional industries but not for enterprises in high-technology industries because they are highly risk averse. By contrast, corporations may invest their capital in venture capital funds to support the development of new technologies, which they may hope to use in their production process later on. Thus, I expect that the specialization of investments in high-technology industries is negatively correlated to the availability of funds coming from banks, and positively correlated to the availability of funds coming from corporations.

The link between venture capitalists' investments and sources of funds has received attention in recent literature. Mayer et al. (2003) have used qualitative micro data of venture capital companies operating in Israel, the United Kingdom, Germany and Japan. Using a probit model, they found evidence that venture capital companies which receive capital from pension funds are less likely to invest in the early stage of enterprises' development. Moreover, using the average stage investment focus,[1] they found that

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[1] The average investment focus results from combing available information on the investment behaviour of venture capital companies. They indicate only whether they invest in the early stage, the expansion stage and the development stage, but they do not always indicate how much of their portfolio is invested in enterprises in particular development stages.

venture capital companies which receive capital from banks are more likely to focus on the later stage of enterprises' development.

While Mayer et al. (2003) have used a qualitative micro data set, I will use a quantitative macro panel data set of venture capital investments in 16 European countries. My data set covers the period 1988 to 2002 and informs about specialization patterns on a country level. In line with the results reported by Mayer et al. (2003), I find a negative link between the importance of banks as a source of funds and the specialization of investments in the early stage of enterprises' development. However, in contrast to the results by Mayer et al. (2003), I find evidence that the importance of pension funds as source of funds is positively linked to the specialization in the early stage.

The role of large financial players for new funds raised for venture capital investments has also been analysed by Jeng and Wells (2000) who used a panel data set of 21 countries for the years 1993 to 1995. They have found evidence that the wealth of private pension funds, which are scaled by GDP in order to correct for differences in the size of economies, has a significant positive impact on new funds raised for private equity when using within-estimations but not when using between-estimations. Because of these results, Jeng and Wells have argued that the wealth of private pension funds is a significant determinant of venture capital investments over time but not across countries.

My paper is also related to the literature analysing the effects of the financial structure on the efficiency of the capital allocation. In this literature, the financial systems of countries are classified as bank-based or market-based system in order to analyse whether countries (Levine and Zervos 1998) or industries which need substantial amounts of external finance grow faster when they can make use of a bank-based or market-based system (Beck and Levine 2002). While these papers distinguish two broad types of financial systems, I use a finer subdivision of capital provision to analyse whether the preferences and risk aversion of the sources of funds matter for investment decisions.

The remainder of the paper is organized as follows. In Section 2, I discuss expected links between specialization of investments in particular stages and industries, as measured either by the volume or the number of investments, on the one hand, and sources of funds, on the other hand. In Section 3, I describe the data set and report descriptive statistics. In Section 4, I present my estimation results, and in Section 5 I offer some concluding remarks.

2 Links between sources of funds and specialization patterns

In a frictionless financial market, sources of funds do not play a role for the specialization pattern of venture capital investments. Sources of funds such as banks, government institutions, pension funds, academic institutions, corporations, and insurance companies offer their capital into a large pool of capital, which then is allocated among enterprises according to the enterprises' productivity of capital. However, when frictions matter in financial markets, investments cause transaction and information costs, so that the allocation of capital across enterprises is not exclusively determined by the enterprises' productivity of capital (Stiglitz and Weiss 1981). Then, apart from the productivity of capital, sources of funds' preferences and risk aversion, and the degree of asymmetric information between the sources of funds and the enterprises demanding capital determine the capital allocation implying that sources of funds and specialization patterns are linked.

Transaction and information costs between sources of funds, enterprises, and venture capitalists are potentially severe in venture capital markets as control mechanisms commonly used in venture capital contracts demonstrate. A large number of papers have focused on control mechanisms used in the contracts between venture capitalists and entrepreneurs (Manigart et al. 2002, Kaplan and Strömberg 2000, Cumming 2002, Schwienbacher 2002) and between venture capitalists and sources of funds (Feinendegen et al. 2002, Gompers and Lerner 1999, Brouwer and Hendrix 1998, Gompers and Lerner 1996).

For my analysis, the link between sources of funds and venture capitalists is of particular importance. Sources of funds can offer capital for venture capital investments either (1) by setting up a subsidiary which selects promising enterprises and invests the capital in a way preferred by the sources of funds, or, (2) by investing in venture capital companies which are independently organized and whose investment behaviour is in line with the sources of funds' preferences. These two alternatives may not be identical because of different incentive structures.[2] After capital infusion, sources of funds might

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[2] Independent and dependent venture capital companies may differ with respect to their investment and divestment behaviour, since dependent venture capital companies neither have to divest their participations in order to receive capital for further investments (because they may receive additional capital from their capital providers on request) nor do they have to re-pay the capital to the capital providers at a particular point in time. In addition, the necessity to divest in order to obtain a high

not affect independent venture capital companies' investment behaviour in such a strong manner than the investment behaviour of dependent venture capital companies. In particular, market conditions and profit expectations might be more important for the investment behaviour of independent than of dependent venture capital companies.

In order to discuss possible links between sources of funds and specialization patterns of investments, I focus on the capital allocation across high- and low-risk investments. In particular, I focus on the share of total capital available for investments in high-risk enterprises denoted by γ_{high}, and the share of total capital available for investments in low-risk enterprises denoted by γ_{low}, with $\gamma_{low} + \gamma_{high} = 1$.

I assume that the specialization pattern of investments in a frictionless financial market, $\left(\gamma_{low}^{NF}, \gamma_{high}^{NF}\right)$, differs from the specialization pattern of investments in a financial market with frictions, $\left(\gamma_{low}^{F}, \gamma_{high}^{F}\right)$. In a world without frictions, the specialization pattern results solely from the productivity of the enterprises. In a world with frictions, however, the specialization pattern depends also on the transaction and information costs of sources of funds and enterprises demanding capital. An asymmetric distribution of information may lead to significant transaction and information costs for the sources of funds. I expect that these transaction and information costs are higher for high-risk enterprises than for low-risk enterprises. High-risk enterprises are those which operate in high-technology industries or which are in the early stage of development. Low-risk enterprises are those which operate in low-technology industries or which are in the later stage of development. Because of the difference in transaction and information costs for high- and low-risk enterprises, I expect that the share of investments in high-risk (low-risk) enterprises is higher (lower) in financial markets without frictions than in financial markets with frictions, $\gamma_{high}^{F} < \gamma_{high}^{NF}$ and $\gamma_{low}^{F} > \gamma_{low}^{NF}$, respectively.

From this it follows that a reduction of transaction costs leads to an increase in the share of investments in high-risk enterprises, and this increases the efficiency of the capital allocation. However, one must also take into account that situations can arise in which the actual share in high-risk enterprises is higher than the efficient one realized in a financial market without frictions.[3] This is important because it implies that an empirically identified positive link between a particular source of funds and high-risk investments does not inform about the efficiency of the capital allocation.

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short-term performance of the portfolio is low because the capital providers of dependent venture capital companies may not be primarily interested in the short-term performance of the portfolio.

3 For example, the over-valuation of firms in the information and communication industry in the second half of the 1990s may have been a situation in which $\gamma_{high}^{NF} > \gamma_{high}^{F}$.

In what follows I consider a financial market with frictions and discuss what happens to the specialization pattern of investments when a marginal unit of capital is redistributed between various types of sources of funds. The effect on the specialization pattern depends on the preferences of the sources of funds to carry high risks and on ability of sources of funds to reduce transaction and information costs.

What might happen to the specialization pattern, $\left(\gamma_{low}^{F}, \gamma_{high}^{F}\right)$, when the share of new funds provided by banks relative to the pool of capital available, ω_{bank}, is increased by a marginal unit? I expect a positive effect on γ_{low} and a negative effect on γ_{high} for three reasons. First, banks can be expected to be more risk averse than some of the other sources of funds, and, therefore, they may finance more low-risk and fewer high-risk enterprises than some of the other sources of funds. Second, banks can be expected to be interested in investing equity capital in those enterprises in which they also hold debt claims. Powerful banks may extract informational rents, which may reduce the capital demand from high-risk enterprises, and protecting established ones (Hellwig 1991, Rajan 1992). Third, an increase of new funds provided by banks is likely to have a positive effect on γ_{low} and a negative effect on γ_{high} because the corporate governance structure of subsidiaries of banks may not be organized to offer equity capital to enterprises with high investment risks.[4] In order to finance high-risk investments in, for example, the life-science industry it is important that fund managers are capable of evaluating business plans in the high-technology industries successfully.

When either the share of new funds provided by pension funds, $\omega_{pension}$, or the share of new funds provided by insurance companies, ω_{insur}, is increased by a marginal unit, I expect a negative effect on γ_{low} and a positive effect on γ_{high} for at least two reasons. First, investment behaviour of pension funds and insurance companies can be expected to be mainly determined by risk-return considerations, and the risk aversion of pension funds and insurance companies is likely to be lower than that of banks. Because the amount of the overall pension fund's or insurance company's portfolio invested in venture capital is comparatively small, the risks of these investments can be high compared with the risk of other investments made by pension funds and insurance companies. Second, capital provision of pension funds and insurance companies may create new tools to finance high-risk enterprises such as independent venture capital

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4 In Germany, for example, the low shares of equity of medium-sized already established enterprises led to the establishment of *Beteiligungsgesellschaften* which have got their capital mainly from banks in the 1960s. Professional managers of these subsidiaries often do not receive profit participation in addition to their basic salary, while their counterparts of independent venture capital companies do (Zemke 1995).

companies, in which the fund managers have the technological experience relevant for selecting promising enterprises out of a large number of enterprises seeking financial means.

When the share of new funds provided by corporations, ω_{cor}, is increased by a marginal unit, I expect a negative effect on γ_{low} and a positive effect on γ_{high}. As pension funds, corporations aim at receiving an appropriate rate of return on their invested capital. However, these two types of sources of funds may differ with respect to their strategic goals (Riyanto and Schwienbacher 2002, Schween 1996). Corporations may have an interest in building long-term cooperative relationships and in keeping an eye on new technological developments, while pension funds do not have such strategic goals. Thus, new funds provided by corporations should be positively correlated with the specialization of investments in the early stage and in research and development intensive industries.

When either the share of new funds provided by government institutions, ω_{gov}, or the share of new funds provided by academic institutions, ω_{aca}, is increased by a marginal unit, I expect a negative effect on γ_{low} and a positive effect on γ_{high} for several reasons. Capital provided by academic institutions is likely to be positively correlated with investments in the early stage of enterprises' development and with investments in research and development intensive industries because academic institutions provide capital for business ideas coming from universities. Capital provided by government institutions may also be correlated positively with investments in the early stage of enterprises' development and with investments in research and development intensive industries. The reason for this is that market failures resulting from frictions in financial markets are expected to be substantial for those enterprises which are very young or which operate in industries in which investments are often made in research and development activities (Bond et al 1999, Engeln 1997, Harhoff 1998, Himmelberg and Petersen 1994).

The Table 1 summarizes the expected effects of an increase in the share of new funds provided by a particular source of funds on the specialization pattern of investments in high- and low-risk enterprises.

It should be noted that I assume that the shares of capital provided by the sources of funds affect the specialization patterns of venture capital investments. There is little reason to believe that the causality is the other way around because I use investment shares. For example, the share of new funds provided by pension funds is not expected to depend on the share of investments spent in the early stage of enterprises'

development. Rather, it may depend on profitability of the early stage compared to other development stages, and regulatory variables, such as tax regulations of venture capital funds.

In my analysis, I consider only the role of sources of funds. I do not, however, consider factors describing venture capital demand. Between countries or within a country over time, specialization of venture capital investments may differ because of variations in venture capital demand. A high share of high-risk investments may be the result of a high demand for capital to finance these investments. However, factors documenting changes in the venture capital demand are unfortunately not available for the time- and country-dimension of my panel data set.

3 Data

3.1 Data description

My panel data set provides information on the amount of capital offered by the various sources of funds and on the allocation of capital across various types of enterprises. It contains data for 16 Western European countries for the time period 1988 to 2002. The countries are: Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. I restrict the analysis to European countries because data on investments and new funds are comparable only for European countries.[5]

My analysis focuses on specialization patterns of investments in enterprises that operate in various industries and of investments in various stages of enterprises' development. I consider two industries: the information and communication industry and the biotechnology and medical-related industry. Moreover, I consider two stages of enterprises' development: the early stage and the expansion stage. I use either the volume or the number of investments as a dependent variable. I define specialization as the investments in a particular stage or industry divided by total venture capital investments.

Using the specialization in the information and communication industry and the biotechnology- and medical-related industry is of particular interest because of the

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5 From a theoretical point of view, it would be interesting to use data that provide information on both the sources of funds and the type of venture capital company, i.e., whether the capital offered by a particular source of funds is managed by a subsidiary of the source of funds or by an independent venture capital company. However, this kind of data is not available.

investment characteristics in these industries. On average, the biotechnology and medical-related industry has higher risks than other industries in which venture capital is invested, such as the manufacturing industry. This higher risk exists because specific knowledge seems necessary to understand business ideas, and because the founder's knowledge and behaviour may have a higher impact on the success of the business foundation. Focusing on the information and communication industry is interesting because this industry experienced a strong boom in the second half of the 1990s.

Using the specialization in the early and expansion stages is of particular interest because investment characteristics of enterprises in the expansion stage differ from those of enterprises in the early stage. In the early stage, the initial business concept is formed and prototypes of new products are developed and compared with competing products in the market. Moreover, production is setup and an initial marketing campaign is launched, the market reaction to which is carefully analysed. By contrast, in the expansion stage, enterprises require large amounts of external funding because the cash flow often does not yet generate enough liquidity for the internal financing of the enterprises' growth. Because of this, the average volume of investments in the early stage of enterprises' development is expected to be lower than the one in the expansion stage of enterprises' development. Moreover, risks of early stage investments are higher than risks of expansion stage investments.[6] In addition, evaluating the risks of early stage investments is likely to be more difficult than evaluating the risks of expansion stage investments.

Tables 2 to 5 describe specialization patterns in Europe's venture capital investments. Specialization varies substantially over time and across countries, but no particular pattern can be observed in the data. With respect to the specialization of investments in particular industries, the European countries show substantial differences. In Austria, about 37 (42) per cent of the volume (number) of investments has been invested in enterprises operating in the information and communication industry. In Italy, by contrast, only about 10 per cent of the volume of investments has been invested in these enterprises. With respect to the investments in enterprises operating in the biotechnology and medical-related industry, Denmark has been the

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6 The risk to lose an investment spent in high-technology enterprises in the early stage of development, that is before production is started, is over 60 per cent (Ruhnka and Young 1987). Internal factors, such as developing a prototype that does not work, predominantly give rise to this risk. Therefore, the risk to lose an investment decreases with enterprises' development progress. External factors, such as unanticipated competition, constantly affect the risk over the development stages of an enterprise; the impact only increases in the exit stage, in which the shares of the venture capitalists are sold to other share holders (Ruhnka and Young 1991).

leading country in terms of the volume and the number of investments. In Denmark, about 15 (20) per cent of the volume (number) of investments has been invested in these enterprises.

With respect to the specialization in the early stage, Finland has invested most in terms of the volume and the number of investments. About 30 (48) per cent of the volume (number) of investments over all years have been invested in enterprises' early stage in Finland. By contrast, in the United Kingdom, only about 5 per cent of the volume of investments and 13 per cent of the number of investments have been invested in the early stage. The fact that volumes of investments have been higher than numbers of investments in the early stage of enterprises' development indicates that enterprises in the early stage have received less capital than enterprises in other development stages.

With respect to expansion stage, Norway has invested most in this stage in terms of the volume and the numbers of investments. While 74 per cent of the volume of investments has been invested in these enterprises, only about 63 per cent of the number of investments belongs to enterprises in the expansion stage. While Norway has had a high level of expansion stage investments, the United Kingdom has invested only 28 per cent of its volume of investments in enterprises' expansion stage, and Italy has invested only 40 per cent of its numbers of investments in enterprises' expansion stage.

3.2 Descriptive statistics

Table 6 presents descriptive statistics of the endogenous and exogenous variables of the panel. The number of observations in the panel data set for the investment data is between 209 and 224. The number of countries is 16. The number of periods per country is between 7 and 15. On average the number of periods per country is 14. Thus, the panel is unbalanced.

On average, over all periods and all countries, 17 per cent of the total capital has been invested in the early stage of the enterprises' development. More than 51 per cent has been invested in the expansion stage. Thus, when using the volumes of investments, early stage activity has played a minor role. However, a look at the numbers of investments in the early stage of enterprises' development reveals that the importance of early stage investments is much higher than suggested by the volumes.

On average, 23 per cent of the volume of investments has been invested in enterprises operating in the information and communication industry. About 8 per cent of the volume of investments has been invested in the biotechnology and medical-

related industry. In the case of the number of investments, the percentage numbers are only slightly higher than the percentage numbers of the volume. This indicates that enterprises operating in the information and communication industry and in the biotechnology and medical-related industry have received, on average, less capital than enterprises operating in other industries.

Table 6 also informs about sources of funds. It shows that banks (BANK) are the most important source of funds followed by corporations (CORP) and pension funds (PENS). While banks have provided about 30 per cent of all new funds over all countries and all periods, corporations and pension funds have provided about 10 per cent. Government institutions (GOV) and insurance companies (INSUR) account for about 8 per cent, while academic institutions (ACA) account for less than one per cent.

As the minimum and maximum values indicate, there are significant variations across countries with respect to the importance of sources of funds in my data set. While one country has new funds provided by banks that account for about 94 per cent of all new funds, another country has no new funds provided by banks. A similar picture, although less extreme, exists with respect to the role of pension funds. One country has new funds provided by pension funds that account for about 50 per cent, while another country has no new funds provided by pension funds. The British venture capital market is the only European market in which pension funds have continuously provided large amounts of capital.

Correlations presented in Table 7 give a first impression at the links between sources of funds and specialization patterns of investments.

With respect to specialization of investments in particular industries, the share of new funds provided by banks is negatively correlated with the share of investments in enterprises operating in the information and communication industry and in the biotechnology and medical-related industry. This holds in terms of the number of investments and in terms of the volume of investments. The share of new funds provided by pension funds is positively correlated with investment activity in enterprises operating in biotechnology and medical-related industries, and it has a very low correlation coefficients with investments in the information and communication industry. The share of new funds provided by corporations shows a considerable high correlation with investments in enterprises operating in information and communication industry, while new funds provided by insurance companies have a comparatively high correlation coefficient with investment activity in enterprises operating in the biotechnology- and medical-related industry.

With respect to the specialization patterns in particular stages of enterprises' development, the shares of new funds provided by corporations and banks are highly correlated with the specialization of investments in the early stage. While corporations have a positive correlation coefficient, banks have a negative one. Both signs are in line with my theoretical considerations presented in Section 2. The share of new funds provided by pension funds and insurance companies are highly correlated with the share of expansion stage investments, both in terms of the number and volume of investments. Both correlation coefficients are negative indicating that when pension funds and/or insurance companies are a main source of funds, venture capital investments in the expansion stage of enterprises' development, which are not as risky as investments in the early stage of development, are lower.

The correlation between new funds provided by banks and pension funds is negative, and almost double as high as the correlation between new funds provided by banks and new funds provided by either corporations or insurance companies. In particular, the correlation between new funds provided by pension funds and banks is as high as –0.32, while the correlation between new funds provided by banks, on the one hand, and corporations and insurance companies, on the other, is about –0.14 and –0.17.

4 Empirical analysis

4.1 Methodology

In order to estimate whether the shares of new funds provided by sources of funds have a significant impact on the specialization patterns of venture capital investments, I employ panel data techniques. In addition to the shares of capital provided by sources of funds, the model considers the change in new funds and country-specific effects:

(1) $$\gamma_{it} = X_{it}\beta + \alpha\Delta fund_{it} + \vartheta_i + \varepsilon_{it},\ t = 1,...,T,\ i = 1,...,N,$$

where X_{it} denotes the vector of the shares of capital provided by sources of funds, $(\omega_{bank}, \omega_{pens}, \omega_{gov}, \omega_{corp}, \omega_{insur}, \omega_{aca})$, Δfund denotes the change in total new funds, ϑ_i denotes the country-specific effects, β and α denote coefficients to be estimated, and ε_{it} denotes the error vector.

I include the change in new funds in order to control for changes in competition. The change in new funds may have a significant impact on the specialization of investments in particular types of enterprises. This might be the case because a boost in

the new funds raised may lead to investments of larger size and not to a larger number of investments (Gompers 1998). There are two reasons for this. First, individual time constraints of venture capitalists lead to a particular number of enterprises that each venture capitalist can select, monitor, and support. Thus, venture capitalists have few incentives to increase the number of enterprises in their portfolios. Second, the supply of experienced venture capitalists is not flexible in the short-term (Gompers 1998).

Venture capitalists can manage an increase in new funds via several strategies. These strategies result from fulfilling two restrictions: to invest the available funds and to have limited time for monitoring (for a theoretical discussion of venture capitalists' portfolio selection, see Kanniainen and Keuschnigg (2003)). Assume that enterprises in the early stage of development cannot employ as much capital as enterprises in the expansion stage, and that venture capitalists need more time to monitor enterprises in the early stage than enterprises in the expansion stage. One strategy can be that venture capitalists select more enterprises in the expansion stage and less in the early stage when new funds increase. By selecting more enterprises in the expansion stage, venture capitalists can invest more capital. In addition, by selecting more enterprises in the expansion stage, venture capitalists can save on time so that they can monitor more enterprises. Then, the change in new funds is expected to have a positive impact on the specialization in the expansion stage and a negative one on specialization in the early stage. This should hold irrespective of whether the number of investments or the volume of investments is used. Another strategy can be to select the same types of enterprises as before so that the time constraint of the venture capitalists is fulfilled. In addition, the venture capitalists can invest more capital in each enterprises. Then, the change in new funds has only a positive impact on the specialization in the expansion stage and a negative one on the specialization in the early stage when the volume of investments is used, but not when the number of investments is used.

Because my panel data set contains only 16 Western European countries, which are not randomly chosen, I assume that country-specific effects are correlated with the exogenous variables of my model. In order to get consistent estimators of the parameters, these country-specific effects must be removed from the regression equation. This is done by a within transformation of the data set. Thus, the regression equation changes to:

$$(2) \qquad \gamma_{it} - \bar{\gamma}_i = \left(X_{it} - \bar{X}_i\right)\beta + \alpha\left(\Delta \text{fund}_{\text{it}} - \overline{\Delta \text{fund}}_{\text{i}}\right) + \varepsilon_{it} - \bar{\varepsilon}_i,$$

$t = 1,...,T$, $i = 1,...,N$, where $\bar{y}$ denotes the mean of y.

My estimation strategy is as follows.

In a first step, I estimate a *standard fixed effects* model, i.e., I estimate (2) by using the OLS (ordinary least square) estimator, which is equivalent to estimate (1) by means of a least square dummy variable estimator. This standard fixed effect model assumes that all members of the panel have the same variance (homoskedastic error terms) and that there is no correlation over time either across nor within the members of the panel.

In a second step, I estimate (2) as cluster model by using OLS and a country-specific correction of the standard errors (Wooldridge 2002). The standard errors are robust to any type of correlation within the countries. However, the cluster model is never fully efficient.

In a third step, I estimate (2) by using the FGLS (feasible generalized least square) estimator because my panel data set has almost as much time periods as countries. I assume a heteroscedastic error structure without cross-sectional correlation and a country-specific first-order autocorrelation. For calculating country-specific first-order autocorrelation coefficients, 16 additional parameters must be estimated. To estimate autocorrelation coefficients consistently requires many time-periods per panel.

Differences between the estimates of the cluster model and the estimates of the FGLS stem from the importance of misspecification of the model and from differences in asymptotic properties. While the cluster model is robust to misspecifications in the form of heteroskedasticity and correlation within clusters (Wooldridge 2002), the FGLS is not. While the FGLS treats each year as an important variable to construct the variance, the cluster model treats each country as an important variable to construct the variance.

4.2 Estimation results: specialization in particular industries

Table 8 and 9 report the results of the three models estimated for specialization in the information and communication industry and in the biotechnology and medical-related industry. The results differ to some extent between standard fixed effects and the cluster model, on the one hand, and the FGLS, on the other hand. This holds irrespective of whether the volume or the number of investments is used.

With respect to the share of the volume invested in the information and communication industry, estimation results suggest that academic institutions and banks may play role. The share of new funds provided by academic institutions has a positive and significant impact at the five per cent level when using the FGLS. However, when

using the cluster model, the share of new funds provided by academic institutions is not significant at the five per cent level (the p-value is 0.15). The difference in the coefficients is considerably small: the coefficient of the FGLS estimation is 11 per cent higher than the one of the cluster model. The share of new funds provided by banks is not significant when using FGLS, while it is negative and significant at the 10 per cent level when using the cluster or the standard fixed effect model.

With respect to the share of the number of investments in the information and communication industry, I find that the higher the share of new funds provided by banks, the lower the share of the number of investments in the information and communication industry is. Taken together, the results presented in Table 8 suggest that banks are not as much interested in financing high-risk investments as the other sources of funds under consideration.

The shares of new funds provided by various sources of funds have little power in explaining the specialization of venture capital volume invested in the biotechnology and medical-related industry. When I use FGLS, none of my variables is significant. The significance changes only slightly when I reduce the number of exogenous variables in the regression. When I use the standard fixed effects or the cluster model, only the share of new funds provided by banks has a significant negative impact on the specialization in biotechnology and medical-related enterprises.

In contrast to the regressions using the volume of investments, the explanatory power of the regressions using the number of investments in the biotechnology and medical-related industry is somewhat higher, and the results are most often in line with the theoretical considerations discussed in section 2. However, the regression results differ substantially between the FGLS estimator on the one hand and the fixed effects and cluster model estimator, on the other hand. When I use the FGLS estimator, the shares of new funds provided by banks and by corporations have a significant negative impact. In contrast, when I use the cluster model estimator, the shares of new funds provided by pension funds and by insurance companies have a significant positive impact. The only variable which has a significant positive impact in all regressions is the share of new funds provided by academic institutions. A one per cent increase in the share of new funds provided by academic institutions leads to an increase in the share of the number of investments of biotechnology and medical-related enterprises of about 0.4 per cent.

I check the robustness of my estimation results by using two additional specifications. First, I run regressions using the cluster model for a sample excluding the

United Kingdom.[7] Second, I run regressions using the cluster model for an equation including a dummy variable equal to one for the time period in which shares of information and communication enterprises were over-evaluated (results not reported). With respect to excluding the data of the United Kingdom, neither the coefficients of the shares of the sources of funds nor the significances of the coefficients change substantially. This holds for the specialization in the information and communication industry as well as for the specialization in the biotechnology- and medical-related industry.

While including the dummy variable for the time of the bubble has no impact on the regression results in the case of the specialization in the biotechnology- and medical-related industry, it changes the estimation results slightly in the case of the specialization in the information and communication industry. The dummy variable has a highly significant impact on the share of investments used to finance enterprises operating in the information and communication industry. In the years 1998, 1999, and 2000, in which the dummy variable assumes the value 1, venture capital investments in the information and communication industry were about 11 per cent higher than in all other years. Including the dummy variable has also an impact on the role of sources of funds in financing enterprises in this industry. The share of capital provided by banks looses its significance in the volume-of-investments equation, while it remains significant in the number-of-investments equation.

By using a micro data set of venture capital companies operating in the United Kingdom, Germany, Israel, and Japan, Mayer et al. (2003) find evidence that venture capital companies that get funds from insurance companies and pension funds do more favour the life science industry more than the information and software industry. My estimation results confirm their results. The shares of new funds provided by pension funds and insurance companies have only a significant impact on the specialization in biotechnology- and medical-related enterprises when using the number of investments.

4.3 Estimation results: specialization in particular stages of development

Table 10 and 11 report the results of the three models which I estimate for the specialization in the early and expansion stage of enterprises' development. Compared to the results presented in the last section, the results of the various estimation

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7 According to the data by Beck and Levine (2002), the United Kingdom is the leading 'market-based economy in my sample.

approaches, i.e., the standard fixed effects estimator, the cluster model estimator, and the FGLS estimator are comparable, suggesting that heteroskedasticity and panel-specific autocorrelation do not matter substantially.

The share of the volume of investments in the early stage of enterprises' development depends significantly on the importance of new funds provided by pension funds, corporations, and academic institutions. According to the cluster model, a one per cent increase in new funds provided by pension funds, increases the share of capital invested in the early stage of development by about 0.17 per cent. A one per cent increase in new funds provided by corporations, increases the share of capital invested in the early stage of development by about 0.3 per cent. A one per cent increase in new funds provided by academic institutions increases the share of capital invested in the early stage of development by about 1.3 per cent. Thus, academic institutions focus strongly on the early stage of development followed by corporations and pension funds. In addition, the coefficient of academic institutions, which is above one, can be interpreted as an accelerator: academic institutions are able to combine their capital with other sources and to invest the resulting amount in the early stage of enterprises' development.

The share of the number of investments in the early stage of enterprises' development depends significantly on the importance of new funds provided by banks, pension funds, and academic institutions. While an increase in the share of new funds provided by banks has a negative impact on the share of early stage activity, an increase in the shares of new funds provided by pension funds and academic institutions have a positive impact. Thus, in countries in which banks play an important role as source of funds for new funds for venture capital, the share of capital invested in risky enterprises, such as enterprises in the early stage of development, is lower than in countries in which pension funds play an important role.

Specialization in the expansion stage of enterprises' development measured either by the volume or the number of investments depends significantly on the new funds provided by pension funds and insurance companies. Increasing the share of new funds provided either by pension funds or insurance companies has a negative impact on the share of capital invested in the expansion stage of enterprises' development.

Specialization in the early and expansion stage of enterprises' development depends on the change in new funds. According to the cluster model, an increase in new funds reduces the specialization in the early stage and increases the specialization in the expansion stage. This holds only in the case of the volume of investments and not in the

case of the number of investments. Thus, an increase in the new funds leads to investments of larger size and not necessarily to a larger number of enterprises which get venture capital.[8]

I check the sensitivity of my estimation results by estimating the cluster model for a sample excluding the United Kingdom on the one hand, and by estimating the cluster model and considering a dummy variable equal to one in the bubble time of the information and communication industry on the other hand. With respect to excluding the data of the United Kingdom, neither the coefficients of the sources of funds nor their significances change substantially. This holds for all stages of enterprises' development considered here.

Including the dummy variable for the bubble time has little impact on the regression results as far as the numbers of investments are considered. When the volumes of investments are considered, the significance of pension funds drops substantially with respect to the specialization in early and expansion stage. The dummy variable is highly significant. In the case of the specialization in early stage it is positive (6.7 per cent when using the volumes of investments and 12.3 per cent when using the numbers of investments), while in the case of the specialization in expansion it is negative (-12.7 per cent when using the volume of investments and -10.4 per cent when using the number of investments). Thus, during the overvaluation of enterprises that operate in the information and communication industry early stage investments were favoured, which might be due to the fact that information and communication enterprises which got venture capital were often in the early stage.

My results are not fully in line with the results reported by Mayer et al. (2003). They find evidence that venture capital companies raising capital from pension funds and banks tend to favour later stages of enterprises' development. According to their results, corporations are more likely to invest in the early stage of enterprises' development. In addition, according to the study by Gompers and Lerner (1998), corporate venture capitalists tend to invest slightly less frequently in start-up enterprises than independent venture capitalists. Corporate venture capitalists prefer investments in the later stages of enterprises' development and they prefer to invest larger amounts of capital per investment deal than independent venture capitalists do (Gompers and Lerner 1998). By contrast, I find evidence that capital provided by pension funds is positively associated with early stage investments and negatively with expansion stage investments. My

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8 From the analysis it follows only that a change in funds does not change the importance of enterprises which are in the early stage. The results do not show whether the change in the new funds increase or decreases the total number of enterprises financed.

results confirm the results by Mayer et al. (2003) with respect to the role of banks and corporations in financing different stages of enterprises' development.

5 Concluding remarks

In this paper, I have analysed the link between sources of funds of venture capital funds and the specialization of venture capital investments in particular industries and in particular stages of enterprises' development. Regression estimations of a panel data set of 16 Western European countries for the time period from 1988 to 2002 have shown statistically significant links between sources of funds and specialization patterns of investments. These results indicate that financial market frictions matter for investment decisions since in frictionless financial markets sources of funds and specialization patterns should be independent.

Sources of funds of venture capital companies can differ with respect to risk aversion as well as with respect to preferences to invest in particular enterprises. For example, I have argued that corporations are interested in financing young and technology-oriented enterprises for technological reasons. Moreover, I have argued that the investment behaviour of pension funds and insurance companies is mainly determined by the profitability of the enterprises. This can be favourable for the early stage of enterprises' development. Table 12 summarizes the expected signs of sources of funds on specialization patterns of venture capital investments. In addition, Table 12 offers the signs of the estimated coefficients for both the volume and the number of investments. I have used the volumes and the numbers of investments to account for size effects.

Table 12 shows interesting similarities and differences between the eight specifications. The share of new funds provided by government institutions has no significant impact. The share of new funds provided by corporations has a positive effect only on the specialization in the early stage. It affects both the number and the volume of investments. The share of new funds provided by academic institutions also has a positive effect on the specialization in the early stage. In addition, it has a positive effect on the specialization in biotechnology and medical-related industry but only when using the number of investments. Thus, academic institutions affect the way in which capital is invested but not the volume of investments. The share of new funds provided by pension funds has a positive effect on the specialization in the early stage and a negative one on the specialization in the expansion stage. By contrast, the share of new

funds provided by banks has a negative impact on the specialization in the industries under considerations, and on the specialization in the early stage.

The coefficients of the shares of new funds provided by pension funds and banks raise the question whether countries dominated by banks have a disadvantage in financing the early stage of enterprises' development compared to countries in which pension funds manage large amounts of capital and may thus invest a part of the capital in venture capital funds. Of particular interest would be to analyse the real implications of differences in the sources of funds, i.e., whether the possible disadvantage leads to lower economic growth.

In addition, the positive coefficients of the share of new funds provided by pension funds and banks raise the question on which way a significant specialization in the early stage of enterprises' development (high-risk investments) depends on these sources of funds. It would be of particular interest to analyse whether new funds provided by pension funds stimulate the development of a corporate governance structure which may better manage the incentive problems arsing when financing young high-technology enterprises, while new funds provided by banks do not. To check whether pension funds play a positive role in the development of venture capital markets is dedicated to future research. For this research a multi-country, quantitative mirco-level data set seems necessary.

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Table 1: Expected effects sources of funds on the specialization pattern of investments

	Expected effects					
	Banks	Pension funds	Government institutions	Corporations	Insurance companies	Academic institutions
Low-risk	+	-	-	-	-	-
High-risk	-	+	+	+	+	+

Table 2: Investments in the information and communication industry

Volume	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	average
Austria	89.6	86.2	39.3	30.1	78.7	58.6	6.3	0.0	0.0	0.0	19.9	16.5	42.8	43.0	36.5
Belgium	15.4	35.8	21.5	17.5	8.0	10.9	15.1	5.6	49.2	60.8	62.1	50.5	47.4	29.8	30.7
Denmark	7.3	18.4	25.7	42.2	5.3	45.2	39.2	32.2	22.0	36.4	42.1	16.7	25.7	50.3	29.2
Finland	33.1	15.5	15.8	30.6	26.8	56.3	38.5	22.0	42.2	28.9	10.3	31.3	38.5	45.1	31.1
France	25.9	15.4	16.2	9.0	15.2	8.9	11.8	15.2	18.7	13.6	16.1	38.6	44.1	27.5	19.7
Germany	38.8	55.3	15.3	11.5	9.7	7.2	9.0	18.9	18.3	20.8	23.2	30.7	37.0	24.6	22.9
Iceland	0.0	0.0	17.9	2.1	36.5	35.8	12.9	52.2	0.0	38.1	19.8	21.7	37.8	69.6	24.6
Ireland	15.7	7.2	19.0	4.0	25.2	3.1	3.6	34.0	34.2	45.9	52.1	68.7	81.3	89.7	34.6
Italy	0.2	5.9	8.2	4.0	9.0	1.2	3.8	2.8	0.8	4.1	10.0	17.0	28.4	44.8	10.0
Netherlands	25.0	20.7	25.0	13.0	23.1	17.0	17.0	39.8	19.3	16.6	16.5	31.0	32.2	23.1	22.8
Norway	23.8	0.0	7.6	22.6	6.7	24.0	15.5	23.3	25.4	34.7	82.2	75.1	42.5	37.3	30.0
Portugal	26.0	5.3	11.1	7.3	7.7	3.9	8.1	5.1	2.9	0.4	9.2	42.6	33.7	19.6	13.1
Spain	22.6	8.5	6.7	2.4	7.9	2.1	3.4	4.1	5.9	13.1	24.0	20.4	29.3	11.7	11.6
Sweden	4.5	0.5	31.5	4.1	3.0	1.6	13.9	14.1	4.6	19.6	30.4	19.7	19.2	18.9	13.3
Switzerland	58.4	16.7	21.8	10.2	7.3	6.6	7.8	28.1	27.6	27.5	37.1	32.8	15.7	39.9	24.1
United Kingdom	10.3	10.1	9.6	10.7	7.9	14.3	9.6	13.7	11.3	15.7	19.4	16.8	23.3	28.7	14.4

Number														
Austria	77.8	50.0	50.0	71.4	50.0	50.0	0.0	0.0	37.5	31.2	26.4	43.0	55.2	41.7
Belgium	38.6	28.7	22.8	12.2	22.9	20.3	12.9	27.2	35.5	70.8	56.7	45.8	43.8	33.7
Denmark	16.7	28.0	46.2	26.3	32.1	27.3	37.5	31.6	65.5	28.0	25.3	24.9	50.0	33.8
Finland	18.5	23.5	24.0	27.8	39.0	28.3	25.4	27.9	29.5	23.7	30.5	43.2	49.1	30.0
France	24.6	24.7	17.4	21.9	21.5	22.1	24.4	23.6	23.5	26.7	37.2	47.3	46.1	27.8
Germany	43.9	22.4	17.1	12.9	14.7	17.8	17.7	21.0	26.5	33.7	33.8	39.4	33.0	25.7
Iceland	0.0	14.3	11.1	37.5	50.0	20.0	35.7	0.0	37.0	20.8	21.3	55.3	64.7	28.3
Ireland	0.0	19.6	9.5	25.0	15.4	12.0	48.5	47.7	48.5	50.9	54.9	74.6	81.0	37.5
Italy	0.0	14.4	6.5	7.2	2.7	6.4	5.9	2.5	3.8	11.6	27.9	42.6	44.0	13.5
Netherlands	21.4	22.7	26.1	20.0	26.0	23.0	40.4	19.1	27.1	23.2	37.8	44.9	43.8	28.9
Norway	0.0	27.1	25.5	24.5	25.7	12.6	20.2	35.1	42.9	73.3	74.4	41.0	45.9	34.5
Portugal	7.3	16.2	7.1	15.4	11.5	9.7	10.2	6.8	3.8	4.4	16.8	30.4	19.5	12.2
Spain	12.9	11.5	9.5	11.1	7.1	7.7	8.3	10.1	12.7	14.3	17.5	34.2	33.7	14.7
Sweden	0.0	35.0	4.4	19.6	10.4	18.3	37.2	23.3	44.2	52.2	40.5	50.9	51.7	29.8
Switzerland	16.7	21.3	36.5	25.7	13.8	3.5	27.6	21.9	34.0	52.3	42.5	50.2	56.5	31.0
United Kingdom	0.0	21.3	17.6	12.8	16.0	15.1	15.3	14.5	18.4	22.2	32.3	48.9	45.8	21.6

Note: Volume denotes the volume of investments in information and communication enterprises as a percentage of the total volume of investments. Number denotes the number of investments in information and communication enterprises as a percentage of the total number of investments. Data are taken from EVCA (various issues).

Table 3: Investments in the biotechnology and medical-related industry

Volume	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	average
Austria	4.7	7.3	16.5	16.9	18.5	10.0	0.0	0.0	0.0	7.1	6.9	4.6	7.9	5.6	7.6
Belgium	8.5	3.1	19.0	12.5	4.0	4.6	10.2	9.0	15.1	13.9	3.2	10.1	9.4	20.6	10.2
Denmark	8.1	14.4	11.3	12.7	9.6	8.4	15.5	9.3	7.2	18.4	18.2	8.2	28.9	32.9	14.5
Finland	2.9	4.7	11.8	13.2	2.5	1.5	14.4	14.1	11.5	4.0	11.0	12.7	17.3	19.3	10.1
France	12.2	7.0	8.3	6.6	6.5	7.2	4.5	7.8	8.0	5.8	11.2	5.5	5.7	8.5	7.5
Germany	1.2	21.6	3.2	3.2	2.3	1.9	3.6	2.3	8.3	4.6	11.4	12.0	15.7	16.6	7.7
Iceland	0.0	0.0	0.4	0.0	1.4	0.0	0.0	0.0	0.0	14.1	21.5	13.6	12.0	2.5	4.7
Ireland	8.9	0.0	0.3	7.5	3.2	2.2	8.0	0.0	9.7	7.5	1.9	2.5	5.8	3.1	4.3
Italy	0.7	3.6	1.3	10.7	10.6	2.1	7.1	1.7	1.4	2.3	0.7	1.2	2.8	0.9	3.4
Netherlands	8.2	9.1	56.0	4.0	7.0	4.0	7.0	9.2	6.2	6.0	6.3	4.5	5.7	3.3	9.7
Norway	14.2	0.0	5.1	3.8	6.7	2.3	6.8	1.2	1.7	1.6	5.0	4.0	4.7	14.8	5.1
Portugal	12.9	3.9	2.5	0.2	0.4	0.6	0.1	2.9	8.3	1.1	0.0	0.7	0.7	1.1	2.5
Spain	1.6	11.4	0.0	2.6	5.3	3.1	2.2	0.8	1.0	4.2	2.4	3.1	5.8	14.0	4.1
Sweden	7.1	40.9	5.2	11.2	4.7	13.5	8.9	6.7	0.8	0.6	23.2	14.9	1.5	9.4	10.6
Switzerland	12.5	2.8	17.6	2.1	7.0	12.0	14.1	18.8	3.6	12.6	14.3	16.9	5.0	5.7	10.4
United Kingdom	2.7	3.8	5.9	3.9	4.3	7.9	4.5	9.8	7.1	9.3	5.5	5.2	15.1	9.8	6.8
Number															
Austria		11.1	13.6	21.4	14.3	25.0	0.0	0.0	0.0	0.0	9.7	14.3	10.6	12.3	10.2
Belgium		7.1	16.0	7.1	7.3	8.4	4.2	13.6	12.7	11.2	5.2	8.9	8.7	13.4	9.5
Denmark		20.0	8.0	15.4	21.1	7.1	24.2	25.0	10.5	23.6	18.0	13.3	40.3	28.1	19.6
Finland		4.6	8.2	16.0	8.9	4.9	16.2	14.0	16.2	8.3	17.5	24.2	21.9	16.1	13.6
France		9.5	6.3	8.8	9.5	8.9	9.8	12.8	13.5	12.1	9.1	6.6	8.5	11.2	9.7
Germany		4.2	4.2	3.2	3.5	2.7	3.6	3.7	4.6	9.6	13.3	14.8	16.0	17.7	7.8
Iceland		0.0	7.1	0.0	6.3	0.0	0.0	0.0	0.0	13.0	20.8	6.7	13.4	3.9	5.5
Ireland		0.0	2.0	4.8	2.1	5.1	12.0	0.0	7.7	7.6	4.7	4.6	5.4	3.3	4.6
Italy		0.0	7.2	11.6	9.0	4.0	4.0	2.3	3.5	5.6	3.4	2.3	4.5	3.5	4.7
Netherlands		11.7	14.1	6.1	7.0	7.2	12.0	8.9	6.3	10.8	8.8	8.7	8.2	9.8	9.2
Norway		0.0	5.7	24.5	16.3	8.3	16.6	4.3	5.2	2.4	8.1	8.7	12.9	15.1	9.8
Portugal		3.7	5.1	0.7	1.0	2.2	2.2	2.2	0.0	3.8	1.5	6.3	0.6	4.6	2.6
Spain		8.8	0.0	5.3	5.5	6.3	4.5	3.2	2.5	7.0	2.5	5.4	5.7	4.6	4.7
Sweden		0.0	6.7	28.9	19.6	13.4	16.9	14.1	6.4	5.0	8.7	19.5	17.2	22.9	13.8
Switzerland		2.8	17.3	9.6	6.7	8.6	14.0	13.8	9.4	6.4	9.3	15.7	16.5	12.0	10.9
United Kingdom		0.0	6.9	8.5	7.2	11.6	6.5	9.7	13.2	12.3	13.0	14.9	13.4	13.8	10.1

Note: Volume denotes the volume of investments in biotechnology and medical-related enterprises as a percentage of the total volume of investments. Number denotes the number of investments in biotechnology and medical-related enterprises as a percentage of the total number of investments. Data are taken from EVCA (various issues).

Table 4: Early stage investments

Volume	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	average
Austria	5.2	90.8	24.4	24.1	0.0	32.9	6.3	28.0	30.6	16.0	24.4	15.8	36.9	28.2	26.0
Belgium	17.0	27.8	11.4	25.1	9.8	12.3	14.0	5.7	18.7	16.6	54.0	31.4	46.9	24.2	22.5
Denmark	17.5	48.0	40.1	24.2	7.8	22.8	21.4	11.0	6.8	13.0	32.8	26.4	12.4	45.8	23.6
Finland	7.1	36.3	44.7	43.8	39.3	31.7	23.2	23.4	22.5	7.7	32.7	27.3	35.2	54.7	30.7
France	16.5	9.5	11.9	3.1	4.1	1.8	2.3	3.1	11.3	7.2	14.5	18.4	21.8	17.1	10.2
Germany	14.1	19.0	6.3	6.9	7.5	8.6	10.2	13.4	13.3	15.1	23.9	31.4	34.7	26.0	16.5
Iceland	39.9	0.0	29.2	0.0	1.7	29.0	8.0	7.7	100.0	34.7	31.5	62.2	26.5	32.8	28.8
Ireland	32.4	1.6	3.0	13.0	5.2	15.8	9.3	4.6	8.0	3.8	32.2	38.6	50.0	26.0	17.4
Italy	1.1	6.6	6.0	11.4	11.1	2.1	13.6	17.7	8.9	12.2	15.7	8.3	18.2	13.3	10.4
Netherlands	15.5	7.5	9.0	7.0	7.9	10.0	13.0	16.3	15.5	20.0	16.0	20.0	19.4	9.7	13.4
Norway	7.1	51.3	12.5	5.2	8.9	18.8	21.1	4.4	6.8	2.1	7.5	11.5	35.1	23.5	15.4
Portugal	38.7	14.9	22.1	16.7	13.6	5.9	9.5	7.7	3.4	17.7	26.3	7.1	16.8	14.8	15.4
Spain	40.1	35.6	15.2	23.8	23.3	14.1	9.0	10.8	6.1	8.1	13.0	12.8	17.8	9.3	17.1
Sweden	6.5	20.0	3.5	2.8	2.2	3.1	1.0	7.2	1.3	1.3	12.0	18.9	9.9	11.7	7.2
Switzerland	17.1	41.7	27.9	7.1	0.6	6.6	8.7	1.4	4.2	3.6	30.2	46.2	9.3	30.7	16.8
United Kingdom	10.0	7.1	6.3	3.9	2.9	2.9	2.6	1.1	1.4	2.3	2.5	2.2	12.2	13.4	5.0
Number															
Austria		88.9	22.7	35.7	0.0	50.0	50.0	25.0	50.0	77.5	63.4	54.9	55.0	50.9	48.0
Belgium		32.3	22.0	33.1	28.7	29.8	25.4	13.6	32.3	43.2	54.5	55.0	54.0	35.3	35.3
Denmark		56.7	48.0	56.4	36.8	32.1	30.3	37.5	18.4	21.8	38.0	40.0	39.9	57.7	39.5
Finland		53.8	42.4	47.0	36.7	41.5	31.3	43.0	50.5	28.0	58.8	59.6	61.6	68.9	47.9
France		19.6	17.6	10.6	11.4	8.6	9.3	11.1	15.4	16.4	28.2	33.8	44.6	40.7	20.6
Germany		26.1	17.0	27.6	27.6	30.7	35.5	40.0	36.5	43.9	46.9	52.5	53.5	50.5	37.6
Iceland		0.0	21.4	0.0	6.3	25.0	20.0	14.3	100.0	33.3	34.2	68.0	56.4	35.3	31.9
Ireland		8.3	7.8	8.3	12.5	28.2	22.0	24.2	20.0	4.5	54.7	48.6	54.1	37.0	25.4
Italy		28.8	28.7	32.9	24.0	12.1	30.7	53.2	28.3	39.7	35.2	39.2	52.5	45.4	34.7
Netherlands		21.0	16.9	19.0	18.1	26.0	29.0	35.7	27.8	28.5	30.8	35.9	31.9	21.4	26.3
Norway		45.5	27.1	16.0	20.4	42.2	33.1	20.2	11.7	3.5	26.7	33.7	51.6	24.7	27.4
Portugal		35.4	50.5	27.1	24.0	18.7	23.1	13.1	5.4	12.7	29.4	24.2	42.9	33.3	26.1
Spain		51.0	35.2	63.4	50.2	23.8	25.0	24.3	26.6	26.6	23.4	26.4	36.5	25.5	33.7
Sweden		20.8	5.0	17.8	7.1	26.9	14.1	17.9	17.4	22.5	62.6	58.6	64.8	42.6	29.1
Switzerland		41.7	29.3	19.2	4.8	15.5	8.8	10.3	25.0	25.5	43.0	47.6	40.9	51.6	28.0
United Kingdom		14.8	13.3	10.4	6.8	8.0	7.5	5.1	6.1	9.1	8.6	10.9	36.1	37.6	13.4

Note: Volume denotes the volume of early stage investments as a percentage of the total volume of investments. Number denotes the number of early stage investments as a percentage of the total number of investments. Data are taken from EVCA (various issues).

Table 5: Expansion stage investments

Volume	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	average
Austria	94.8	9.2	67.3	75.9	100.0	67.1	93.8	72.0	69.3	26.0	47.5	45.5	54.2	58.4	62.9
Belgium	39.5	56.7	57.5	65.5	71.4	59.6	36.0	89.5	72.6	77.1	37.7	56.0	46.2	49.1	58.2
Denmark	56.3	18.7	37.7	54.8	52.6	70.1	78.6	36.4	71.0	85.2	64.8	45.4	46.1	44.4	54.4
Finland	40.8	46.4	54.3	43.3	48.1	60.5	64.8	63.7	65.4	72.2	27.9	26.0	29.3	28.1	47.9
France	60.8	46.1	50.5	55.3	41.1	45.0	46.2	36.0	48.2	36.4	32.8	38.0	35.5	21.9	42.4
Germany	40.8	39.9	72.1	78.6	67.5	66.4	54.2	66.5	65.6	49.0	43.4	49.7	44.9	35.1	55.3
Iceland	59.4	69.2	29.9	60.6	34.9	55.8	60.0	92.3	0.0	63.7	62.7	29.3	49.5	67.2	52.5
Ireland	35.1	37.8	82.4	78.4	77.6	44.4	72.9	95.4	85.3	92.3	26.4	36.2	44.9	59.8	62.1
Italy	40.8	64.3	63.4	57.8	58.0	63.7	40.3	55.6	43.4	26.4	36.3	22.1	32.6	34.1	45.6
Netherlands	63.3	57.9	66.0	55.0	58.2	61.1	67.0	60.7	53.3	40.9	36.8	32.9	54.5	39.5	53.4
Norway	76.0	48.7	84.0	84.7	84.9	68.3	73.6	93.8	85.8	88.8	74.9	53.5	63.6	57.2	74.1
Portugal	57.5	72.3	51.0	74.4	73.8	64.5	69.5	79.9	55.4	50.6	64.5	35.7	56.7	52.6	61.3
Spain	30.3	36.2	43.2	71.4	67.8	84.7	76.0	71.5	86.0	64.6	39.5	53.7	50.5	63.7	59.9
Sweden	65.0	60.0	26.0	26.1	17.8	33.9	40.4	18.9	51.8	15.1	49.4	13.5	14.5	32.5	33.2
Switzerland	58.4	52.8	51.5	54.3	63.8	51.2	46.0	41.9	39.3	61.4	31.4	38.9	20.0	35.2	46.1
United Kingdom	32.5	32.7	36.2	36.5	30.5	28.7	28.7	25.1	19.1	24.3	20.6	19.8	34.0	25.1	28.1

Number															
Austria		11.1	68.2	64.3	100.0	50.0	50.0	75.0	50.0	15.0	34.4	39.6	43.7	41.5	49.4
Belgium		55.1	42.7	57.5	59.8	52.7	41.5	78.0	50.0	52.1	43.8	35.9	42.4	56.2	51.4
Denmark		23.3	36.0	35.9	47.4	57.1	69.7	52.1	68.4	76.4	58.0	49.3	41.5	30.4	49.7
Finland		33.8	51.8	45.0	58.2	54.9	60.6	43.0	40.5	43.5	25.9	26.6	26.6	23.1	41.1
France		53.6	48.4	61.1	59.0	59.1	57.1	52.7	56.8	53.5	35.6	37.6	38.1	40.6	50.3
Germany		59.1	69.9	62.8	59.5	52.6	53.5	50.9	55.5	46.3	44.6	40.8	41.5	44.6	52.4
Iceland		61.5	35.7	66.7	31.3	37.5	60.0	85.7	0.0	63.0	40.8	29.3	42.5	64.7	47.6
Ireland		66.7	82.4	70.2	77.1	59.0	66.0	75.8	75.4	90.9	27.4	40.5	41.5	57.6	63.9
Italy		37.0	52.8	42.1	46.2	47.7	43.6	30.9	42.4	35.0	33.7	35.4	36.4	38.0	40.1
Netherlands		64.1	69.0	60.0	61.9	54.9	54.0	47.1	49.7	49.4	39.3	37.3	50.3	55.5	53.3
Norway		54.5	67.1	66.0	65.3	45.0	61.6	72.4	71.4	92.9	63.4	50.0	46.5	68.1	63.4
Portugal		57.3	41.4	65.0	67.3	57.6	61.2	70.1	67.6	73.4	64.7	50.5	47.2	55.2	59.9
Spain		25.2	47.3	35.0	47.7	75.7	70.0	67.0	67.1	62.3	59.8	63.1	54.2	69.4	57.2
Sweden		58.3	51.7	31.1	57.1	49.3	54.9	61.5	65.1	45.0	26.1	29.5	29.1	46.7	46.6
Switzerland		52.8	49.3	65.4	56.2	50.0	64.9	48.3	40.6	55.3	43.0	47.2	38.4	40.8	50.2
United Kingdom	41.9	56.9	53.0	53.5	54.1	54.2	45.3	50.1	44.2	49.8	44.6	50.1	47.0	40.9	49.0

Note: Volume denotes the volume of expansion stage investments as a percentage of the total volume of investments. Number denotes the number of expansion stage investments as a percentage of the total number of investments. Data are taken from EVCA (various issues).

Table 6: Descriptive statistics

	Observations	Mean	Std. Dev.	Min	Max
a. Endogenous Variables					
Percentage of the volume of investments					
Early	233	17.26	14.16	0.00	100.0
Expansion	233	51.72	19.50	0.00	100.0
Information technology	233	22.90	17.79	0.00	89.74
Life science	233	7.99	8.03	0.00	56.0
Percentage of the number of investments					
Early	220	31.82	17.02	0.00	100.00
Expansion	220	51.61	14.38	0.00	100.00
Information technology	215	29.00	17.04	0.00	80.98
Life science	215	9.88	7.18	0.00	40.31
b. Exogenous Variables					
Share of new funds provided by					
Banks	227	29.86	20.97	0.00	93.65
Pension funds	227	10.74	13.36	0.00	61.98
Government institutions	227	7.93	12.67	0.00	95.36
Corporations	227	9.76	12.60	0.00	100
Insurance companies	227	8.08	9.16	0.00	57.24
Academic institutions	227	0.45	1.97	0.00	22.98
Δ new funds	224	205.19	1715.00	-98.08	25393.22

Note: Early (Expansion) denotes early (expansion) stage investments as a percentage of total investments. Information technologies denotes investments in enterprises operating in the information and communication technology as a percentage of total investments. Life science denotes investments in enterprises operating in the biotechnology and medical-related industry as a percentage of total investments. *Δ new funds* denotes the changes in new funds raised.

Table 7: Correlations

	Early stage	Expansion stage	Information technology	Life science
		Volume of investments		
Banks	-0.15 (0.03)	0.06 (0.37)	-0.22 (0.00)	-0.21 (0.00)
Pension funds	0.00 (0.92)	-0.32 (0.00)	0.03 (0.64)	0.19 (0.00)
Government institutions	0.05 (0.47)	0.07 (0.29)	-0.03 (0.63)	-0.08 (0.21)
Corporations	0.21 (0.00)	0.01 (0.83)	-0.01 (0.87)	0.03 (0.61)
Insurance companies	-0.04 (0.56)	-0.29 (0.00)	0.02 (0.77)	0.12 (0.07)
Academic institutions	0.12 (0.06)	-0.19 (0.00)	0.08 (0.21)	0.18 (0.01)
		Number of investments		
Banks	-0.10 (0.14)	0.05 (0.50)	-0.28 (0.00)	-0.29 (0.00)
Pension funds	0.03 (0.43)	-0.24 (0.00)	0.11 (0.11)	0.35 (0.00)
Government institutions	0.05 (0.24)	0.03 (0.67)	-0.05 (0.46)	-0.03 (0.74)
Corporations	0.11 (0.12)	-0.01 (0.88)	-0.04 (0.58)	-0.04 (0.59)
Insurance companies	0.07 (0.31)	-0.24 (0.00)	0.13 (0.05)	0.23 (0.00)
Academic institutions	0.06 (0.41)	-0.07 (0.34)	0.14 (0.04)	0.20 (0.00)

	Banks	Pension funds	Government institutions	Corporations	Insurance companies
Pension funds	-0.32 (0.00)	1.000			
Government institutions	-0.08 (0.22)	-0.12 (0.08)	1.000		
Corporations	-0.14 (0.03)	-0.16 (0.01)	-0.05 (0.47)	1.000	
Insurance companies	-0.19 (0.00)	0.27 (0.00)	-0.13 (0.05)	-0.01 (0.93)	1.000
Academic institutions	-0.09 (0.16)	0.16 (0.02)	-0.06 (0.36)	0.04 (0.59)	0.08 (0.26)

Note: p-values in parenthesis.

Table 8: Specialization in information technologies

	Standard	FGLS	Cluster	Standard	FGLS	Cluster
	Volume of investments			*Number of investments*		
Banks	-0.144*	-0.063	-0.146*	-0.163**	-0.106**	-0.162*
	(-1.91)	(-1.25)	(-1.93)	(-2.23)	(-2.47)	(-2.08)
Pension funds	0.033	0.022	0.032	0.004	-0.050	0.004
	(0.30)	(0.33)	(0.29)	(0.04)	(-0.77)	(0.03)
Government institutions	-0.022	-0.064	-0.023	0.056	-0.034	0.053
	(-0.22)	(-0.95)	(-0.20)	(0.56)	(-0.57)	(0.40)
Corporations	-0.030	-0.008	-0.030	-0.059	-0.070	-0.059
	(-0.31)	(-0.11)	(-0.33)	(-0.61)	(-1.04)	(-0.58)
Insurance companies	0.008	-0.068	0.007	0.353**	0.076	0.335
	(0.06)	(-0.67)	(0.03)	(2.18)	(0.83)	(1.71)
Academic institutions	0.829	0.986**	0.886	0.688	0.079	0.691
	(1.56)	(2.41)	(1.50)	(1.27)	(0.21)	(1.23)
Δ new fund	-0.001	-0.000	-0.001***	-0.000	0.000	-0.000
	(-1.01)	(-0.17)	(-3.30)	(-0.35)	(0.82)	(-1.13)
Constant	26.67***	0.049	-0.079	30.47***	0.096	-0.129
	(6.68)	(0.05)	(0.46)	(7.88)	(0.09)	(-0.44)
R^2	0.05		0.05	0.09		0.08
#observations	224	224	224	209	209	209
# countries	16	16	16	16	16	16
F/Wald	1.36	9.29	10.35***	2.33**	7.26	8.24***

Note: Dependent variable is venture capital investments in enterprises operating in the information and communication industry as a percentage of total investments. The role of sources of funds such as banks, and pension funds is measured by the share of new funds provided by the respective source of funds relative to total capital available. *Δ new fund* denotes the changes in new funds raised.

Standard reports results from a within regression. *FGLS* reports results from regression with heteroskedastic panels corrected standard errors and panel-specific first-order autocorrelation AR(1). *Cluster* reports results from OLS regression with panel-specific Huber White corrected t-values.

***, **, * denotes significance at the 1, 5 and 10 per cent level. z-values are given under the coefficients.

Table 9: Specialization in life science technologies

	Standard	FGLS	Cluster	Standard	FGLS	Cluster
	Volume of investments			*Number of investments*		
Banks	-0.069*	-0.042	-0.070*	-0.028	-0.032**	-0.028
	(-1.96)	(0.98)	(-2.07)	(-1.04)	(-1.91)	(-1.11)
Pension funds	0.024	0.008	0.025	0.078**	0.013	0.080***
	(0.48)	(0.22)	(0.42)	(1.99)	(0.47)	(3.05)
Government institutions	-0.025	-0.005	-0.024	0.056	0.002	0.054
	(-0.53)	(-0.16)	(-0.58)	(1.50)	(0.10)	(1.25)
Corporations	0.023	0.010	0.023	-0.040	-0.039*	-0.040
	(0.50)	(0.32)	(0.30)	(-1.12)	(-1.74)	(-1.04)
Insurance companies	-0.001	-0.004	0.000	0.092	0.041	0.087**
	(-0.01)	(-0.09)	(0.01)	(1.54)	(1.03)	(2.22)
Academic institutions	0.380	0.413	0.379	0.392*	0.350**	0.393**
	(1.43)	(1.40)	(1.39)	(1.96)	(2.12)	(2.04)
Δ new fund	-0.000	0.000	-0.000	-0.000	-0.000	-0.000**
	(0.03)	(0.58)	(-0.09)	(-1.24)	(-1.09)	(-2.84)
Constant	9.57***	-0.149	-0.084	8.90****	-0.019	-0.061
	(5.12)	(-0.56)	(-0.93)	(6.23)	(-0.09)	(-0.71)
R^2	0.07		0.04	0.17		0.10
#observations	224	224	224	209	209	209
# countries	16	16	16	16	16	16
F/Wald	1.19	3.93	2.92**	3.05***	15.14**	13.63***

Note: Dependent variable is venture capital investments in enterprises operating in the biotechnology and medical-related as a percentage of total investments. For explanatory variables see Table 8.

***, **, * denotes significance at the 1, 5 and 10 per cent level. z-values are given under the coefficients.

Table 10: Specialization in the early stage

	Standard	FGLS	Cluster	Standard	FGLS	Cluster
	Volume of investments			*Number of investments*		
Banks	-0.086	-0.042	-0.085	-0.220***	-0.167***	-0.216**
	(-1.52)	(-1.22)	(-1.33)	(-3.13)	(-3.26)	(-2.38)
Pension funds	0.172**	0.071	0.172*	0.266**	0.153**	0.266***
	(2.09)	(1.52)	(1.93)	(2.57)	(2.08)	(3.50)
Government institutions	0.053	-0.009	0.054	-0.036	-0.076	-0.035
	(0.69)	(-0.21)	(0.87)	(-0.38)	(-1.06)	(-0.39)
Corporations	0.315***	0.246***	0.314***	0.115	0.102	0.116*
	(4.30)	(5.03)	(5.36)	(1.28)	(1.41)	(1.83)
Insurance companies	0.037	-0.090	0.038	0.148	0.041	0.147
	(0.34)	(-1.37)	(0.54)	(1.00)	(0.04)	(1.53)
Academic institutions	1.283***	0.986***	1.284***	0.785	0.680*	0.785**
	(2.99)	(3.57)	(5.11)	(1.51)	(1.74)	(2.38)
Δ new fund	-0.000	-0.000	-0.0001**	0.000	0.000	0.000
	(-0.39)	(-0.74)	(-2.55)	(0.24)	(0.22)	(0.95)
Constant	13.62***	0.367	0.131	33.17***	0.276	0.418
	(4.53)	(0.59)	(0.69)	(8.96)	(0.26)	(0.95)
R^2	0.07		0.16	0.02		0.16
#observations	224	224	224	214	214	214
# countries	16	16	16	16	16	16
F/Wald	5.6***	48.85***	26.67***	4.32***	31.65***	14.43***

Note: Dependent variable is venture capital investments in the early stage of enterprises' development (seed and start-up investments) as a percentage of total investments. For explanatory variables see Table 8.
***, **, * denotes significance at the 1, 5 and 10 per cent level. z-values are given under the coefficients.

Table 11: Specialization in the expansion stage

	Standard	FGLS	Cluster	Standard	FGLS	Cluster
	Volumes of investments			*Numbers of investments*		
Banks	-0.025	-0.031	-0.025	0.045	0.098**	0.043
	(-0.33)	(-0.52)	(-0.27)	(0.76)	(2.30)	(0.56)
Pension funds	-0.165	-0.144*	-0.165*	-0.294***	-0.253***	-0.293***
	(-1.51)	(-1.65)	(-1.84)	(-3.34)	(-3.63)	(-3.59)
Government institutions	-0.140	-0.127	-0.139	-0.072	0.014	-0.072
	(-1.38)	(-1.39)	(-1.55)	(-0.89)	(-0.22)	(-1.08)
Corporations	-0.139	-0.119	-0.140	-0.085	-0.022	0.086
	(-1.43)	(-1.45)	(-1.45)	(-1.11)	(-0.35)	(1.46)
Insurance companies	-0.403***	-0.248**	-0.401**	-0.353***	-0.161*	-0.349***
	(-2.80)	(-2.00)	(2.51)	(-2.82)	(-1.74)	(4.92)
Academic institutions	-0.738	-0.694	-0.739	-0.094	-0.079	-0.094
	(-1.29)	(-1.54)	(-1.17)	(-0.21)	(-0.27)	(-0.34)
Δ new fund	0.000	0.001*	0.001**	0.000	0.000	0.000
	(1.14)	(1.79)	(2.70)	(0.65)	(0.43)	(1.38)
Constant	59.32***	0.509	-1.414	57.06***	-0.206	-0.587
	(14.80)	(-0.49)	(-0.94)	(18.19)	(.-030)	(-1.21)
R^2	0.15		0.07	0.12		0.11
#observations	224	224	224	214	214	214
# countries	16	16	16	16	16	16
F/Wald	2.2**	13.65*	6.2***	3.66***	31.99***	16.11***

Note: Dependent variable is venture capital investments in the expansion stage of enterprises' development as a percentage of total investments. For explanatory variables see Table 8.
***, **, * denotes significance at the 1, 5 and 10 per cent level. z-values are given under the coefficients.

Table 12: Summary of estimation results

	Expected effects					
	Banks	Pension funds	Government institutions	Corporations	Insurance companies	Academic institutions
Low-risk	+	-	-	-	-	-
High-risk	-	+	+	+	+	+
	Estimated effects					
	Dependent variable is as percentage of the volume of investments					
Information technology	-	0	0	0	0	0
Life science	-	0	0	0	0	0
Early stage	+	0	0	+	0	+
Expansion stage	0	-	0	0	-	0
	Dependent variable is as percentage of the number of investments					
Information technology	-	0	0	0	0	0
Life science	0	+	0	0	+	+
Early stage	-	+	0	+	0	+
Expansion stage	0	-	0	0	-	0