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Driving Forces of Venture Capital Investments in Europe: A Dynamic Panel Data Analysis

by

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Abstract

Using dynamic panel estimations, this paper identifies driving forces of venture capital activity for Western European countries. Driving forces might be the liquidity of stock markets, human capital endowment, and labour market rigidities. The paper shows that these factors do not affect expansion stage investments used as a broader definition of venture capital, while they positively affect early stage investments used as a narrow definition. Thus, the results suggest not only that liquid stock markets play an important role for the development of venture capital markets but also that they are not the only factor that drives venture capital activity.

Keywords: venture capital investments, Europe, dynamic panel

JEL classification: G24, G32

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1 Introduction

Venture capital investments have grown impressively in many European countries during the last decade. In Europe, venture capital investments in enterprises' early stages of development increased from about € 0.3 billion in 1991 to about € 6.6 billion in 2000 (EVCA, various issues). However, differences in venture capital activity across European countries are still substantial even though these differences have decreased during recent years. In 1991, for instance, Austria invested 0.005 per million of GDP in enterprises' early stage of development, while Finland invested 23 times as much in relative terms. These gaps changed over time. In 2001, Austria invested 0.19 per million of GDP in enterprises' early stage, while Finland invested more than five times as much.

This paper aims at explaining differences in venture capital activity and changes in these patterns over time by using a panel data set of 14 European countries over the period 1988 to 2000. In particular, the paper tests whether the liquidity of stock markets and the human capital endowment of the economies as well as institutional regulations of labour and financial markets are driving forces of venture capital activity. In a recent paper, Jeng and Wells (2000) also analysed the driving forces of venture capital activity using a panel data set of 15 countries. They found evidence that the market value of initial public offerings explains differences in venture capital investments only in later stages of enterprises' development across countries, but not differences in venture capital investments in the enterprises' early stages of development. Moreover, Jeng and Wells (2000) identified pension funds as a driving force of venture capital activity over time but not across countries.

In contrast to the paper by Jeng and Wells (2000), this paper analyses whether human capital endowments, which are approximated either by the number of research and development employees or by the number of patents, are a significant driver behind venture capital activity. The idea behind the expected positive correlation between human capital endowments and venture capital activity

is as follows: what distinguishes venture capital from other sources of financing is that experienced venture capitalists are actively involved in monitoring and supporting enterprises they have chosen to finance (Sahlman 1990). The monitoring and supporting services make venture capital finance expensive compared to other sources of finance. Therefore, demand for venture capital comes only from peculiar enterprises, such as young high-technology enterprises, since control mechanisms that can be embedded in standard contracts are not necessarily applicable to these enterprises. Therefore, venture capital activity depends on the number of young high-technology enterprises in an economy. This number is, of course, affected by several factors, such as the capability of individuals to generate new ideas. And new business ideas are developed only if the economy has the particular human capital to do so. Therefore, I expect that higher human capital endowments are associated with higher venture capital activity.

Using dynamic panel estimators, this paper finds three driving forces that affect early stage investments used as a narrow definition of venture capital. These factors do not affect expansion stage investments used as a broader definition of venture capital. First, the analysis shows that the countries' human capital endowments have a significant positive impact on venture capital investments in enterprises' early stages of development. Second, it shows that the liquidity of stock markets has a significant positive impact on early stage investments. This result is in contrast to the result by Jeng and Wells (2000), who did not find a significant relationship between early stage investments and the liquidity of stock markets. This can be due to differences in the data: while Jeng and Wells (2000) used the market value of initial public offerings, I use the stock market capitalisation as a proxy for the liquidity of stock markets. Third, the analysis shows that labour market rigidities have a significant positive impact on early stage investments.

The remainder of the paper is organized as follows. Section 2 discusses determinants of venture capital demand and supply, and derives a reduced-form

equation determining venture capital activity. Section 3 describes the data set and offers some descriptive statistics. Section 4 presents the regression results, and Section 5 concludes.

2 Driving Forces of Venture Capital Activity

In this section, I discuss the driving forces of venture capital activity in order to motivate the empirical analysis. I discuss determinants affecting venture capital demand and venture capital supply separately, while in the empirical analysis I estimate a reduced-form equation. Discussing the demand and supply side separately seems sensible to identify what channels the driving forces can take.

2.1 Venture Capital Demand

The level of the venture capital demand depends on three groups of factors. First, venture capital demand increases with individual incentives for entrepreneurship that determine investment decisions. Second, the innovation potential of the economy determines the number of innovative ideas and, thus, the number of venture-capital-backed enterprises that try to realize innovative ideas. Third, venture capital demand depends on the institutional environment determining the way in which innovative ideas are financed in order to realize them. These three groups of factors, which are dependent on each other, are discussed in the following.

Individual incentives for entrepreneurship include all factors that influence the decision of an individual – being either employed or unemployed – to start their own high-technology enterprise. The tax system is very important in these factors since it determines the revenue and profit of entrepreneurship (Poterba 1989). The higher the capital gains tax rate, the lower the entrepreneurial activity in an economy, and, thus, the lower the demand for venture capital is.

Regulations of labour markets affect entrepreneurial activity as well. An employee has lower incentives to start his own high-technology enterprise in

economies with rigid labour markets than in economies with flexible markets. The reason for this is that an employee who has an innovative idea to start his own high-technology enterprise compares his expected pay-off in the entrepreneurial activity with his income as an employee (i.e., with his opportunity costs of the entrepreneurial activity). If, for example, the protection against dismissal is high, he has a safe wage income in a rigid labour market compared to what his wage income would be in a labour market with a flexible structure. Moreover, the higher the rigidities in labour markets are, the lower the expected pay-off of the entrepreneurial activity. This is because in the case of a failure of the enterprise, the re-integration of the former entrepreneur into employment needs more time in a rigid labour market than in a flexible market, which means lower wage incomes after the entrepreneurial activity in rigid markets than in flexible labour markets (given an identical level of social insurance). As a consequence, I expect lower incentives for entrepreneurial activity in economies whose labour markets are rigid.

But what about an unemployed individual? For an unemployed individual, the expected wage income as an employee can be higher in a flexible labour market than in a rigid labour market because the probability of finding a job might be much lower in rigid than in flexible labour markets. Thus, one can argue that in more rigid labour markets, unemployed individuals have higher incentives to start their own high-technology enterprises resulting in a higher demand for venture capital. However, it seems sensible to assume that incentives for entrepreneurial activity are higher in economies whose labour markets are flexible.

Regulations of labour markets do not only affect the decision to become entrepreneurs but also the labour demand and the capital demand by high-technology enterprises. Jeng and Wells (2000) argue that hiring qualified employees is comparatively more expensive in rigid labour markets than in flexible labour markets. Therefore, one can expect that high-technology enterprises operating in rigid labour markets use a lower labour-capital-ratio than high-technology enterprises operating in flexible labour markets. This can lead to a higher

volume of venture capital demand in economies whose labour markets are rigid, but not to a higher number of enterprises demanding venture capital. In conclusion, if venture capital volumes are used as endogenous variables, the relationship between venture capital activity and measurements of the rigidity of labour markets can be positive as well as negative. If the number of venture-capital-backed enterprises is used, the relationship between venture capital activity and measurements of the rigidity of labour markets is expected to be negative.

Individual incentives for entrepreneurship also depend on the existence of liquid stock markets for fast-growing enterprises. Black and Gilson (1998) argue that a liquid stock market offers venture capitalists and entrepreneurs who want to start high-technology enterprises the opportunity to enter into an implicit contract over control. Since an initial public offering gives the entrepreneur the opportunity to re-acquire control at least partly (since the entrepreneur can get a leading management position in the listed enterprise), the entrepreneur has lower incentives for opportunistic behaviour. Moreover, if entrepreneurs have the opportunity to re-acquire control, they are more interested in venture capital finance. This means that liquid stock markets increase the demand for venture capital because they lower the transaction costs arising when high-technology enterprises are started.

Apart from the incentives for entrepreneurship discussed above, venture capital demand can differ across countries because of differences in the innovation potential. Only if the economy is endowed with sufficient human capital, which is necessary to generate innovative ideas, one can expect a liquid venture capital market to develop. For the development of venture capital a sufficient number of highly qualified scientists and engineers seems sensible. To be endowed with large amounts of particular human capital is certainly a necessary but not a sufficient condition for venture capital finance to emerge. Moreover, the style of the innovation system can have a profound impact on the emergence of venture capital finance. For example, one can expect that the more creativity and individualism a university system initiates, the higher the number of individuals

with high-technology ideas who demand venture capital to realize their business ideas might be.

Finally, venture capital demand depends on the institutional environment and institutional regulations determining the way in which innovative ideas are financed in order to realize them.[1] The more in-house the research and development activities are, the less likely the development of a venture capital market is. However, in less developed financial markets, research and development activities are carried out more in-house. Shareholder and creditor rights may also have a significant impact on venture capital activity because they determine the transaction costs for investments, which likewise influence the investment decision of entrepreneurs and of capital providers.

2.2 Venture Capital Supply

Venture capital supply can be divided into the supply of active involvement in the form of management support by experienced venture capitalists and the capital supply by capital providers, who have less information about the profitability of high-technology enterprises. Therefore, I distinguish three sets of driving forces of venture capital supply. First, those factors that affect the supply of active involvement by experienced venture capitalists. Second, those factors that affect the capital supply by capital providers. Third, those factors that affect the relationship between venture capitalists and capital providers.

The supply of active involvement by experienced venture capitalists is positive only if regulations and contract law do not prevent venture capitalists from having exclusive control rights, such as board and voting rights, in the enterprises they have chosen to finance. Only with exclusive control rights are

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[1] The progress reports on the Risk Capital Action Plan prepared each year by the European Commission give an overview of factors hindering the emergence of venture capital markets and discuss which countries of the European Union have removed which barriers (Europäische Kommission 1999, and European Commission 2000, 2001).

venture capitalists capable of intervening in business decisions and, thus, adding value to the enterprises. If regulations prevent venture capitalists from being actively involved in the management of the enterprises, the price for being actively involved is prohibitive.

Moreover, the supply of venture capital including active selection, support, and monitoring of high-technology enterprises depends, as does venture capital demand, on the factor endowment of the economy and on labour market regulations. The higher the human capital, the higher the number of individuals is who have the necessary skills and experience to become venture capitalists. Labour market rigidities affect the decision of individuals to become venture capitalists in a similar way than they affect the decisions of individuals to become entrepreneurs. Thus, labour market rigidities may lower the incentives of individuals to become venture capitalists.

The presence of liquid stock markets for shares of high-technology enterprises can support the development of an appropriate skill composition necessary for venture capital markets to develop. To do their job, venture capitalists need a basic technological experience. Liquid stock markets may have a positive impact on the number of individuals in an economy who have this basic experience. Entrepreneurs who sell their enterprises on stock markets for fast-growing enterprises have hands-on experience in managing a high-technology enterprise, they have a comprehensive knowledge of a particular technology area, and they have basic experience of how to go public. These entrepreneurs are natural candidates for becoming venture capitalists who offer management support in addition to financial means.

The capital supply by capital providers depends on the risk-return relationship of venture capital investments in comparison to alternative investments. The tax system is expected to have a significant impact on this relationship because taxes can reduce the returns without changing the risks of the investments. Moreover, the tax system is expected to have a significant impact on the capital providers' portfolio decisions since it can favour particular forms of invest-

ments. In addition, the risk of an investment in venture capital depends on several pieces of legislation and regulations such as shareholder and creditor rights.

What about the factors that affect the relationship between venture capitalists and capital providers? These factors depend on whether the venture capitalists are legally connected to capital providers or whether the venture capitalists are independent from capital providers. In the case of independent venture capitalists, capital providers have initially little information about the venture capitalists' experience in supporting high-technology enterprises. The relationship between independent venture capitalists and capital providers is therefore subject to both moral hazard and adverse selection problems. By contrast, dependent venture capitalists receive their money from a parent company, which can be a private bank, a subsidiary of savings banks, or a corporation. The relationship between dependent venture capitalists and capital providers is less likely to be subject to moral hazard and adverse selection problems because of the interconnection between the two parties.

Stock markets for shares of fast-growing enterprises are important for the development of venture capital for two reasons. First, with initial public offerings of venture-capital-backed enterprises, venture capitalists can signal their experience to the market and this can reduce transaction costs in the relationship between venture capitalists and entrepreneurs. This argument holds for both independent and dependent venture capitalists. Second, by successfully exiting from some venture-capital-backed enterprises firms via an initial public offering, independent venture capitalists build a reputation that they use to raise capital from capital providers at more favourable conditions.

Venture capital activity does not have to be a linear function of the determinants identified above, because of venture capitalists' investment behaviour. In particular, venture capitalists form their portfolios on enterprises at particular development stages and/or on particular industries. Amit et al. (1998) argue that due to specialization, venture capitalists have a comparative advantage in the

selection and monitoring of high-technology enterprises compared to other financial intermediaries. Therefore, the number of high-technology enterprises and, thus, the demand for venture capital must exceed a minimum level so that venture capitalists can endogenously focus their investments on particular stages of enterprises' development and/or on particular technology areas. If the technology sector as a whole is too small, or if high-technology ideas are dispersed over a wide range of technology fields so that venture capitalists cannot specialize and cannot accumulate technology-specific experience, one cannot expect a liquid venture capital market to develop.

2.3 Venture Capital Activity: The Reduced Form

For the empirical analysis, I use a reduced form of venture capital activity. Following Jeng and Wells (2000), this reduced form results from combining venture capital demand and supply.

Venture capital demand in a particular country *i* in period *t* can be written as:

$$(1)\quad VCD_{it} = f(\underset{(-)}{P_{it}}, \underset{(-/+)}{IR_{it}}, \underset{(-/+)}{LR_{it}}, \underset{(+)}{SM_{it}}, \underset{(+)}{HC_{it}}),$$

where *P* denotes the price for venture capital, *IR* denotes the institutional regulations affecting entrepreneurial activity, *LR* captures the rigidity of labour markets, *SM* denotes the liquidity of stock markets, and *HC* denotes the human capital endowment.

The signs in the brackets are the expected effects of the respective exogenous variables that result from the theoretical considerations presented above. With respect to the institutional regulations affecting entrepreneurial activity *IR*, the expected sign is to be discussed below, because the effect depends on the variable used.

Venture capital supply in a particular country *i* in period *t* can be written as:

$$(2)\quad VCS_{it} = k(VC_{it}^{Aktive}, VC_{it}^{Non-Aktive}),$$

where VC_{it}^{Aktive} denotes the supply of active involvement when selecting and supporting high-technology enterprises by experienced venture capitalists, and $VC_{it}^{Non-Aktive}$ denotes the capital supply by capital providers.[2]

The supply of management support by experienced venture capitalists is specified as:

$$(3)\quad VC_{it}^{Aktive} = g(\underset{(+)}{P_{it}^{Aktive}}, \underset{(-/+)}{IR_{it}}, \underset{(-/+)}{LS_{it}}, \underset{(+)}{HC_{it}}, \underset{(+)}{SM_{it}}),$$

where P_{it}^{Aktive} denotes the price for venture capitalists' active involvement.

The capital supply by capital providers can be written as:

$$(4)\quad VC_{it}^{Non-Aktive} = h(\underset{(+)}{P_{it}^{Non-Aktive}}, \underset{(-/+)}{IR_{it}}),$$

where $P_{it}^{Non-Aktive}$ denotes the price for capital investments in venture capital funds with: $P_{it}^{Non-Aktive} + P_{it}^{Aktive} = P_{it}$.

Assuming linear functions for the supply and demand of venture capital, one can solve supply and demand for the price of venture capital. Then, the two equations are equated and solved for the venture capital activity VC in a particular country i in period t:

$$(5)\quad VC_{it} = \alpha_1 + \underset{(-/+)}{\alpha_2}\, IR_{it} + \underset{(-/+)}{\alpha_3}\, LR_{it} + \underset{(+)}{\alpha_4}\, SM_{it} + \underset{(+)}{\alpha_5}\, HC_{it}.$$

3 Data

3.1 Data Definitions

The panel data set contains data from 14 Western European countries for the time period 1988 to 2000. These countries are: Austria, Belgium, Denmark,

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[2] Venture capital supply can be limited either by the supply of experienced venture capitalists or by the supply of financial means offered by capital providers because capital and active involvement in form of management support by experienced venture capitalists cannot be substituted perfectly.

Finland, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The analysis is restricted to European countries because data on early stage and expansion stage investments are comparable for European countries.

I use two measures of venture capital activity: investments in enterprises' early stage (seed and start-up stages) as a narrow definition for venture capital and investments in enterprises' expansion stage of development as a broader definition of venture capital. In the seed stage, the initial business concept is formed and prototypes of new products are developed and compared with competing products in the market. In the start-up stage, production is set up and an initial marketing campaign is launched, the market reaction to which is carefully analysed. Compared to other stages of development, such as the expansion stage, the seed and start-up stage are very risky stages. 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.

Since European countries differ substantially in size, I scale venture capital investments either by the gross domestic product (GDP) or by the gross capital formation. While gross domestic product approximates the overall size of an economy (that results from capital and labour endowment), the gross capital formation approximates only the capital endowment. One can argue that the capital endowment is the better measure to scale venture capital activity because of the capital component in venture capital. However, venture capital might also be related to the labour endowment, especially to human capital endowment. Therefore, I use the gross domestic product as a second scale measure.

As a measure for human capital endowment that economies need to generate and to realize business ideas in high-technology fields, I use two variables. First, I use the number of research and development employees in the business sector. Second, I use the number of patent applications to the European Patent

Office. Both variables are scaled either by the total labour force or by the total population.

As a measure of the liquidity of stock markets *SM*, I use either the capitalisation of stock markets or the number of firms listed. The capitalisation of stock markets is scaled either by gross domestic product or by gross capital formation. The number of firms listed is scaled either by the number of total labour force or by the population.

Both measures of the liquidity of stock markets contain stock market segments for fast-growing enterprises as well as segments for already established, more traditional, enterprises. Therefore, the measures of the liquidity of stock markets are only approximations because venture capital activity is expected to depend most of all on the liquidity of the stock market segment for fast-growing enterprises due to reputation concerns. However, due to data availability, I have to use data on all stock markets segments.

In addition to human capital endowment and stock market liquidity, I use several variables capturing the characteristics of institutional regulations in labour and financial markets. The rigidity of labour markets *LR* is approximated by the strictness of protection against dismissals either for regular employment only (*LR1*), or for temporary employment only (*LR2*), or for a combination of both (*LR3*). Moreover, I include accounting standards *AS*. These affect the transaction costs arising when investors gather information. It is expected that the better the accounting standards are, the easier and cheaper it is to get information about a particular enterprise, and thus, the higher the venture capital activity should be. Anti-director rights *AR* and a dummy for legal system *Law* are also used. The higher the anti-director rights index is, the higher the shareholder protection. The better shareholders are protected, the more shareholders are willing to invest. However, better shareholder protection can give entrepreneurs incentives to prefer inside financing. The dummy for the legal system *Law* indicates whether a system has a common-law tradition or a civil-law tradition. Law traditions affect the extent of shareholder and creditor protection.

Table 1 summarizes the variables used in this paper, gives a description of these variables, and of the respective sources.

Table 1: Data Definitions and Sources

Variable	Description	Source
$VC_{it}(\theta,\delta)$	Measures venture capital investments If $\theta = e$, investments in early stages (government and private sector funded) are included If $\theta = ee$, investments in early and expansion stages (government and private sector funded) are included If $\delta = GDP$, venture capital is scaled by gross domestic product If $\delta = GCF$, venture capital is scaled by gross capital formation	EVCA (various issues)
$HC_{it}(\mu,\eta)$	Measures human capital endowment If $\mu = rd$, the number of research and development employees in business sector is used. If $\mu = pat$ the number of patents is used. If $\eta = pop$, human capital endowment is scaled by the total population. If $\eta = emp$, human capital endowment is scaled by the total labour force.	OECD CS (2002)
$SM_{it}(\delta)$	Measures the liquidity of stock markets through stock market capitalisation If $\delta = GDP$, stock market capitalisation is scaled by gross domestic product If $\delta = GCF$, stock market capitalisation is scaled by gross capital formation	Emerging stock markets factbook (1993, 2001)
$SMN_{it}(\eta)$	Measures the liquidity of stock markets through number of firms listed If $\eta = pop$, number of firms listed is scaled by the total population. If $\eta = emp$, number of firms listed is scaled by the total labour force.	Emerging stock markets factbook (1993, 2001)
$LR_{it}(\phi)$	Measures the labour market rigidity through strictness of protection against dismissals If $\phi = 1$, the strictness of regular employment is used. If $\phi = 2$, the strictness of temporary employment is used. If $\phi = 3$, the strictness of regular and temporary employment is used. Two values are available over the observation period: one describes the strictness in the late 1980s, while the other describes the strictness in the late 1990s. Value of the late 1980s is used for the years 1984-1993, while the value of the late 1990s is used for the years 1994-2000.	OECD (1999), Table 2.5
ΔGDP_{it}	Growth rate of GDP.	OECD CS (2002)
ΔSMC_{it}	Growth rate of stock market capitalisation	Emerging stock markets factbook (1993, 2001)
AS_i	Accounting standards: The International Accounting and Auditing Trends has created this index by examining how many of 90 accounting items have been included in the 1990 annual reports of enterprises. Higher values mean better accounting standards.	La Porta et al. (2000)
Law_i	indicates whether a system has a common-law tradition or a civil-law tradition. The UK has a common-law tradition (dummy is equal to one), while all other countries in the sample have a civil-law tradition.	La Porta et al. (2000)
AR_i	Anti-director rights: The index ranges from 0 to 5. Higher values mean higher shareholder protection.	La Porta et al. (2000)

3.2 Descriptive Statistics

Table 2 presents some descriptive statistics of the endogenous and exogenous variables of the unbalanced panel. The number of observations of the panel data set is 182 for all variables except the patent variable. Patent data are only available for 1988 to 1998 so that the number of observations for this variable is only 154.

Table 2: Descriptive Statistics

	Observations	Mean	Std. Dev.	Min	Max
	a. Endogenous Variables				
VC(e,gdp)	182	0.015	0.023	0.000	0.107
VC(e,gcf)	182	0.072	0.119	0.000	0.624
VC(ee,gdp)	182	0.043	0.043	0.000	0.624
VC(ee,gcf)	182	0.213	0.220	0.001	1.655
	b. Exogenous Variables				
SMN(pop)	182	0.002	0.001	0.000	0.006
SMN(emp)	182	0.004	0.002	0.001	0.102
SM(gdp)	182	0.595	0.566	0.703	3.213
SM(gcf)	182	2.982	3.001	0.301	15.246
HC(pat,pop)	154	0.009	0.007	0.000	0.033
HC(pat,emp)	154	0.019	0.013	0.000	0.061
HC(rd,pop)	182	0.267	0.136	0.191	0.591
HC(rd,emp)	182	0.541	0.250	0.039	1.124
Law	182	0.071	0.258	0.000	1.000
AR	182	2.500	1.299	0.000	5.000
AS	182	65.286	11.208	36.000	83.000
LR1	182	2.426	0.935	0.800	4.800
LR2	182	2.524	1.280	0.300	5.400
LR3	182	2.468	0.973	0.500	4.100

On average, over all periods and all countries, venture capital investments in enterprises' early stage of development are about 0.015 per cent of GDP or 0.072 per cent of gross capital formation. Thus, early stage investments are

small compared to the overall economic activity. As the minimum and maximum values indicate, differences in venture capital activity across countries and/or time are substantial. While one country has early stage investments as low as 0.00 per cent of GDP, another country has early stage investments of 0.1 per cent of GDP. The early stage investments either as a percentage of GDP or of gross capital formation increased in all countries during the observation period.

Venture capital investments in enterprises' expansion stage are about 0.043 per cent of GDP and about 0.213 per cent of gross capital formation over all countries and all periods. Thus, expansion stage investments are three times as high as early stage investments. Moreover, the differences between the minimum and maximum values are much larger than the differences for the early stage investments. While one country has expansion stage investments as low as 0.00 per cent of GDP, another country has expansion stage investments as high as 0.6 per cent of GDP.

The countries also differ substantially with respect to the liquidity of stock markets and human capital endowments. The number of firms listed as a percentage of the countries' labour force, used as a proxy for the liquidity of stock markets, is as low as 0.001 in one country, while it is as high as 0.102 in another country. In one country, the capitalisation of stock markets as a percentage of gross capital formation is as low as 0.3, while in another country it is as high as 15.2. The capitalisation of stock markets has increased substantially in almost all European countries because of the higher stock prices at the end of the 1990s. The number of research and development employees as a percentage of labour force varies little over time. Portugal with about 0.05 per cent of labour force and Spain with about 0.13 per cent of labour force have low levels of research and development employees. By contrast, Sweden and Switzerland have high levels of research and development employees.

The European countries also differ with respect to labour and financial market regulations. The United Kingdom is the only country in the sample that has a

common-law tradition. Accounting standards, which can take values between zero and 99, are comparably high with an average value of 65. Portugal has the lowest accounting standards in the sample, while Sweden has the highest accounting standards. With respect to the protection against dismissal, many European countries have changed their regulations towards more flexibility in labour markets. The strictness of protection against dismissals for regular employment has been relaxed in Spain from 3.8 at the beginning of the 1990s to 2.6 at the end of the 1990s. By contrast, in Germany the respective indicator has increased from 2.7 to 2.8.

Simple correlations presented in Table 3 offer a first hint at the relationships between venture capital and the liquidity of stock markets or human capital endowment. The correlation coefficients between venture capital investments either in enterprises' early stages or development stages and the capitalisation of stock markets either as a percentage of GDP or gross capital formation are comparatively high (about 0.5). By contrast, the correlation coefficients between venture capital investments and firms listed as a percentage of the countries' labour force are below 0.25. The correlation between venture capital and measures of liquidity of stock markets are much stronger than the correlations between venture capital and measures of human capital endowment. Patents, used as a proxy for human capital endowment, seem to be weakly correlated with venture capital investments in enterprises' early stages, while they seems to be uncorrelated with venture capital investments in enterprises' expansion stage.

Simple correlations between venture capital and the regulatory variables indicate that regulatory issues seem to have a stronger impact on venture capital investments in enterprises' expansion stage than they have on venture capital investments in enterprises' early stage. In particular, expansion stage investments are positively correlated with the law tradition (*Law*), anti-director rights (*AR*) and accounting standards (*AS*). The correlation coefficient between strictness of labour markets (*LR*) and expansion stage investments is also higher than

the one between the strictness of labour markets and the early stage investments.

Table 3: Correlations

	Observations	VC(e,gdp)	VC(ee,gdp)	VC(e,gcf)	VC(ee,gcf)
SMN(pop)	182	0.060	0.156	0.081	0.185
SMN(emp)	182	0.085	0.204	0.104	0.230
SM(gdp)	182	0.554	0.498	0.565	0.529
SM(gcf)	182	0.530	0.499	0.553	0.554
HC(rd,emp)	182	0.064	0.010	0.095	0.057
HC(rd,pop)	182	0.015	–0.028	0.046	0.023
HC(pat,emp)	154	0.165	–0.025	0.187	0.008
HC(pat,pop)	154	0.123	–0.052	0.146	–0.015
Law	182	0.052	0.405	0.077	0.482
AR	182	–0.051	0.237	–0.029	0.273
AS	182	0.109	0.172	0.152	0.250
LR(1)	182	–0.074	–0.136	–0.100	–0.204
LR(2)	182	–0.182	–0.273	–0.193	–0.316
LR(3)	182	–0.162	–0.253	–0.181	–0.315

4 Regression Results

In order to estimate whether the theoretically identified driving forces have a significant impact on the level of venture capital activity, I employ dynamic panel data techniques. Estimating a dynamic model seems sensible because of the dynamic processes taking place in venture capital markets. In particular, venture capitalists have to build reputation and to accumulate experience. Experience is needed to successfully select, monitor and support and, thus, to add value to young high-technology enterprises. Venture capitalists accumulate experience by being involved in the management of young high-technology enterprises. Reputation, i.e., a track record of successfully financing young

high-technology enterprises, is needed in order to raise capital from capital providers who a priori have little information about the profitability of venture capital investments. By estimating a dynamic model, the effects of reputation building and experience accumulation can be captured.

In addition to the driving forces identified above, the dynamic model considers the lagged endogenous variable, fixed effects (country-specific effects) and time effects:

(6) $VC_{it} = VC_{it-1}\delta + X_{it}\beta + \psi_t + \vartheta_i + \varepsilon_{it}$,

where X_{it} denotes the matrix of exogenous variables, ϑ_i denotes the country-specific effects, ψ_t denotes the time effects, ε_{it} is the error term.

Country-specific effects have to be removed from equation (6) because it is expected that they are correlated with the lagged endogenous variable. They can be removed by calculating the first differences. Anderson and Hsiao (1982) proposed this approach first. This procedure does not only remove the county-specific effects but also all variables that are time-invariant. Therefore, the regulatory variables law tradition *Law*, accounting standards *AS*, and anti-director rights *AR* are not included in the regression analysis.

Removing the country-specific effects due to differences leads to a correlation between the lagged endogenous variable and the error term. Arellano and Bond (1991) argue that using generalized method of moments (GMM) and lags as instruments can produce consistent estimators if the error term is serially uncorrelated. Valid instruments in this model are the endogenous variables lagged two or more periods given that the time-varying component of the error term is not serially correlated. Only if error term is uncorrelated, and if the instruments are valid, estimation is consistent. Therefore, I perform tests on serial correlation, using a test on the second-order residual correlation coefficient, and I perform a Sargan test of over-identifying restrictions to check the validity of instruments (Arellano and Bond 1991).

For unbalanced panels that have a time dimension smaller than twenty periods and a small number of cross-sections, Judson and Owen (1999) recommend a one-step GMM estimator. In particular, Judson and Owen (1999) find that the computational efficiency of the estimator can be increased without reducing substantially the effectiveness by using only a subset of available lagged values as instruments. Therefore, I use the one-step GMM estimator and a subset of available lags of the endogenous variable as instruments.

In addition, I have to think about whether some of my exogenous variables might be endogenous. My measurements of human capital endowments and liquidity of stock markets can be the result of venture capital activity. Research and development employees can be the result of venture capital finance, since venture capital investments create employment (Belke 2002) most often in the form of high-qualified jobs (Engel 2001). Patents can be the result of venture capital finance as well, since venture-capital-backed enterprises take out significantly more patents than other comparable enterprises (Kortum and Lerner 2000). The number of firms listed and the capitalisation of stock markets can be the result of venture capital finance because of the importance of initial public offerings of venture-capital-backed enterprises as an exit channel for venture capitalists (Black and Gilson 1998).

Since I cannot rule out that the variables capturing the liquidity of stock markets and the human capital endowment are endogenous, I have to use instruments for these variables in order to get consistent parameter estimations. In particular, I assume that variables capturing liquidity of stock markets and human capital endowment are predetermined and I use lags of these variables as instruments in a similar way than I use the endogenous variable lagged two or more periods to instrument the lagged endogenous variable.

Table 4, and Table 5 present the results of the one-step GMM estimation using the early stage investments as a percentage of GDP and the early stage investments as a percentage of gross capital formation as endogenous variables. The

Table 4: Determinants of Early Stage Investments as a Percentage of GDP

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
$VC(e,gdp)_{-1}$	0.635*** (2.99)	0.568*** (2.89)	0.619*** (2.88)	0.711*** (4.13)	0.645*** (3.03)	0.651*** (3.13)	0.414** (2.37)
SM(gdp)	0.0001* (1.84)	0.0001** (1.96)	0.0002** (2.06)	—	0.0002* (1.88)	0.0002** (1.95)	0.0001* (1.95)
SMN(emp)	—	—	—	3.216 (1.10)	—	—	—
HC(rd,emp)	0.084*** (2.66)	0.047** (2.34)	0.086*** (2.68)	0.097*** (3.49)	0.080** (2.51)	0.071** (2.55)	—
HC(pat,emp)	—	—	—	—	—	—	0.760*** (2.78)
ΔSM	—	—	–0.003 (–1.50)	—	—	—	—
Bubble	—	0.015*** (3.37)	—	—	—	—	—
LR(1)	—	—	—	—	—	0.003 (0.60)	—
LR(2)	—	—	—	—	0.005** (2.57)	—	—
LR(3)	0.011*** (2.98)	0.004** (2.28)	0.010*** (2.94)	0.011** (2.15)	—	—	0.001 (0.94)
Constant	0.001** (2.13)	0.000 (0.53)	0.001* (1.87)	0.002*** (3.28)	0.001** (2.04)	0.001 (1.14)	-0.001 (-2.38)
m(1) (p-value)	0.021	0.020	0.021	0.023	0.022	0.023	0.002
m(2) (p-value)	0.730	0.406	0.680	0.808	0.765	0.816	0.514
Sargan Test (p-value)	0.723	0.869	0.720	0.221	0.722	0.657	0.002
# observations	178	178	178	178	178	178	150
# countries	14	14	14	14	14	14	14

Note: Dependent variable is venture capital investments in enterprises' early stages (seed and start-up investments) as a percentage of GDP. *$VC(e,gdp)_{-1}$* denotes the lagged dependent variable; I used three lags as instruments. *SM(gdp)* is the capitalisation of stock markets as a percentage of GDP. *SMN(emp)* denotes the number of firms listed as a percentage of labour force. *HC(rd,emp)* denotes the number of employees in research and development as a percentage of the labour force. *HC(pat,emp)* denotes the number of patents as a percentage of labour force. HC and SM are predetermined variables. For *SM(.)* and for *HC(.)*, I used two lagged values as instruments. *ΔSM* denotes the growth rate of the stock market capitalisation. *LR(.)* denotes the rigidities of labour markets (see Table 1). Bubble denotes a dummy variable equal to one for the years 1998, 1999, and 2000.

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

Table 5: Determinants of Early Stage Investments as a Percentage of Gross Capital Formation

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
$VC(e,gcf)_{-1}$	0.616*** (2.92)	0.558*** (2.83)	0.602*** (2.84)	0.702*** (4.05)	0.625*** (2.94)	0.634*** (3.07)	0.353** (2.15)
SM(gcf)	0.0001* (1.74)	0.0001* (1.87)	0.0002** (1.98)	—	0.0001* (1.80)	0.0002* (1.96)	0.0001 (1.08)
SMN(emp)	—	—	—	14.948 (0.90)	—	—	—
HC(rd,emp)	0.434*** (2.70)	0.249** (2.17)	0.440*** (2.63)	0.437*** (3.35)	0.413** (2.47)	0.372*** (2.71)	—
HC(pat,emp)	—	—	—	—	—	—	4.943*** (3.58)
ΔSM	—	—	–0.016 (–1.44)	—	—	—	—
Bubble	—	0.072*** (3.16)	—	—	—	—	—
LR(1)	—	—	—	—	—	0.019 (0.54)	—
LR(2)	—	—	—	—	0.031*** (2.95)	—	—
LR(3)	0.619*** (3.64)	0.028*** (3.22)	0.061*** (3.43)	0.059** (2.22)	—	—	0.012 (1.36)
Constant	0.006** (1.96)	0.001 (0.40)	0.005* (1.78)	0.010*** (3.40)	0.005* (1.85)	0.003 (0.92)	-0.002 (-1.35)
m(1) (p-value)	0.040	0.041	0.040	0.051	0.041	0.042	0.002
m(2) (p-value)	0.634	0.354	0.599	0.736	0.666	0.721	0.921
Sargan Test (p-value)	0.799	0.883	0.810	0.238	0.800	0.724	0.001
# observations	178	178	178	178	178	178	150
# countries	14	14	14	14	14	14	14

Note: Dependent variable is venture capital investments in enterprises' early stages (seed and start-up investments) as a percentage of gross capital formation. *$VC(e,gcf)_{-1}$* denotes the lagged dependent variable; I used three lags as instruments. *SM(gcf)* is the capitalisation of stock markets as a percentage of gross capital formation. *SMN(emp)* denotes the number of firms listed as a percentage of labour force. *HC(rd,emp)* denotes the number of employees in research and development as a percentage of the labour force. *HC(pat,emp)* denotes the number of patents as a percentage of labour force. HC and SM are predetermined variables. For *SM(.)* and for *HC(.)*, I used two lagged values as instruments. *ΔSM* denotes the growth rate of the stock market capitalisation. *LR(.)* denotes the rigidities of labour markets (see Table 1). *Bubble* denotes a dummy variable equal to one for the years 1998, 1999, and 2000.

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

lagged endogenous variable has a positive and highly significant coefficient in all model specifications. Thus, reputation building and experience accumulation seem to increase venture capital activity. As indicated by the p-values of m(2), the error terms lack second-order correlation, which is necessary for GMM estimators to be consistent. The p-values of the Sargan tests indicate that the null hypothesis cannot be rejected. Under the null hypothesis, the model is correctly specified and the instruments are uncorrelated with the error term. Thus, both tests indicate that the estimation produce consistent parameter estimations.

In my analysis, the liquidity of stock markets approximated by the capitalisation *SM* has a significant positive impact on venture capital investments in enterprises' early stages,[3] while Jeng and Wells (2000) do not find a significant relationship between early stage investments and liquidity of stock markets. Thus, liquidity of stock markets can affect venture capital activity either because venture capitalists and entrepreneurs have the opportunity to write implicit contracts over control, or because venture capitalists can build reputation for financing high-technology enterprises successfully, or because stock markets support the development of an appropriate skill composition, i.e., stock markets can increase the number of individuals that have appropriate skills to become venture capitalists.

Human capital endowments, approximated by the number of research and development employees as a percentage of the total labour force *HC(rd,.)*, has also a positive impact on the level of venture capital investments in enterprises' early stages. Thus, one can argue that the higher the population share with

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[3] This suggests that venture capital markets develop predominantly in those countries that have liquid stock markets, as argued by Black and Gilson (1998). However, for a venture capital market to develop, the stock market does not have to be a domestic one as the success of the Israeli venture capital market suggests (Rock 2001, 2002). The exit of Israeli venture-capital-backed enterprises is on the NASDAQ. But it must be questioned whether this result can be passed on other countries.

sufficient skills to develop new business ideas in the high-technology area is, the higher the venture capital activity will be.

Most interestingly, two of the three measures approximating the rigidity of labour markets are positive and significant. While the coefficient of the strictness of protection against dismissal of regular employment is insignificant, the coefficients of the strictness of protection against dismissal of temporary and both regular and temporary employment are significant. As noted in the second section, positive coefficients of the rigidity of labour markets can be the result of differences in the labour-capital ratio of high-technology enterprises. In particular, high-technology enterprises operating in rigid labour markets may demand more capital than comparable high-technology enterprises operating in flexible labour markets.

Surprisingly, the growth rate of the stock market capitalisation does not have a significant impact on venture capital investments in enterprises' early stage. This variable is also not significant in the regression analysis by Jeng and Wells (2000).

I include also year dummies and a dummy variable *bubble* that is equal to one for the years 1998, 1999, and 2000. Including year dummies does not change the p-value of the Sargan test, but it changes the significance of some variables. The lagged endogenous variable and the variable approximating labour market rigidity (*LR3*) are insignificant when year dummies are included, while the capitalisation of stock markets as a percentage of GDP *SM(gdp)* and the number of research and development employees as a percentage of labour force *HC(rd,emp)* keep their signs and significance. Including the dummy variable bubble, which has a positive and highly significant coefficient, does not substantially change the signs and significance of the exogenous variables.

As another proxy for human capital endowment I include the number of patents as a percentage either of the labour force or of the total population (Model 7 in Table 4, and Table 5). The coefficients of the patent variable are positive and

highly significant. However, the Sargan test indicates a misspecification of the model. The quality of the instruments tested by the Sargan test does not improve if fewer instruments (either lags of the endogenous or exogenous variables) are used. The reason for this seems to be the lower number of observations due to the fact that patent data are not available for 1999 and 2000. Thus, the number of observations is reduced from 178 without patents data to about 150 when patents are included in the regression analysis.

So far, I have assumed that increasing stock market capitalisation or the human capital endowment of a country by a marginal unit has the same impact on venture capital investments in enterprises' early stages of development in all countries. In order to analyse whether the impact of the variables of interest is identical across the countries in my sample, I now include country-specific coefficients for several subgroups. In a first step, I test whether the British coefficients of the stock market capitalisation and the human capital endowment differ from the coefficients of the rest of the sample. One might expect a difference because the British financial market is more market-based than the other European markets considered here. Since stock markets play an important role as exit channels from venture capital investments, differences in the structure of the financial system may have an impact on the relationship between stock market capitalisation and venture capital investments. In a second step, I separate small countries from large countries. Large countries are France, Germany, Italy, and the United Kingdom. The size of an economy may have important implications for the coefficients of the stock market capitalisation and the human capital endowment since large economies may be more able to realize economies of scale. Venture capitalists operating in large economies may realize more often economies of scale since they may have more opportunities to syndicate their investments and to concentrate their investment activity on particular technologies and stages of enterprises' development. By focusing their investment activity on particular stages and technologies, venture capitalists may accumulate more specific experience necessary for a successful selection and monitoring of high-technology enterprises. These economies of scale

may be reflected in different coefficients of the stock market capitalisation and the human capital endowment.

Table 6 reports the results of the regressions with country-specific coefficients. In Models 1-3, I test whether the British coefficients differ from the coefficients of the rest of the sample. In Model 4-6, I test whether the coefficients of large economies, i.e., the United Kingdom, France, Germany, and Italy, differ from the coefficients of small countries.

Model 1-3 show that the British coefficient of the stock market capitalisation differs from the coefficient of the stock market capitalisation in the rest of the sample, while the coefficients of the human capital endowment do not differ as much. The British coefficient is about three times as large as the coefficient of the rest of the sample. Because of this, one can argue that the coefficient of the stock market capitalisation without country-specific coefficients (see Table 4, Model 1) is driven by including the United Kingdom in the sample.

Models 4-6 in Table 6 show significant differences between small and large countries. The coefficient of the stock market capitalisation of large countries is more than two times larger than the respective coefficient of small countries. In the second half of the 1990s, the large countries in my sample have developed comparatively liquid stock market segments for fast-growing firms, while the small countries have not (Bottazzi and Rin 2002). The coefficients of the human capital endowment do also differ between large and small countries. While the small countries' coefficient of the human capital endowment is not significant in Model 5, the large countries' coefficient is positive and highly significant. These differences between large and small countries do also hold if I allow for country-specific coefficients of the stock market capitalisation and human capital endowment in a single equation. Because of this, I cannot distinguish whether economies of scale or the structure of the financial market drives the differences between countries.

Table 6: Country-specific Effects of Early Stage Investments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$VC(e,gdp)_{-1}$	0.617***	0.571***	0.487***	0.511***	0.528***	0.569***
	(2.96)	(2.91)	(2.79)	(4.18)	(4.39)	(4.83)
SM(gdp)	—	0.0001*	0.0001**	—	0.0001***	—
		(1.72)	(1.98)		(2.62)	
SM(gdp)*D	0.0003***	—	—	0.0003***	—	0.0002***
	(4.98)			(3.03)		(2.87)
SM(gdp)*(1-D)	0.0000	—	—	0.0001**	—	0.0001**
	(1.22)			(2.42)		(2.46)
HC(rd,emp)	0.099***	—	—	0.042***	—	—
	(4.70)			(3.16)		
HC(rd,emp)*D	—	0.120**	0.105**	—	0.100***	0.098***
		(2.42)	(2.58)		(4.85)	(3.19)
HC(rd,emp)*	—	0.087***	0.036***	—	0.009	0.028**
(1-D)		(3.30)	(2.71)		(0.45)	(1.99)
Bubble	—	—	0.018***	0.016***	0.018***	0.016***
			(4.67)	(3.46)	(4.56)	(3.35)
LR3	0.011***	0.014***	0.005**	0.003	0.002	0.001
	(3.85)	(3.31)	(2.11)	(1.23)	(0.80)	(0.45)
Constant	0.001**	0.002**	0.000	0.000	0.000	0.000
	(2.52)	(2.59)	(1.13)	(0.10)	(0.68)	(0.36)
m(1) (p-value)	0.016	0.023	0.025	0.025	0.025	0.023
m(2) (p-value)	0.676	0.691	0.301	0.352	0.322	0.366
Sargan Test (p-value)	0.281	0.146	0.453	0.276	0.172	0.868
# observations	178	178	178	178	178	178
# countries	14	14	14	14	14	14

Note: Dependent variable is venture capital investments in enterprises' early stages (seed and start-up investments) as a percentage of GDP. *$VC(e,gdp)_{-1}$* denotes the lagged dependent variable; I used three lags as instruments. *SM(gdp)* is the capitalisation of stock markets as a percentage of GDP. *HC(rd,emp)* denotes the number of employees in research and development as a percentage of the labour force. HC and SM are predetermined variables. For *SM(.)* and for *HC(.)*, I used two lagged values as instruments. D denotes a country dummy variable. In model 1, 2, and 3 this variable is equal to one in the case of United Kingdom, and in model 4, 5, and 6 it is equal to one in the case of the United Kingdom, France, Italy and Germany. *LR(.)* denotes the rigidities of labour markets (see Table 1). *Bubble* denotes a dummy variable equal to one for the years 1998, 1999, and 2000.

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

Table 7 reports the results of the regressions with time-specific coefficients. Of particular interest is whether the influence of the stock market capitalisation and

Table 7: Time-specific Effects of Early Stage Investments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$VC(e,gdp)_{-1}$	0.627*** (3.13)	0.600*** (3.05)	0.553*** (2.62)	0.562*** (2.90)	0.563*** (2.91)	0.615*** (3.23)
SM(gdp)	—	—	—	0.0001 (1.34)	0.0001 (1.38)	0.0001 (1.19)
SM(gdp)*D	0.0002* (1.86)	0.0002 (1.60)	0.0001** (2.22)	—	—	—
SM(gdp)*(1-D)	0.0000 (0.14)	0.0001 (1.11)	-0.001*** (-3.93)	—	—	—
HC(rd,emp)	0.039*** (2.69)	0.032*** (2.71)	0.082*** (3.82)	—	—	—
HC(rd,emp)*D	—	—	—	0.051*** (3.42)	0.048*** (3.22)	0.007 (1.26)
HC(rd,emp)* (1-D)	—	—	—	0.018 (1.36)	0.019 (1.41)	-0.018*** (-4.37)
Bubble	—	0.011 (1.53)	—	—	0.002 (0.61)	—
LR3	0.004* (1.75)	0.003 (1.53)	0.008** (2.48)	0.003** (2.16)	0.003* (1.93)	0.002 (0.70)
Constant	0.001* (1.66)	0.000 (1.19)	0.002*** (3.16)	0.000 (0.89)	0.000 (0.68)	0.001 (2.73)
m(1) (p-value)	0.018	0.019	0.015	0.027	0.026	0.016
m(2) (p-value)	0.670	0.471	0.862	0.567	0.534	0.932
Sargan Test (p-value)	0.981	0.983	0.999	0.9761	0.979	0.999
# observations	178	178	178	178	178	178
# countries	14	14	14	14	14	14

Note: Dependent variable is venture capital investments in enterprises' early stages (seed and start-up investments) as a percentage of GDP. $VC(e,gdp)_{-1}$ denotes the lagged dependent variable; I used three lags as instruments. *SM(gdp)* is the capitalisation of stock markets as a percentage of GDP. *HC(rd,emp)* denotes the number of employees in research and development as a percentage of the labour force. HC and SM are predetermined variables. For *SM(.)* and for *HC(.)*, I used two lagged values as instruments. D denotes a time dummy variable. In model 1, 2, 4, 5 this variable is equal to one for the years 1998, 1999, 2000, and in model 3 and 6 it is equal to one for the years 1997, 1998, 1999, 2000. *LR(.)* denotes the rigidities of labour markets (see Table 1). *Bubble* denotes a dummy variable equal to one for the years 1998, 1999, and 2000.
***, **, * denotes significant at the 1, 5 and 10 per cent level. z-values are given under the coefficients.

the human capital endowment differs between the beginning and the end of the 1990s that was characterized by high stock prices. In Model 1, Model 2, Model 4, and Model 5, I distinguish between the period 1988 to 1997 and 1998 to 2000. In Model 3 and Model 6, I distinguish between the period 1988 to 1997 and 1997 to 2000. Using the data of the year 1997 in both sub-samples has the advantage that the number of observations in the second sub-sample is higher in which I use the data of the year 1997 only as instruments.

Model 1-3 indicate that there is some evidence that the impact of the stock market capitalisation differs between the time period of the beginning and the end of the 1990s. In particular, in Model 1, only the coefficient of the stock market capitalisation of the end of the 1990s is weakly significant, while the coefficient of the beginning of the 1990s is not. Model 3, in which I use the data of 1997 as instruments, shows significant differences between the two coefficients: While the stock market capitalisation has a negative impact on early stage investments at the beginning of the 1990s, it has a positive impact at the end of the 1990s.

Model 4-6 indicate that the impact of the human capital endowment is only significantly positive at the end of the 1990s but not at the beginning of the 1990s. In addition, when using the data of 1997 as instruments in the second sub-sample, the coefficient of the human capital endowment of the first sub-sample is significantly negative, while it is not significant for the second sub-sample.

I repeat the whole analysis for venture capital investments in enterprises' expansion stage of development as endogenous variable. Some of the results are reported in Table 8. Most surprisingly, for all model specifications, the Sargan tests indicate a model misspecification: i.e. the instruments used are not valid. Therefore, regression results cannot be interpreted in the case of venture capital investments in the enterprises' expansion stage of development.

Table 8: Determinants of Expansion Stage Investments either as a Percentage of GDP or of Gross Capital Formation

	VC(ee,gcf)	VC(ee,gcf)	VC(ee,gcf)	VC(ee,gdp)	VC(ee,gdp)	VC(ee,gdp)
$VC(ee,gcf)_{-1}$	0.391 (1.37)	0.351 (1.35)	0.356 (1.24)	—	—	—
$VC(ee,gdp)_{-1}$	—	—	—	0.433 (1.61)	0.381 (1.52)	0.391 (1.45)
SM(gcf)	0.0002 (1.25)	0.0001 (1.41)	0.0002 (1.47)	—	—	—
SM(gdp)	—	—	—	0.0002 (1.27)	0.0002 (1.40)	0.0002 (1.46)
HC(rd,emp)	0.337 (1.21)	0.076 (0.31)	0.351 (1.21)	0.088 (1.34)	0.041 (0.75)	0.095 (1.41)
ΔSM	—	—	-0.055** (-2.09)	—	—	-0.012** (-2.13)
Bubble	—	0.106*** (2.56)	—	—	0.021*** (2.76)	—
LR3	0.091*** (3.06)	0.041 (1.46)	0.084*** (3.03)	0.018*** (3.66)	0.010** (1.98)	0.016*** (3.50)
Constant	0.017*** (3.59)	0.010* (1.80)	0.016*** (3.03)	0.003*** (2.62)	0.002 (1.47)	0.003** (2.28)
m(1) (p-value)	0.022	0.012	0.021	0.008	0.005	0.009
m(2) (p-value)	0.087	0.081	0.072	0.057	0.058	0.046
Sargan Test (p-value)	0.000	0.002	0.000	0.001	0.004	0.001
# observations	178	178	178	178	178	178
# countries	14	14	14	14	14	14

Note: Dependent variable is venture capital investments in enterprises' expansion stage either as a percentage of GDP or gross capital formation. *VC(e,gcf)*$_{-1}$ denotes the lagged dependent variable; I used three lags as instruments. *SM(gcf)* is the capitalisation of stock markets as a percentage of gross capital formation. *HC(rd,emp)* denotes the number of employees in research and development as a percentage of the labour force. *HC(pat,emp)* denotes the number of patents as a percentage of labour force. HC and SM are predetermined variables. For *SM(.)* and for *HC(.)*, I used two lagged values as instruments. *ΔSM* denotes the growth rate of the stock market capitalisation. *LR(.)* denotes the rigidities of labour markets (see Table 1). *Bubble* denotes a dummy variable equal to one for the years 1998, 1999, and 2000.

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

The reason for this might be that expansion stage investments as a proxy for venture capital activity (as a proxy for investments in young high-technology enterprises) are too broadly defined. In fact, expansion stage investments do not

only cover investments in high-technology enterprises, but also investments in traditional enterprises.

In order to explain differences in expansion stage investments within Europe it seems to me more important to include variables capturing differences in the financial systems. Evidence based on Bach data suggests substantial differences in how firms are financed. For example, large French firms classified as manufacturing had a debt-equity ratio of less than 3.5. By contrast, their German counterparts had a debt-equity ratio of almost 8 at the end of the 1990s. Determinants that cause these differences in financing patterns might also explain differences in expansion stage investments across countries.

5 Summary

This paper has analysed driving forces of venture capital activity for Western European countries. I have used one broad and one narrow definition of venture capital activity. Venture capital narrowly defined contains only investments in enterprises' early stages of development, while venture capital broadly defined contains investments in enterprises' expansion stages. In order to correct for differences in the size of the economies, I have scaled investments either by the gross domestic product or by the gross capital formation.

While using the narrow definition of venture capital has led to interpretable results, using the broad definition of venture capital has not yielded interpretable results. In particular, specification tests have indicated a model misspecification if venture capital was broadly defined, while this was not the case if venture capital was narrowly defined. The reason for this can be that the broader definition of venture capital, i.e., investments in enterprises' expansion stages, is affected by determinants so far not considered in the analysis.

As shown by dynamic panel estimations, the level of venture capital investments narrowly defined depends positively on the capitalisation of stock markets, on the human capital endowment of the economies approximated by

research and development employees and on the degree of rigidities on labour markets. I have expected a positive impact of the capitalisation of stock markets on venture capital investments because stock markets are an important exit channel for venture capitalists. In addition, I have expected a positive impact of human capital endowment on venture capital investments because venture capital with its monitoring and support functions is predominantly used to finance young high-technology enterprises and human capital is necessary for the development of business ideas in high-technology fields. The positive impact of labour market rigidities seems counterproductive since one can expect that incentives for entrepreneurial activity are higher in economies with flexible labour markets than in economies with rigid labour markets. However, the positive coefficient can be the result of different capital-labour-ratios: enterprises operating in economies with rigid labour markets demand more capital per employee than their counterparts operating in flexible labour markets.

Literature

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