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Christian Schröder

Financial System and Innovations: Determinants of Early Stage Venture Capital in Europe

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EUROPÄISCHES INSTITUT FÜR INTERNATIONALE WIRTSCHAFTSBEZIEHUNGEN (EIIW)/
EUROPEAN INSTITUTE FOR INTERNATIONAL ECONOMIC RELATIONS
Bergische Universität Wuppertal, Campus Freudenberg, Rainer-Gruenter-Straße 21, D-42119 Wuppertal, Germany
Tel.: (0)202 – 439 13 71
Fax: (0)202 – 439 13 77
E-mail: welfens@uni-wuppertal.de
www.euroeiiw.de

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Summary: This paper highlights the role of financial development in producing innovative products and services. Venture Capitalists (VCs) seem to play a crucial role in achieving product and service innovation. Young entrepreneurs particularly face the problem of financial constraints if starting their business, and risk capital could be their sole solution. However, the level of early-stage venture capital (VC) investments across European countries differ profoundly. I employ a panel analysis to illustrate whether technical and innovative opportunities as well as entrepreneurial environment influence early-stage venture capital investments. In addition, I emphasize the role of the financial system in attracting early stage VC. The empirical analysis was conducted in 15 European countries and looked at the period from 1995 to 2005. The results show that technical and innovation opportunities as well as entrepreneurial environment influence the level of early-stage risk capital. Taking the financial system also into account, the analysis revealed that a bank-based system has a negative impact on the relative amount of early stage VC investments, as a market-based system attracts risk capital for young entrepreneurs. Assumedly, venture capital and debt provided by banks are found not to be complements but rather substitutes.

Christian Schröder, Research Assistant at European Institute for International Economic Relations (EIIW) at the University of Wuppertal, Rainer-Gruenter-Str. 21, D-42119 Wuppertal, Phone: +49-202-4391371, Fax: +49-202-4391377

schroeder@wiwi.uni-wuppertal.de, www.euroeiiw.de

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1. Introduction

From the 1990s until now, the most developed economies in Europe have significantly lower GDP growth rates than the US. These considerable lower growth rates go along with lower productivity growth and a poor development on the labour markets in the most European countries, especially in the large economies like Germany, France and Italy. One main challenge which faces the EU-15 economies is to be more innovative in terms of goods and services in order to counter the pressure of labour costs in EU-15 for unskilled labour triggered from the new EU member states and developing countries worldwide. Other than flexible institutions and less bureaucracy (see e.g. ALESINA et al, 2003, KLAPPER et al, 2004), small- and medium-sized enterprises face one major hindrance to unlock their full innovative ability: access to capital. Improving SMEs' access to finance is one of the key factors for more innovative business start-ups with high growth perspectives. Thus, the financial environment plays a crucial role in promote innovation.

The Lisbon Programme notes that the limited availability of finance is an obstacle in setting up and developing businesses in Europe. A Eurobarometer poll published in 2005 showed that many small- and medium-sized enterprises (SMEs) find it increasingly difficult to obtain bank loans. In response to the question as to what would best assure the development of their company, fourteen percent of 3,047 interviewed SMEs in the EU-15 stated easier access to means of financing.[1] The results of the fourth community innovation survey (2004) support country specific surveys and shows that 23.6% of a sample of 70,623 interviewed innovative firms in the EU-27 complain about innovation costs being much too high; thus this is an important factor of hampering innovation activities.[2]

In the traditional perfect market approach to the analysis of financial markets, services are bought and sold in an anonymous manner, and the only information transfer consists of signals given by movements in prices. In this Arrow-Debreu world there is no need for financial intermediaries, as borrowers would obtain their loans directly from depositors. We have learned from MODIGLIANI/MILLER (1958) that in such a world, the financial structure of a firm does not matter. Nevertheless, one can find in the literature many reasons why the MODIGLIANI/MILLER theorem does not hold in the real world especially in financing innovations, e.g. STONEMAN (2001):

- The completeness of a capital market concerns issues relating to the diversity of capital instruments available. There could be a lack of such instruments, e.g. venture capital in underdeveloped financial markets, and affect the innovative entrepreneur or R&D investments of firms.
- A perfect market needs high numbers of participants on both the demand and the supply side. Even with offers on the supply side in certain areas, the financial services could have a monopolistic structure and thus avoid the development of a culture of innovative entrepreneurship.
- Financing innovative projects that have not yet been undertaken elsewhere, it may be particularly difficult to observe the systematic risk of similar projects in other firms

1 http://europa.eu.int/comm/enterprise/entrepreneurship/financing/surveys.htm

2 http://epp.eurostat.ec.europa.eu/extraction/retrieve/en/theme9/inn/inn_cis4_ham?OutputDir=EJOutputDir_428&user=unknown&clientsessionid=36B5ACB284DB9EF789B3402F5C84B21D.extraction-worker-1&OutputFile=inn_cis4_ham.htm&OutputMode=U&NumberOfCells=28&Language=en&OutputMime=text%2Fhtml&

(GOODACRE/TONKS, 1995) and thus difficult to determine the appropriate discount rate.

- Moral hazard problem in R&D investment arises in the usual way: modern industrial firms normally have separation of ownership and management. This leads to a principal-agent problem when the goals of the two conflicts, which can result in investment strategies that do not share value maximizing (HALL, 2002).
- The asymmetric information problem refers to the fact that an inventor frequently has better information about the likelihood of success and the nature of the contemplated innovation project than potential investors. Therefore, the marketplace for financing the development of innovative ideas looks like the "lemon" market modelled by AKERLOF (HALL, 2002).
- Risk assessment on the stock market might be determined not by future, long term potentials of the firm, but rather by the psychologically determined peculiarities of the stock market (e.g., the stock market bubbles in Europe and US from 1998 to 2001).
- Financing decisions will be based upon after-tax costs and returns. The tax environment will thus have considerable influence upon the degree of investment and the means of financing investment. As tax regimes, especially in Europe, differ across countries, one may expect to find inter-country differences on preferred finance structures and financial instruments.
- For innovative projects, assets are highly specific and difficult to resell and thus bankruptcy costs are high. The difference between R&D investments and real capital goods are that the former has an essential higher rate of personnel costs (e.g., for R&D, construction, design, training and market launch). In Germany in 2004, only one-third of knowledge intensive goods and services fall upon real assets (KFW, 2006).
- The knowledge one earns from research is often implicit and it is not possible to codify the new knowledge; moreover, if research staff leaves the firm the new knowledge is lost for the company.

In this context one kind of financial intermediary has been well-established in the US and has successfully dealt with the problems of financing innovative projects: venture capitalists (VCs). VCs mediate risk capital normally from institutional investors like pension funds, insurance companies, banks, funds of funds, etc. Institutional investors manage large amounts of assets which are well-diversified. These investors then seek additional returns and are thus willing to allocate a small fraction of their capital in riskier investments. They use VCs normally specialized in one specific sector to screen the market for promising companies with extraordinary high growth opportunities. VCs bring supply and demand of risk capital together. The success of the VCs depends not only on their experience and ability to find adequate enterprises, but also on the economic environment as a whole.

This paper examines factors which could influence the relative amount of early stage Venture Capital (VC) investments within Europe from a macroeconomic view. Early Stage VC means VC which is provided in the beginning of the business cycle the so-called seed (or pre-seed) and start up phase which is critical, as very often no final product exists. This investment stage is obviously risky but provides potentially high returns in the case of a successful firm development. The less risky later stage VC investments which encompass expansion and replacement investments could be more attractive for VCs. So the financing gap exists especially in the start up phase. The difference of the early stage VC investments relative to GDP between the European countries is tremendous. In addition to the already

existing analysis of GOMPERS/LERNER (1998), JENG/ WELLS (2000), SCHERTLER (2003), ROMAIN/VAN POTTELSBERGHE (2004) in terms of the level of (early stage) VC, I use for the most part other variables, in particular the inclusion of the financial system of each country is new. Aside from the technology capability, high skilled human capital stock, company tax rates, entrepreneurship, labor costs and growth opportunities, the panel data analysis of 15 European countries includes variables which indicate whether the financial system is more bank-based or market-based. The existing literature suggests that VC investments are affected by the financial system and could be one reason for different VC investment levels. A market-based system may be more suitable than a bank-based system for VC investments, since an IPO is the most profitable exit strategy.

In the following section, I show some arguments why VCs are successful in establishing young firms. Section three provides arguments in the literature as to which financial system – a bank-or market-based system – may be more efficient in promoting innovative firms. This may be useful in two respects. On the one hand, the existence of financial intermediaries needs to be justified in economic terms, and on the other hand, the arguments made for both systems make clear why VC is especially efficient in fostering innovation or in other words market failure in financing innovations occur in both kind of financial system and so affects the demand and supply function of VC. I derive my main hypotheses that a market-based system fosters and a bank-based system rather prevents early-stage VC investment in the context of the arguments the literature is providing. However, the literature provides comprehensible arguments for both a bank- and a market based system to boost innovations, but a market-based system creates an environment which attracts early-stage VC as banks seem instead to be substitutes for VC due to their similar business model. The panel analysis in section four supports this view. Section five closes with some concluding remarks.

2. Venture Capital and Innovative Firms

VC is primarily funding provided to young and typically innovative companies not quoted on the stock market, but it is provided in return for a share of equity in the company. The investors normally have a time horizon of 3 to 7 years, but sometimes as many as 10 years is allowed.[3] Frequently VCs support the nascent entrepreneur not only with capital but also with advice and management expertise. VCs may sit on boards of directors to valuable governance and advisory support (ROMAIN/POTTESBERGHE, 2004). VC companies are typically specialized in very few or one industry sector. This specialization deepens technical knowledge and enables the VCs to select risky investments more efficiently. FENN et al. (1995) estimate that only one percent of all firms seeking capital obtain venture capital financing. GEBHARDT/SCHMIDT (2001) also conclude that VC promotes less than five percent of all potential projects. Even actual data of National-, European- and US Private Equity and VC Associations confirm this ratio. As a result of such a stringent selection process, KORTUM/LERNER (2000) find out for the US that increases in VC activity are associated with significant increases in patent rates. Moreover, they show that VC investments are three times more effective in generating industrial innovation than R&D expenditures. A very similar study for Europe by POPOV/ROSENBOOM (2009) discovers

3 Along DI MASI et al. (2003) e.g. the development process of biopharmaceuticals demands on average 12 years and 100 million US $ R&D expenditures with only one out of 5000 initial drug canditates reaching market launch (EVANS/VARAIYA, 2003).

that the impact of €1 of private equity[4] relative to €1 of industrial R&D expenditures is 2.6 times more effective in terms of producing innovations measured by patents.

HELLMANN/PURI (2000) discover that a start-up company financed by VCs needs less time to bring a product to the market. However, their survey contains 149 recently-formed firms in the Silicon Valley, and this local concentration should be taken into account before interpreting their results.

BAUMOL (2002) argues that entrepreneurial activity may account for a significant part of the "unexplained" proportion of the historical growth output. Empirical evidence shows that VC-backed firms grow much faster at least in the beginning than non-VC-backed firms (ENGEL, 2002; ENGEL/KEILBACH, 2002). BERGER/UDELL (1998) and GOMPERS/LERNER (1999) emphasize that venture-backed firms outperform non-venture-backed firms because of their willingness to conduct pre-investment screening and their special ability to monitor and assess value added.

On further aspect is that the VCs does not make an investment all at once. Instead, capital is provided in stages, and the entrepreneur only receives enough funding to reach the next stage. An important theoretical prediction is that the objective of the first stage is to provide capital to a cash-constrained entrepreneur. After this first round, an agency relationship is established between the entrepreneur and the investor. Follow-up rounds are intended to mitigate the agency costs associated with this relationship. Objectives other than removing a cash constraint take precedence in follow up rounds. DAVILA/FOSTER/GUPTA (2003) deliver empirical results which go along with the theoretical prediction.

If performance objectives are not met, the VCs must make a decision: should the firm's strategy be reconsidered or must the management be changed (GORMAN/SAHLMAN, 1989)? HELLMAN/PURI (1999) show that VCs replace the founder twice as often as non VC-backed firms. In the worst case, the venture capitalist stops his activity. Even if the venture capitalist decides to continue the project, he or she demands a greater participation on the part of the firm. So the venture capitalist has a powerful position. The venture capitalist usually receives convertible preferred stock. Like a debt contract, preferred stock requires the firm to make fixed payments to the shareholders whereas the promised payments must be made before any common shareholder gets dividend payments and impeded in that way that the entrepreneur is not paying himself high dividends (BERLIN 1998). When a venture capitalist holds the shares of a young firm, which means the shares are not marketable to other investors, the venture capital investor avoids the free-rider problem. The investor is able to earn profit from its monitoring activities and relieve the information costs of moral hazard (HUBBARD, 2008, p.240). VCs in the US are able to efficiently invest in young innovative firms due to their selection process, specialization, know-how and financial instruments. However, the early-stage market in Europe is very heterogeneous in terms of the (early-stage) investment levels and underdeveloped in the most countries in comparison to the US.

Early Stage Venture Capital in Europe

According to the OECD assessment lack of an equity investment culture, information problems, and market volatility especially from mid-2000 to 2003 hinder the development of

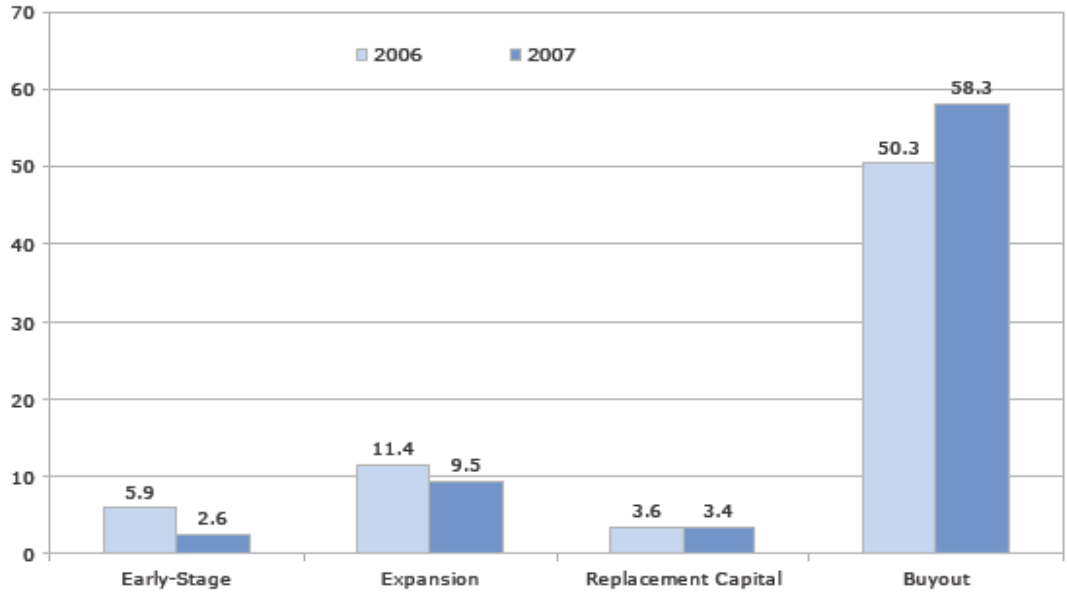
4 Private Equity includes beside VC also management buyins (MBI) and management buyouts (MBO). A management buyout (MBO) is a form of acquisition where a company's existing managers acquire a large part or all of the company and a MBI occurs when a manager or a management team from outside the company raises the necessary finance, buys it, and becomes the company's new management. In general MBIs and MBOs are financed by debt and occur in less risky and therefore often less innovative industry sectors which are characterized by relative stable cash flows.

early-stage financing in many European countries (OECD 2003). In spite of the existence of VC, the so-called seed (or pre-seed) and start up stage is critical. The less risky later stage VC investments which encompass expansion and replacement investments could be more attractive for VCs. The costly and time consuming phase for due diligence in seed and early-stage deals often makes these investments less profitable compared to later stage VC investment deals that provide more attractive risk-return profiles (EUROPEAN COMMISSION, 2005b). Therefore, the so-called business angels and early stage VCs play a crucial role to fill the capital gap in the seed stage.[5]

European early stage venture capital represents only a small fraction of all private equity invested in Europe. The amount of Leverage Buyouts (LBOs) and Management Buyouts (MBOs) is ten times higher than in early stage venture capital.

Figure 1. Stage Distribution of Investments in Europe

in billion Euro



Source: EVCA

STOREY (1995) and MURRAY (1998) describe the difficulties in financing especially young high-tech firms as follows:

- It is difficult for outside investors to make reliable assessments of demand for the products/services in highly immature markets;
- The investments frequently encompass the research and developmental costs and high expenditure in the marketing phases;
- The authors also point out that the threat of accelerated redundancy in rapidly changing technology-based sectors remains;

[5] Business angels are wealthy private persons with normally successful experience as an entrepreneur or a manager. They contribute their network of personal contacts in business and company finance circles. In addition to their experience, they also provide capital for young entrepreneurs with convincing business ideas. The European Business Angel Network (EBAN) reports that in the US, 250,000 angels invested $24 billion in 2005 in comparison to 75,000 angels who invested only €2-3 billion in Europe (http://www.eban.org/download/Standard%20EBAN%20Presentation_2007.ppt#287,18,Benchmarking angel activity)

- The entrepreneurial recipients of the investors' funds frequently lack the managerial experience and therefore the ability to exploit the advantages of the new technological innovation.

Young and fast growing firms often need years to reach the break-even point. These firms have negative cash flow and need a developed venture capital market. A developed VC market means that there are enough independent VCs which are specialized in specific sectors and have built up both reputation and experience (the so called track record) to attract potential investors for high-risk investments.

The next section devotes some attention to the role of the financial systems in fostering innovations. The following remarks should clarify why market failure in financing innovative firms occurs in both market- and bank-based financial systems. This market failure creates demand for risk capital in the high income countries I consider in the empirical analysis. One could argue that a market-based system creates a better risk/return ratio by means of the most lucrative exit strategy for VCs via IPO, but on the other hand, one could argue that bank-based systems additionally influence the amount of early-stage VC investment negatively due their similar business model. Through the competitive situation between banks and VCs, the latter could be underdeveloped in terms of their relative size. In the end of the following section I derive my hypotheses as to which determinants may stimulate early stage VC investments in Europe and showing the empirical results in section 4.

3. Financial System, Venture Capital and Innovations

Financial constraints have a large and significant impact on investments in innovative projects. SCHUMPETER (1911) was one of the first to discuss the importance of credit in the process of innovation. According to Schumpeter, the entrepreneur is the driving force behind the process of innovation, and he considers the lender's assessment of the borrower to set the limit of credit expansion. In a further step, PAGANO (1993) employs a simple endogenous AK growth model to illustrate how financial development can influence growth through the enhanced accumulation of capital through higher savings (HICKS, 1969) and the improved ability of the financial sector to increase technological progress through the efficient selection, funding and monitoring of projects. On the one hand, larger volumes of financial funds saved promote growth as more savings are available to fund investment projects. This effect relates to the Hicksian view that better developed financial systems are those which channel higher quantities from savers to investors. On the other hand, an improved quality of intermediation can both enhance factor productivity and reduce the fraction of savings that are foregone due to suboptimal production plans of financial agents. Both effects resemble the Schumpetrian view, with better financial systems fostering capital by investing in more profitable projects (KOETTER/WEDOW, 2006). In this context, LEVINE (2004) and ANG (2007) deliver a useful summary about the functions and recent developments in the finance and growth literature.

Debt financing of R&D projects could be difficult because of the above-mentioned characteristics of financing innovations. The Flash EB Report (EUROPEAN COMMISSION, 2005a, p.25) seems to support this view. Answers to the claim that banks do not want to take risks in lending provide insight into the reasons why many SMEs are sceptical about access to financing through banks. 71% of SMEs totally agree or tend to agree with the statement that banks do not want to take risks in lending to companies and only 23% disagree with it.

There are some further problems which especially banks face. Due to fixed interest payments, banks do not participate in the high returns of successful outcome. They are therefore more concerned with the probability of failure when calculating the price of a loan. In this context, STIGLITZ/WEISS (1981) analyze why it could come to credit rationing instead of a higher interest rate which clears the market. The effects of moral hazard and adverse selection in debt markets explain why lenders may deny a loan agreement even if the project is profitable. Because of asymmetric distributed information about the risk characteristics and default probabilities of firm's investment projects, lenders may ration credit rather than accept a higher interest rate to clear the market, because increases in the interest rate induce low-risk borrowers to exit the pool of applicants first. In addition, borrowers whose actions cannot be monitored by lenders have an intrinsic incentive to invest in risky, higher-return projects that increase the probability of bankruptcy. It is primarily for this moral hazard problem that equity rather than debt is considered the natural source of external finance for firms investing in risky R&D projects (KUKUK/STADLER, 2001).

ALLEN (1993) argues that such a system which aggregates diverse views of many market participants is appropriate where are legitimate grounds for differences in views with respect to the investment decision. LEVINE (2001) and LEVINE/ZERVOS (1998) maintain that market-based systems create more suitable conditions in enhancing risk management, information dissemination, corporate control and capital allocation. Powerful banks use their close relationships to well established firms in order to prevent the entrance of newcomer. Hence, established firms are protected due to higher entrance barriers (HELLWIG, 1991). Dispersed shareholders can more credibly commit to not interfering in the running of firms than can dedicated owners.

Despite this and the argument of credit rationing, one can also find arguments which emphasize the role of banks in financing innovative projects. STIGLITZ (1985) himself argues that well developed stock markets reveal information very quickly and they therefore reducing incentives for individual investors to invest in innovative projects. GERSCHENKRON (1963) and BOOT/GREENBAUM/THAKOR (1993) argue in this context that banks could mitigate that problem by building up long-run relationships to firms. A further argument could be the ability of banks to realize economies of scales in monitoring firms (CARLIN/MEYER, 1999). STULZ (2000) claims that banks are more effective in financing innovative activities that require staged financing, because banks can credibly commit to making additional funding available as the project develops (BECK/LEVINE, 2002). MAYERS/MAJULJ (1984) explained in their so called pecking order theory, why firms may be forced to issue new shares at a discount for financing R&D or be forced to self-finance their R&D projects because of the adverse selection problems.

Taking these arguments in account, firms often rely on internal funds as a consequence of imperfect capital markets. Empirical studies provide results demonstrating that R&D expenditures will be determined by available cash flow (e.g. HALL 1992; HIMMELBERG/PETERSEN, 1994; HARHOFF, 1998). However, the effect differs between countries (MULKEY/HALL/MAIRESSE, 2001). Empirically, results dedicated to young firms show that they are more financially constrained because they cannot use earlier profit accumulations for financing their R&D projects (MOORE, 1994; PETERSEN/RAJAN, 1995, BERGER/UDELL, 2002; CARPENTER/PETERSEN, 2002; CZARNITZKI, 2006). Moreover, older firms could benefit from their established relationships to banks and therefore reduce problems of asymmetric information. There are higher exit rates for young companies because of inexperienced management, problems of developing a costumer base

and problems of establishing the product in the market (MUELLER/ZIMMERMANN, 2006, p.4). LINK/BOZEMAN (1990) highlight the differences among small innovative companies with respect to different competition environments which could affect their financial decision. BOYD and SMITH (1998) do not argument in such a controversial way; banks and markets might act as complements in providing financial services.

The aim of the VCs is to create value and to exit via buyout or initial public offering (IPO). The exit via IPO is to some extent the most profitable option for the investor and the entrepreneur. BLACK/GILSON (1997) stress this view. They highlight the role of stock markets and their complementary role as regards venture capital. This could be one determinant as to why the VC industry has more weight in the US than in Europe. The stock market for young, high-tech firms in the US is much better developed and enables many more IPOs than in Europe. This ensures much higher average returns on VC investments in the US than in Europe. On average a VC in the US yields returns of 26% p.a. for a ten-year investment to 31 December 2004 in comparison to 6.3% in Europe (EVCA, NVCA). In this context I enunciate my first hypothesis.

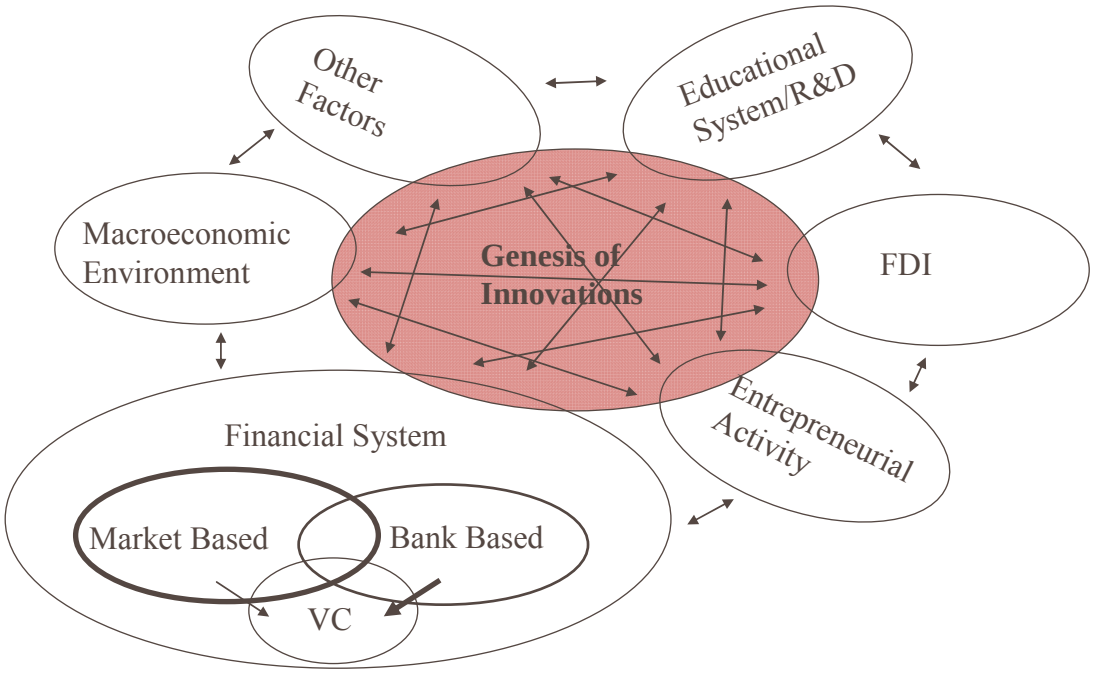
Hypothesis 1: Market-based financial systems stimulate VC investments.

AUDRETSCH/LEHMANN (2004) empirically analyzed whether debt and equity are complements or rather substitutes in financing young and high-tech firms. The results provided from AUDRETSCH/LEHMANN confirm the view of BLACK/GILSON. Using a data set of the firms listed on the Neuer Markt in Germany reveals that they suffer from lower performance as long as finance is restricted to traditional banks. They also point out the necessity for institutions such as the former Neuer Markt, because venture capital and debt provided by banks is found not to be complements but rather substitutes. I follow their approach and think that banks and VCs are rivals in terms of their business model. To find out whether these results hold for other European countries, I include the size of the banking sector of each country in the panel analysis and derive the second hypothesis.

Hypothesis 2: Bank-based systems prevent VC Investments as banks are to some extent substitutes.

The third hypothesis considers other macroeconomic factors which may influence the level of early stage VC investments. VCs companies are interested in a strong demand for VC that means they are interested in a huge human capital stock of highly skilled people willing to start a business. The stock of knowledge depends i.a. on the educational system, the (international) networks of companies and R&D expenditures. VCs prefer also low company tax rates and labour costs which enhance their portfolio value. High GDP growth rate supports the demand for VC and may influence the survival rate of portfolio companies. All these factors are interrelated. The innovation system which METCALFE (1995) defines as a "… set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies" clarify that the mentioned factors interact. For example the causality between finance and the genesis of innovation or growth is unambiguously.

Figure 2: Innovation System



Hypothesis 3: The existing stock of later stage VC, qualified human capital, growth opportunities, entrepreneurship, interest rates, and technology capabilities positively influence early stage VC levels while the corporate tax rate and labor costs negatively affect early stage VC investments.

The following section deepens some aspects concerning the third Hypothesis as I explain the used variables.

4. Empirical Analysis

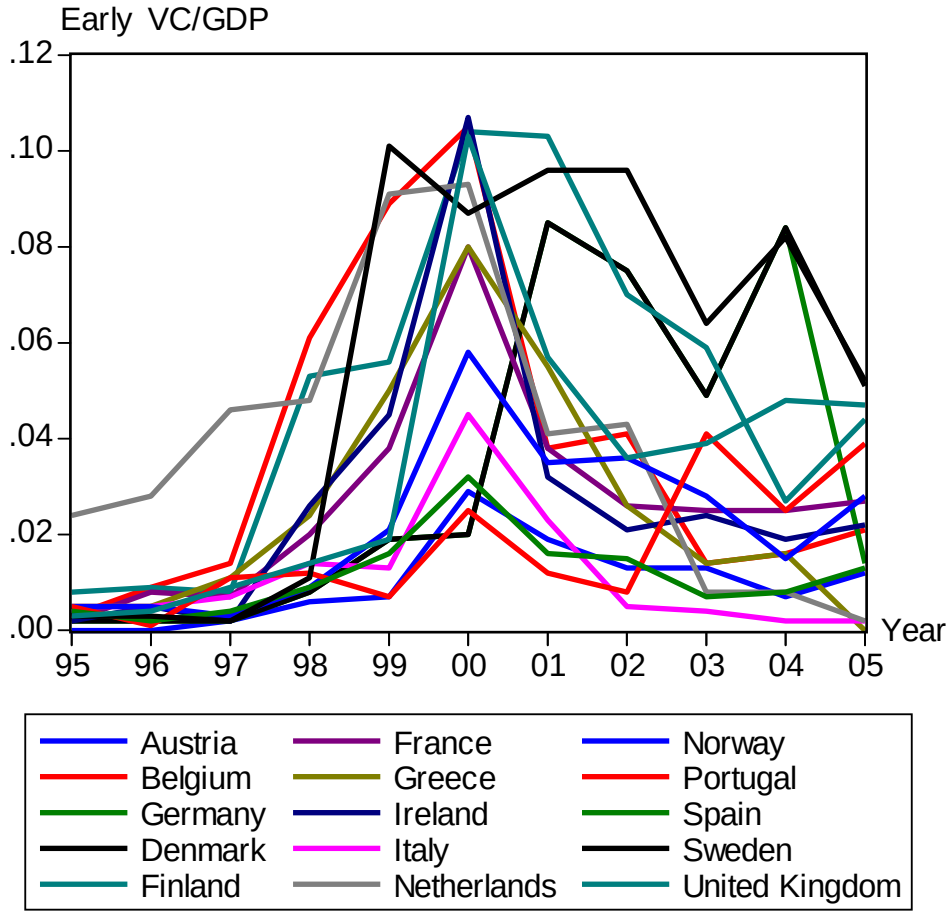
Empirical results from a macroeconomic perspective which explain determinants of VC via panel analysis are relatively scarce. JENG/WELLS, 2000; SCHERTLER, 2003; ROMAIN/POTTELSBERGHE, 2004 have done similar analysis, but for different countries, time periods and for the most part, different variables. Nevertheless, the following panel analysis follows their approach.

Descriptive Statistics

As mentioned above, early-stage VC capital investments raised from 1995 to 2005 in Europe differ profoundly across the European countries. In Denmark and Sweden, early-stage VC investments in 2005 amount to upwards of 0.051 and 0.052 percent of GDP, respectively; in Greece, early stage VC scarcely exits. I apply a GLS panel analysis to find out if the determinants formulated by the three hypotheses are responsible for such huge differences in the amount of early-stage risk capital in 15 European countries. The analysis includes the countries Austria, Belgium, Germany, Denmark, Finland, France, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom from 1995 to 2005.

These countries have been selected because of their similar per capita income, available data and the fact that an analysis of this country sample has never been done before. In Eastern Europe, VC hardly plays a role in the observed time period.

Figure 3: Early VC Investments in selected EU countries



Source: EUROSTAT

Variables[6]

The dependent variable is early-stage VC investments. The VC data are available at EUROSTAT.[7] Hence, following their definition, early-stage means the sum of seed and start-up risk capital. The variable is scaled by gross domestic product at market prices.

The explanatory variables are proxies for the technological and growth opportunities, qualified human capital stock, macroeconomic and entrepreneurial environment as well as the financial system. Including the amount of VC investments in the later-stage (expansion and replacement capital) also makes sense considering the evolution of the VC markets. Evolution of a VC market means it seems logical to assume that in the beginning, VCs prefer to invest in less risky projects such as already-existing firms, which have a successful business model and need VC to assure growth opportunities. VCs need time to build expertise and confidence. Building a track record (e.g., building trust) is essential for convincing potential investors to commit money to a venture capitalist (SCHERTLER, 2002). Successful exits of portfolio firms build reputation, enable economies of scale and syndicate with other VCs, thus allowing the venture capitalist to invest in risky, early-stage investments. ZARUTSKIE

6 For a more detailed data definition see Appendix.

7 http://epp.eurostat.ec.europa.eu/tgm/web/table/description.jsp

(2006) determines that in seed stage VC funds, having a founding venture capitalist team with both venture investing experience and experience managing a start-up is the strongest predictor of fund performance. First-time seed stage funds with such founding teams strongly outperform their counterparts. An additional aspect is that in a more mature VC market as in the US, the VC portfolios are on average larger and provide better options for diversifying portfolios in early and later stage VC investments.

The banking sector and stock market developments represent the financial system. Stock market development also affects the exit strategy and therefore the returns of VCs. To measure the weight of the banking sector, I follow the approach of LEVINE/ZERVOS (1996). The variable banking sector equals the value of loans made by banks to private enterprises divided by GDP. Specifically, I divided line 22d by 99b from the IMF´s International Financial Statistics. The market capitalization of listed companies (% of GDP) represents the size of the market-based system. Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchange(s) at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. I also include the stock turnover into the regression in order to measure the liquidity of the national stock markets. The turnover ratio is the total value of shares traded during the period divided by the average market capitalization for the period. Average market capitalization is calculated as the average of the end-of-period values for the current period and the previous period.

(High-tech) patent applications, foreign direct investment inflows (FDI) and research and development (R&D) expenditures represent both technological ability and innovation activities. Patents reflect a country's inventive activity. Patents also show the country's capacity to exploit knowledge and translate it into potential economic gains. In this context, indicators based on patent statistics are widely used to assess the inventive performance of countries (EUROSTAT). I differentiate between patent applications and high-tech patent applications to the European Patent Office scaled by population assuming the later delivers better results to explain early stage VC investment, since VCs are interested in investing in fast growing high-tech sectors like information and communication technologies, biotechnology, and nanotechnology. R&D expenditures of the public and private sector represent the creation of new knowledge. In addition, I add FDI inflows which can permanently increase knowledge spillovers and the transfer and diffusion of technologies, ideas, management and organizational processes. In the regression, (high-tech) patent application, R&D expenditures and FDI represent the technological opportunities (TO) of each country. FDIs inflows represent also potential networks to foreign multi national enterprises and can be seen as an indirect measurement of labour market rigidities.

New technologies are being developed and applied, in many cases very quickly. An increasingly skilled and effective workforce will be required if countries are to negotiate the rapid change and new challenges emerging in science and technology (S&T). Human resources in science and technology (HRST) signify the stock of human capital which fulfils one or other of the following conditions: successfully completed education at the third level in a S&T field of study; not formally qualified as above, but employed in a science and technology occupation where the above qualifications are normally required. The share of HRST of the whole work force may also be a proxy of potential entrepreneurs in high-tech sectors and therefore even a driver for the demand of VC.

Table 1: Descriptive Statistics

	VC Early Stage[1]	VC Later Stage[1]	High-tech patents[2]	Patents[2]	FDI[1]	R&D Expenditure[1]	Stock-marketcap[1]	Banking Sector[4]
Mean	0.028	0.076	19.953	97.094	4.66	1.688	73.125	0.882
Median	0.019	0.055	11.891	86.68	2.15	1.72	61.793	0.831
Maximum	0.107	0.351	124.435	271.93	92.67	4.250	271.11	1.730
Minimum	0.000	0.000	0.05	1.40	14.73	0.433	12.688	0.306
Std. Dev.	0.028	0.0654	25.675	75.996	9.645	0.903	46.442	0.345
Sum	4.718	12.632	3292.36	16020.5	768.9	278.62	12065.63	145.554
Sum Sq. Dev.	0.131	0.702	108112.5	947175.6	15258.5	133.94	353735.9	19.572
Observations	165	165	165	165	165	165	165	165
Cross sections	15	15	15	15	15	15	15	15

	GDP Growth[3]	Corporate Tax Rate[3]	Interests[3]	Stock-turnover[1]	Laborcosts[5]	HRST[5]	Self-employment[7]
Mean	3.053	33.136	5.759	55.47	0.577	34.91	18.938
Median	3.032	34.00	5.055	37.57	0.596	35.15	14.10
Maximum	11.681	53.20	17.270	257.94	0.705	49.77	46.10
Minimum	-1.119	12.50	3.320	2.80	0.338	16.15	7.10
Std. Dev.	1.911	5.839	2.311	48.92	0.081	8.830	10.809
Sum	503.76	5467.54	950.39	9153.27	95.29	5760.4	3124.8
Sum Sq. Dev.	599.28	5592.05	876.42	392575.8	1.098	12788.3	19162.33
Observations	165	165	165	165	165	165	165
Cross sections	15	15	15	15	15	15	15

1 in % of GDP

2 per million inhabitants

3 in %

4 value of loans made by banks to private enterprises/GDP

5 quotient of total labour costs and real output

6 % of active persons in the age class of 25-64 years

7 % of total civilian employment

I use the self-employment rates as a percentage of total civilian employment to measure entrepreneurial activity or spirit. One has to handle this proxy with care since it contains all kinds of self-employment. Numerous entrepreneurs are not relevant for the demand of VC because of their less innovative business model. Moreover, becoming an entrepreneur can be triggered from the demand or the supply side of entrepreneurship. Being involved in entrepreneurial activity could be a necessity; there are simply no other options for earning a living, and there is no comparative assessment to be made. However, the countries in the panel analysis are high-income countries, and we can assume that the perception of people who start a business is opportunity-driven in the sense that they have the opportunity of an alternative occupation as an employee.

The corporate tax rate negatively influences the value of the potential portfolio company as future gains have a higher discount rate and could affect the supply side of VC negatively. I also expect such a negative effect for the labour costs on early stage VC investments. Annual unit labour costs (ULCs) are calculated as the quotient of total labour costs and real output.

An increase in interest rates should positively affect the demand from entrepreneurs for early-stage VC. Otherwise if the supply effect is higher – i.e., the VCs invest more when interest rates fall –, the coefficient should be negative. I use the logarithm of the interest rates of ten year government bonds and expect a positive sign as ROMAIN/POTTELSBERGHE (2004) already show in their analysis based on a panel data set of 16 OECD countries from 1990 to 2000. I use the logarithm as I assume a non linear correlation of VC investments and interest rates. The expansion of an economy, measured as real GDP per capita growth, should affect the opportunities of firm growth and the survival rate of potential portfolio companies.

Model

Following the model of JENG/WELLS (2000) and ROMAIN/POTTELSBERGHE (2004), I create a supply and a demand function of early-stage venture capital. I assume the early stage venture capital supply (equation (1)) is driven by the level of later-stage VC investments, the corporate tax rate, the relatively size of the stock market capitalization and liquidity, labor costs, and banking sector as well as GDP growth. Equation (2) shows the demand function. I expect the later-stage VC, the corporate tax rates, technical opportunities, stock market developments, GDP growth, the stock of qualified human capital, entrepreneurial activity and the growth of interest rates influence the demand of early-stage VC. The variable technical opportunity is measured by FDI inflows, high-tech patent applications and all R&D expenditures.

(1) $$VC^{S}_{early_{it}} = a_0 + a_1 Returnpercentage + a_2 VC_{later_{it}} + a_3 Tax_{it} + a_4 Stockmarket_{it} + a_5 Stockturnover_{it} + a_6 GDPGrowth_{it} + a_7 Labor\,costs_{it}$$

(2) $$VC^{D}_{early_{it}} = b_0 + b_1 Returnpercentage + b_2 VC_{later_{it}} + b_3 Tax_{it} + b_4 TO_{it} + b_5 Stockmarket_{it} + b_6 Stockturnover_{it} + b_7 GDPGrowth_{it} + b_8 HRST_{it} + b_9 Banks_{it} + b_{10} Selfemployment_{it} + b_{11} \log(Interest_{it})$$

where in the equilibrium

(3) $$VC^{S}_{early_{it}} = VC^{D}_{early_{it}} = VC_{early_{it}}\ funds$$

hence the regression equation

$$(4)\quad VC_{early}\,funds_{it} = \gamma_0 + \gamma_1 VC_{later_{it}} + \gamma_2 Tax_{it} + \gamma_3 TO_{it} + \gamma_4 HRST_{it} + \gamma_5 Stockmarket_{it} + \gamma_6 Stockturnover_{it} + \gamma_7 GDPGrowth_{it} + \gamma_8 Labor\,costs_{it} + \gamma_9 Banks_{it} + \gamma_{10} Selfemployment_{it} + \gamma_{11}\log(Interest_{it}) + \mu_i + \varepsilon_{it}$$

To obtain (4), I solve the supply equation for the return percentage, and substitute this expression into the demand equation. The index i represents the country and t time; μ_i is a country specific unobserved fixed effect (see WOOLDRIDGE, 2002). One should expect positive signs for all γ, except for γ_2, γ_8, and γ_9 in the case that the panel analysis is able to support the three hypotheses I have formulated. Before starting the regression analysis, I apply the panel-based unit root test of LEVIN/LIN/CHU (2002). As one can see (in table A.2 in the Appendix) that the test fails to reject the presence of a unit root of the variables banking (sector) and labor costs, I modify the regression and take into account the first differences of the two relevant variables:

Model 1:

$$(5)\quad VC_{early}\,funds_{it} = \gamma_0 + \gamma_1 VC_{later_{it}} + \gamma_2 Tax_{it} + \gamma_3 TO_{it} + \gamma_4 HRST_{it} + \gamma_5 Stockmarket_{it} + \gamma_6 Stockturnover_{it} + \gamma_7 GDPGrowth_{it} + \gamma_8 d(Labor\,costs_{it}) + \gamma_9 d(Banks_{it}) + \gamma_{10} Selfemployment_{it} + \gamma_{11}\log(Interest_{it}) + \mu_i + \varepsilon_{it}$$

It is also worth noting that d represents the first differences. In the second model presented in table 3, I include lags where it seems to be reasonable in an economic sense.[8]

Model 2 (including lags for the variables R&D, high-tech patent application, self-employment and GDP growth):

$$(6)\quad VC_{early}\,funds_{it} = \gamma_0 + \gamma_1 VClater_{it} + \gamma_2 Tax_{it} + \gamma_3 TO_{it-1} + \gamma_4 HRST_{it} + \gamma_5 Stockmarket_{it} + \gamma_6 Stockturnover_{it} + \gamma_7 GDPGrowth_{it-1} + \gamma_8 d(Labor\,costs_{it}) + \gamma_9 d(Banks_{it}) + \gamma_{10} Selfemployment_{it-1} + \gamma_{11}\log(Interest_{it}) + \mu_i + \varepsilon_{it}$$

Regression Results:

The regressions results for models 1 and 2 are presented in table 2 and 3. All variables which are considered insignificant were taken out so as not to distort the R-squared or Durbin-Watson value. To estimate the regression, I use the pooled general least square method with country-specific fixed effects. Using a heteroksedasticity consistent covariance matrix estimator which provides correct estimates of the coefficient covariances in the presence of heteroskedasticity, derived from WHITE (1980), the tables accordingly present a weighted and unweighted estimation test result. The Durbin Watson test indicates no linear association between adjacent residuals from the regression models at the 5% level. Using the WHITE covariance estimator, there is not much of a difference. The weighted value of the particular model, 1.6 and 1.56, lies between the critical value from 1.60 to 1.86 for model 1 and 1.56 to 1.90 for model 2 along the corresponding test statistic (see e.g. SAVIN/WHITE, 1977, 1989-1996).[9] Even the charts of the residuals for each country illustrate this fact (see appendix figure A.1 and A.2). Table 2 shows that two of the three proxies for the technological and innovation capacity, namely R&D expenditures and FDI inflows, are highly significant. In model 1 (without lags), the coefficient of high-tech patent applications is not significant, but in the model within which I have lagged this variable back to one year, the coefficient becomes highly significant.

8 It needs time before R&D expenditures as well as patent applications become marketable products.

9 http://www.stanford.edu/~clint/bench/dw05b.htm

Table 2: Regression Results Model 1

Dependent Variable: VC Early Stage Funds
Method: Pooled EGLS (Cross-section weights)
Sample (adjusted): 1996 2005
Included observations: 10 after adjustments
Cross-sections included: 15
Total pool (balanced) observations: 150
Linear estimation after one-step weighting matrix
White diagonal standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.082927	0.020864	-3.974549	0.0001
VC Later Stage	0.159797	0.041449	3.855318	0.0002
FDI	0.000780	0.000152	5.132427	0.0000
Banking Sector	-0.036393	0.014346	-2.536744	0.0124
Stockmarket	0.000154	7.30E-05	2.110038	0.0368
Stockturnover	0.000167	6.48E-05	2.585072	0.0109
Log Interests	0.022036	0.007028	3.135439	0.0021
Corporate Tax Rate	-0.000640	0.000331	-1.934749	0.0553
R&D Expenditure	0.036127	0.008657	4.173218	0.0001
Laborcosts	-0.235038	0.126356	-1.860122	0.0652
Fixed Effects (Cross)				
Austria--C	-0.000798			
Belgium--C	0.001936			
Germany--C	0.007772			
Denmark--C	0.001937			
Finland--C	-0.045558			
France--C	-0.009654			
Greece--C	0.056389			
Ireland--C	0.025554			
Italy--C	0.026525			
Netherlands--C	-0.019440			
Norway--C	0.002405			
Portugal--C	0.046571			
Spain--C	0.008155			
Sweden--C	-0.069562			
United Kingdom--C	-0.032232			

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.654581	Mean dependent var	0.031804
Adjusted R-squared	0.591529	S.D. dependent var	0.026261
S.E. of regression	0.018740	Sum squared resid	0.044252
F-statistic	10.38151	Durbin-Watson stat	1.606942
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.626970	Mean dependent var	0.031460
Sum squared resid	0.047431	Durbin-Watson stat	1.679994

Table 3: Regression Results Model 2 (Including Lags)

Dependent Variable: VC Early Stage Funds
Method: Pooled EGLS (Cross-section weights)
Sample (adjusted): 1996 2005
Included observations: 10 after adjustments
Cross-sections included: 15
Total pool (balanced) observations: 150
Linear estimation after one-step weighting matrix
White diagonal standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.094940	0.023758	-3.996156	0.0001
VC Later Stage	0.162085	0.041398	3.915327	0.0001
FDI	0.000722	0.000144	5.006242	0.0000
Banking Sector	-0.026770	0.017309	-1.546565	0.1245
Stockmarket	0.000146	6.62E-05	2.207790	0.0291
Stockturnover	0.000130	5.73E-05	2.274124	0.0247
Log Interests	0.016028	0.008666	1.849574	0.0668
Corporate Tax Rate	-0.000695	0.000367	-1.895123	0.0604
R&D Expenditure Lag 1	0.028856	0.009505	3.035867	0.0029
Laborcosts	-0.245794	0.124068	-1.981132	0.0498
GDP Growth Lag 1	0.001645	0.001029	1.598240	0.1126
High-Tech Patent Lag 1	0.000338	0.000147	2.302944	0.0230
Selfemployment Lag 1	0.001516	0.000950	1.594540	0.1134
Fixed Effects (Cross)				
Austria--C	0.009752			
Belgium--C	0.006204			
Germany--C	0.020098			
Denmark--C	0.015016			
Finland--C	-0.054130			
France--C	0.005029			
Greece--C	0.017412			
Ireland--C	0.011505			
Italy--C	0.012205			
Netherlands--C	-0.019748			
Norway--C	0.017632			
Portugal--C	0.030879			
Spain--C	0.004965			
Sweden--C	-0.052551			
United Kingdom--C	-0.024267			

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.686200	Mean dependent var	0.031951
Adjusted R-squared	0.619869	S.D. dependent var	0.026743
S.E. of regression	0.018362	Sum squared resid	0.041471
F-statistic	10.34500	Durbin-Watson stat	1.556902
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.641180	Mean dependent var	0.031460
Sum squared resid	0.045624	Durbin-Watson stat	1.595679

The stock market capitalization and the stock turnover as a sign for the liquidity of the stock market seem to be important determinants in explaining early stage VC investments since both are significant in both models between the 1% and 3% level. This result goes along with Hypothesis 1 and other already existing empirical results which show that vibrant stock markets are important due the higher chance of a lucrative exit strategy for VCs. However, the most important outcome is that the size of the banking sector could have a negative impact on early-stage risk capital investments. It appears that along the lines of AUDRETSCH/LEHMANN, the volume of credits to firms guaranteed from banks substitutes early-stage VC investments. This interesting empirical result supports the strand of financial literature which postulates that a market-based financial system is more appropriate to finance innovations if one believes that VCs are really more efficient in selecting and financing young and innovative entrepreneurs, because a market-based system creates an environment which attracts VCs. The negative coefficient which in model 1 is highly significant and in model 2 of low significance, suggesting that banks to some extent replace VCs. A further reason could be that one can observe an increasing number of bank-dependent VCs in Europe. HIRSCH/WALZ (2006) and HELLMANN et al. (2008) observed that bank-dependent VCs invest in early investment stages less often.[10] The panel analysis also supports the view that later-stage VC is a precondition for early-stage VC. The negative coefficients of the corporate tax rate and laborcosts indicate that the entrepreneurial environment counters. The lagged selfemployment rate boosts the demand for early-stage risk capital investments. As JENG/WELLS (1998) and ROMAIN/POTTELSBERGHE (2004) determined that GDP growth has a positive impact on early-stage investment, this analysis indicates this pro-cyclical process with a time delay of one year as shown in the results of model 2. The R-squared suggests that the independent variables might explain more than 65% of early stage VC.

Human Resources in Science & Technology (HRST) as a Percentage of Active Persons in the Age Class of 25-64 Year is the sole variable which delivers no significant results in either model.

5. Concluding Remarks

In Europe young firms and firms with between 10 and 49 employees face specific challenges in obtaining capital for achieving their innovative ideas in marketable goods and services due to moral hazard, adverse selection and lack of collaterals. VC is appropriate to alleviate these problems. However, the difference between European countries in terms of early-stage VC in terms of the relative size is enormous.

This paper is an attempt to analyze possible determinants that could influence the level of early-stage VC. The empirical results in this paper suggest that the technological capability, low corporate taxes and labor costs, growth opportunities, entrepreneurial activities, interest growth rates as well as later-stage capital enhance the activities of early-stage venture capital investments. It is worth noting that the financial system could also play a significant role in attracting early-stage VC. While it might be unsurprising that developed stock markets go along with high investment activities, the fact that the size of the banking sector has a

[10] HELLMAN et al (2008) simply show that the probability is higher that independent VCs invest in early stage deals in comparison to bank dependent VCs. In absolute terms early stage VC deals or investments can increase with an increasing number of bank depending VCs.

significant negative impact is striking. The hypothesis that banks substitute VC due to their similar business models might be an explanation, but one must nevertheless be careful when interpreting these results. The analysis does not take into account which kind of firm receives capital. The applied variable banking sector does not differentiate between the size and innovation activities of companies. Moreover the industry structure remains unconsidered.

Nevertheless the results suggest that goal of policy makers should be to support a single European stock market, which is appropriate for an investment exit via IPO to achieve higher investment returns for VC investments in Europe. A European stock market segment like the AIM in UK, where investors have essential tax benefits if they invest in companies traded on AIM, is achievable. One adequate instrument to spur early-stage investments which follows the same goal is to implement low tax rates for potential portfolio firms. This also enhances the value of the firm and makes it more attractive for venture capitalists to invest in Europe. This strategy seems to be more effective than a direct subsidy for innovative SMEs. A uniform tax regulation for Europe might enhance transparency, but it impedes competition for a best practise solution and does not account for country-specific conditions. The strategic objectives of the Lisbon Agenda (e.g., enhancing R&D expenditures) seems to be appropriate, even though the presented analysis is of course no cost-benefit analysis, and it remains unconsidered that the marginal costs could be higher than the marginal benefits. Moreover the considered variables interact and potential efficiency gains can be realized by an improved networking of the institution within the innovation system, e.g. between universities, Greenfield investments and VC companies.

An interesting aspect in terms of stimulating early stage venture capital markets is to examine the role of government programmes or public depending VCs. Are publically funded VCs adequate at stimulating the VC market? If publically funded VC is required to develop VC markets, at which time would public help be useful and when could it become redundant? Depending on the composition of VC providers in different countries, one could expect varying risk profiles in investment behaviour and government structures to protect investors. In the case of Germany, BECKER/HELLMANN (2002) have analysed the clash of the WGF, the first German VC fund, determining that German norms on contracting and corporate governance provided insufficient investor protection, especially for the financing of early-stage, high-risk ventures. More research may be done in this direction to learn more about VCs and their role in pushing innovations especially in Europe with heterogeneous conditions in the different countries. This heterogeneity may be helpful for finding the most appropriate solutions.

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Appendix

Table A.1: Data Definitions and Sources

Variable	Description	Source
Early Stage Venture Capital in % of GDP Later Stage Venture Capital in % of GDP	Venture capital investment is defined as private equity raised for investment in companies; management buyouts, management buy-ins and venture purchase of quoted shares are excluded. Data are broken down into two investment stages: early stage (seed + start-up) and later Stage (expansion and replacement capital). The data are provided by the European Private Equity and Venture Capital Association (EVCA). The indicators are presented as a percentage of GDP (gross domestic product at market prices), which is defined in conformity with the European System of national and regional Accounts in the Community (ESA 95).	EUROSTAT
Research and Development Expenditures (R&D) in % of GDP	Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D expenditures include all expenditures for R&D performed within the business enterprise sector (BERD) on the national territory during a given period, regardless of the source of funds. R&D expenditure in BERD is shown as a percentage of GDP (R&D intensity).	EUOSTAT
Foreign Direct Investments (FDI) inflows in % of GDP	FDI net inflows as a percentage of gross domestic product Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.	World Development Indicators CD 2007
Stock Market Capitalization in % of GDP	Market capitalization of listed companies (% of GDP) Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles.	World Development Indicators CD 2007

Stock Turnover as a Percentage of the Average Market Capitalization	Turnover ratio is the total value of shares traded during the period divided by the average market capitalization for the period. Average market capitalization is calculated as the average of the end-of-period values for the current period and the previous period. Source: Standard & Poor's, Emerging Stock Markets Factbook and supplemental S&P data.	World Development CD 2007
Banking Sector (Loans/GDP)	To measure the weight of the banking sector I follow the approach of LEVINE/ZERVOS (1996). The variable banking sector equals the value of loans made by banks to private enterprises divided by GDP. Specifically, I divided line 22d by 99b from the IMF´s International Finanical Statistics	International Financial Statistics from the International Monetary Fund (Yearbook 2006)
Corporate Tax Rate in %	The basic combined central and sub-central (statutory) corporate income tax rate given by the adjusted central government rate plus the sub-central rate.	OECD Tax Database
Gross Domestic Product Growth (gdpgrowth) in %	GDP growth (annual %) Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2000 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Development Indicators CD 2007
Hightech Patent Applications to the EPO per Million Inhabitants	The data refers to the ratio of patent applications made directly to the European Patent Office (EPO) or via the Patent Cooperation Treaty and designating the EPO (Euro-PCT), in the field of high-technology patents per million inhabitants of a country. The definition of high-technology patents uses specific subclasses of the International Patent Classification (IPC) as defined in the trilateral statistical report of the EPO, JPO and USPTO.	EUROSTAT
Patent Application to the EPO per Million Inhabitants	Patent applications to the EPO by priority year at the national level. When a patent was invented by several inventors from different countries, the respective contributions of each country is taken into account. This is done in order to eliminate multiple counting of such patents. For example, a patent co-invented by 1 French, 1 American and 2 German residents will be counted as ¼th of a patent for France, ¼th for the USA and ½ a patent for Germany.	EUROSTAT

Human Resources in Science & Technology (HRST) as a Percentage of Active Persons in the Age Class of 25-64 Years	Data examines the existing labour market stocks of HRST at national and regional levels. Unless otherwise stated, data is collected in line with the recommendations laid down in The Manual on the Measurement of Human Resources devoted to S&T (Canberra Manual) issued in 1995 by the OECD. HRST are people who fulfil one or other of the following conditions: • Have successfully completed a tertiary level education or; • are not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required. The conditions of the above educational or occupational requirements are considered according to the internationally harmonised standards ISCED and ISCO. Eurostat does not include managers (ISCO 1) in the HRST population.	EUROSTAT
Annual Unit Labor Costs (Business Sector excl. Agriculture	Annual unit labour costs (ULCs) are calculated as the quotient of total labour costs and real output. For more information on the OECD System of Unit Labour Cost, see http://stats.oecd.org/mei/	OECD Statistics
Self-Employment Rates as a Percentage of Total Civilian Employment	Self-employment jobs re those jobs where the remuneration is directly dependent upon the profits (or the potential for profits) derived from the goods or services produced (where own consumption is considered to be part of profits). The incumbents make the operational decisions affecting the enterprise, or delegates such decisions while retaining responsibility for the welfare of the enterprise. In this context "enterprise" includes one-person operations.	OECD Factbook 2009: Economic, Environmental and Social Statis-tics
Interest Rates in %	Long term (in most cases 10 year) government bonds are the instrument whose yield is used as the representative 'interest rate' for each country. Generally the yield is calculated at the pre-tax level and before deductions for brokerage costs and commissions and is derived from the relationship between the present market value of the bond and that at maturity, taking into account also interest payments paid through to maturity.	OECD Statistics

Table A.2: Common Pool Unit Root Test Results / LEVIN, LIN, CHU Method
Sample: 1995 2005

Exogenous variables: Individual effects

User-specified lags: 1 and Bartlett kernel

Total (balanced) observations: 135

Cross-sections included: 15

Variable	**Statistic**	**Probability***
Venture Capital Early Stage	-2.34291	0.0096
Venture Capital Later Stage	-3.66284	0.0001
Hight Tech Patent Application	-6.45178	0.0000
Patent Application	5.10520	0.0000
Foreign Direct Investment Inflows	3.27781	0.0005
R&D Expenditures	3.74187	0.0001
Stock Market Capitalization	5.47631	0.0000
Stockturnover	3.53733	0.0002
GDP Growth	3.06084	0.0011
Corporate Tax Rate	-6.33028	0.0000
Interests Rate	-10.2301	0.0000
Banking Sector	1.64344	0.9499
HRST	-4.94271	0.0000
Selfemployment	3.82449	0.0001
Labor Costs	-1.12914	0.1294

*Probabilities are computed assuming asymptotic normality

Table A.3: Common Pool Unit Root Test Results / LEVIN, LIN, CHU Method (1st Differences)

Sample: 1995 2005

Exogenous variables: Individual effects

User-specified lags: 1 and Bartlett kernel

Total (balanced) observations: 112

Cross-sections included: 14

Variable	**Statistic**	**Probability***
Venture Capital Early Stage	-3.59301	0.0002
Venture Capital Later Stage	-2.18883	0.0143
Hight Tech Patent Application	-9.75054	0.0000
Patent Application	-0.86201	0.1943
Foreign Direct Investment Inflows	-4.39294	0.0000
R&D Expenditures	-4.59215	0.0000
Stock Market Capitalization	-4.01439	0.0000
Stockturnover	-3.52805	0.0002
GDP Growth	-5.84061	0.0000
Corporate Tax Rate	-5.34751	0.0000
Interests Rate	-5.25741	0.0000
Banking Sector	-3.67208	0.0001
HRST	-10.8963	0.0000
Selfemployment	-3.14969	0.0008
Labor Costs	-5.36502	0.0000

*Probabilities are computed assuming asymptotic normality

Figure A.1: Distribution of the Residuals (of the Regression Presented in Table 2)

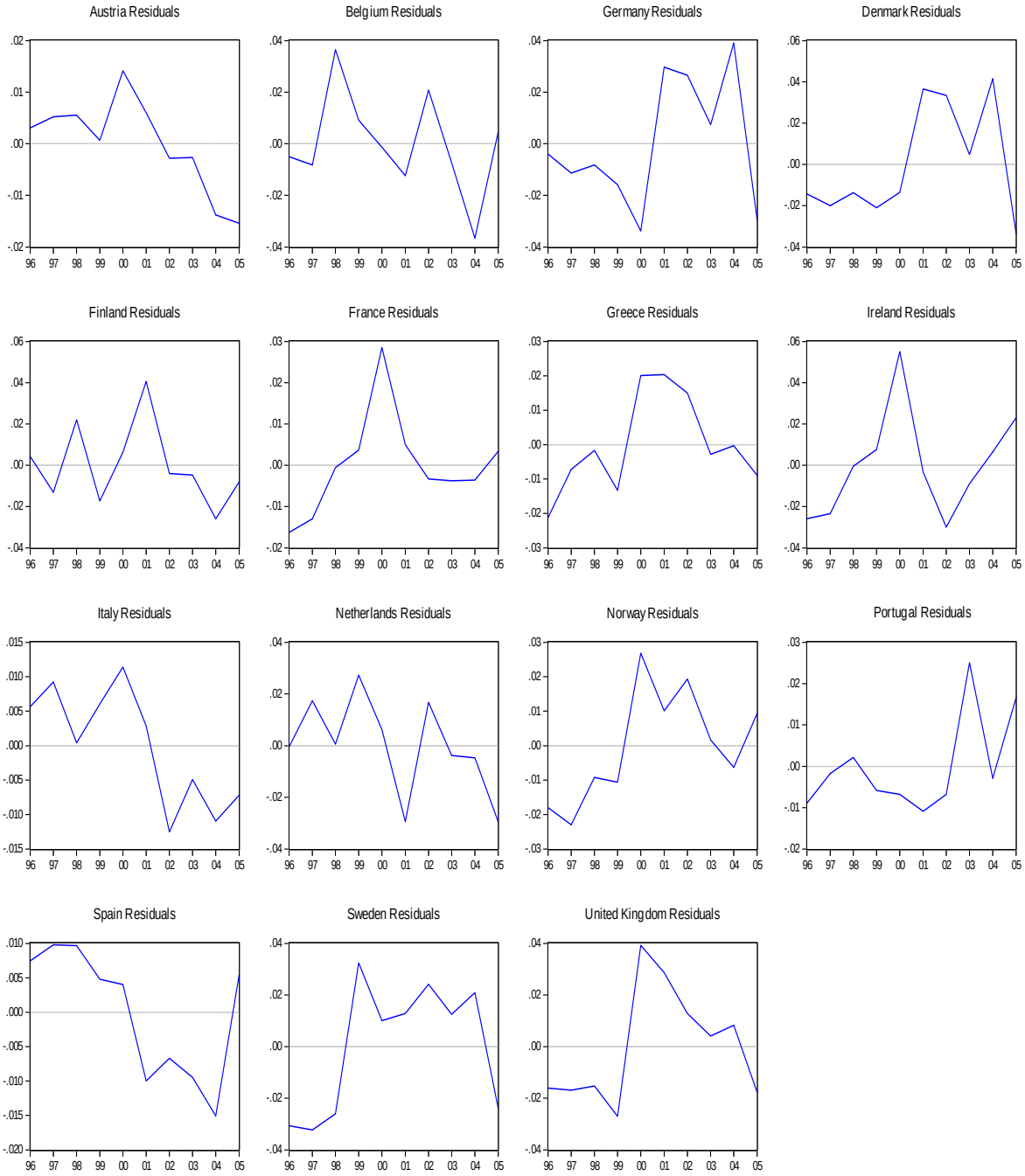
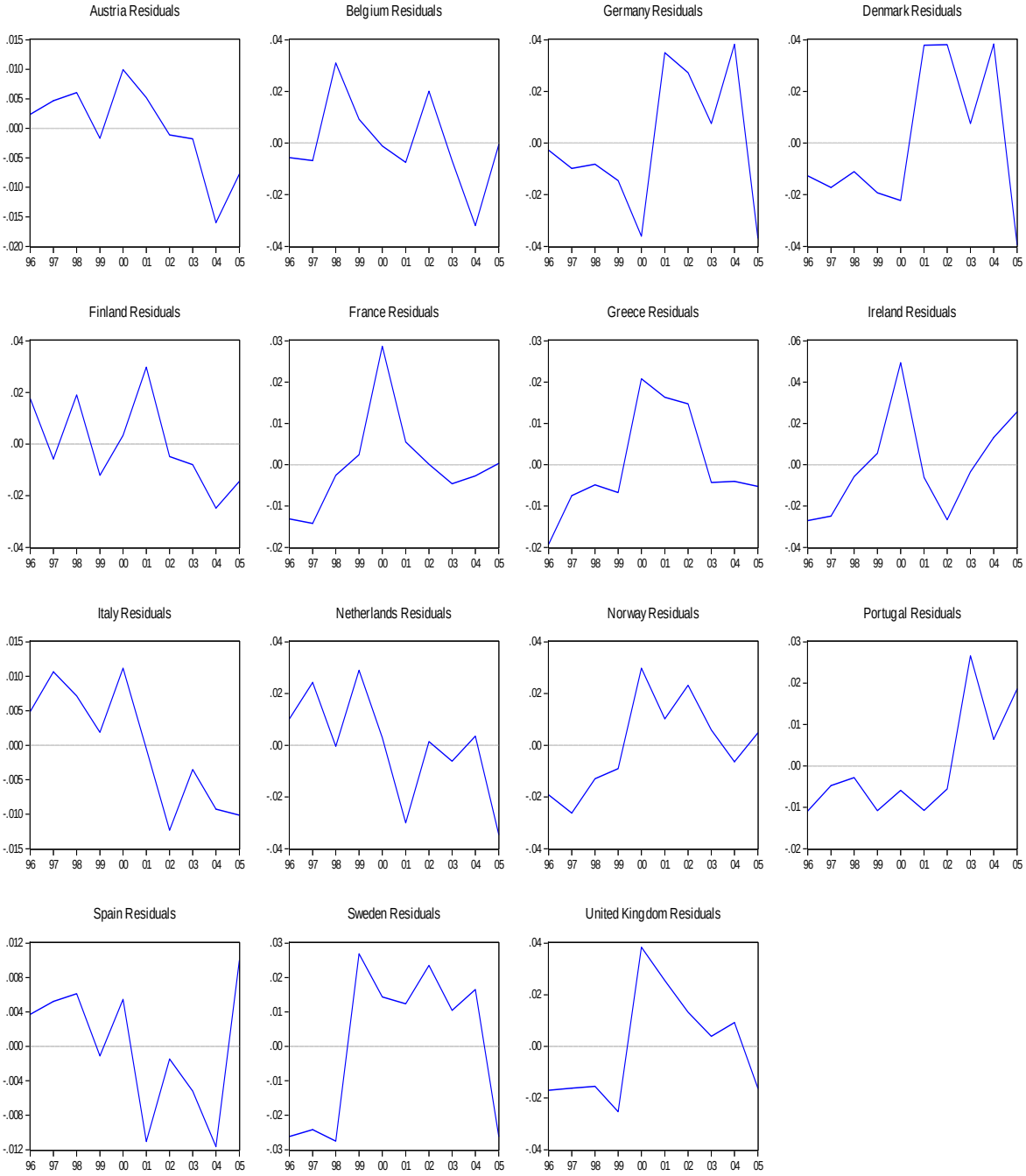


Figure A.2: Distribution of the Residuals (of the Regression Presented in Table 3)



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