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AUTHORS	Christian Schröder
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Christian Schröder (Germany)

Does the financial system affects early stage venture capital investments?

Abstract

Improving access to finance is one of the key factors for increasing the number of innovative business start-ups with high growth potential. In this context, venture capitalists (VCs) have successfully dealt with the problems of financing innovative projects.

The existing literature suggests that VC investments are strongly negatively affected by the characteristics of a bank-centered financial system and this negative influence could be one reason for different VC investment levels across the OECD countries.

This paper is the first analysis that includes the relative size of the banking sector to produce evidence regarding whether, as is suggested in the predominant theoretical financial literature, the negative impact of a more bank-based financial system can withstand the empirical evidence. The fundamental argument supplied by Black and Gilson argues that banks are not able to duplicate the implicit contract regarding future control as a market-based system can. Additionally, a more market-based system provides more lucrative exits via IPOs. Whereas markets are complements for VC, banks are substitutes. The panel analysis conducted for 16 OECD countries supports this view.

Keywords: early stage venture capital, risk capital, financial system, financing innovations.
JEL Classifications: G24.

Introduction

Improving access to finance is one of the key factors for increasing the number of innovative business start-ups with high growth potential. Thus, the financial environment plays a crucial role in promoting innovation. In the process of financing innovative firms, a notably large information asymmetry between the capital seeking innovator and the capital provider regarding the likelihood of success in realizing a new idea as a marketable product is possible; moral hazard is a significant obstacle. Therefore, the marketplace for financing the development of innovative ideas is similar to the "lemon" market modeled by Akerlof (Hall, 2002). Therefore, it is difficult for outside investors to make reliable assessments of the demand for products/services in highly immature markets. The threat of accelerated redundancy in rapidly changing technology-based sectors is strong. Investments frequently include research and development (R&D) costs and large expenditures in the marketing phases. Even if the product is promising, the entrepreneurial recipients of the investors' funds frequently lack the necessary managerial experience and, therefore, the ability to exploit the profits from the new technological innovation (Storey, 1995; Murray, 1998). Empirical studies provide results demonstrating that R&D expenditures will be determined by the available cash flow (e.g., Hall, 1992; Himmelberg and Petersen, 1994, Harhoff 1998). However, the effect differs between countries (Mulkey et al., 2001). Empirically, results focusing on new firms show that they are more financially constrained because they cannot use profits accumulated earlier to finance their R&D project (Moore, 1994; Petersen and Rajan, 1995; Berger and Udell, 2002; Carpenter and Petersen, 2002; Czarnitzki, 2006). Moreover, older firms could benefit from their established relationships with banks and, therefore, reduce problems of asymmetric information.

The success of the VCs depends not only on their experience and ability to find adequate enterprises but also on the economic environment of the country in which VCs invest. Jeng and Wells (2000), Romain and Van Pottelsberghe (2004a) and Schertler (2004, 2007) have examined which factors drive VC investments in OECD countries from a macroeconomic perspective, as the amount of VC invested (e.g., in Europe) differs enormously. While in Greece, early-stage VC investment was 0.001% of the gross domestic product (GDP), in the United Kingdom the amount was 0.218%.

The studies mentioned above do not include the role of the banking sector in explaining early-stage VC investments, but the existing VC literature suggests that VC investments are strongly negatively affected by the characteristics of a bank-centered financial system and this negative influence could be one reason for different VC investment levels. If so, one can argue that innovative start-ups in a more bank-based economy have disadvantages in raising capital compared to young entrepreneurs in market-based economies. However, this finding means that with a more bank-based financial system, the existing macroeconomic innovation potential of the whole econ-

omy is not optimally explored. As other studies have already shown, a vibrant stock market is an important positive factor to stimulate VC investments; this study demonstrates that the relative size of the banking system has a significant negative impact on early-stage VC investments. The following section presents, in a nutshell, some arguments for why VCs are successful in establishing young firms. Section 2 discusses how market-based and bank-based financial systems affect VC investments. This section arrives at the hypotheses that a market-based system fosters early-stage VC investment and that a bank-based system prevents early-stage VC investment. The panel analysis conducted for 16 OECD countries in section 3 supports this view. The last section concludes the paper.

1. The positive economic impact of venture capital

Frequently, VCs support the nascent entrepreneur not only with capital but also with advice and management expertise (Amit et al., 1998). VCs may sit on boards of directors to provide valuable governance and advisory support (Romain and Pottesberghe, 2004a). If performance objectives are not met, the VCs are normally in a powerful, contractually guaranteed position to reconsider the strategic objectives and the members of the management team. Hellman and Puri (2000) show that VCs replace the founder twice as often as non VC-backed firms. The capital seeker has to grant additional rights to the VCs. The VC usually receives convertible preferred stock. Like a debt contract, preferred stock requires the firm to make fixed payments to the shareholders, while the payments promised to preferred stockholders must be made before any common shareholder gets dividend payments and implemented such that the entrepreneur is not paying himself high dividends (Berlin, 1998). When a VC holds shares in a young firm, which means that the shares are not marketable to other investors, the venture capital investor avoids the free-rider problem. The investor is able to earn profits from its monitoring activities and relieve the information costs of moral hazard (Hubbard, 2008, p. 240). An additional aspect is that the VCs do 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 (Davila et al., 2003).

VC companies are typically specialized in one or a few industry sectors. 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 financing through venture capital. Gebhardt and Schmidt (2001) also conclude that VC promotes less than five percent of all potential projects. Actual data from national, European and US Private Equity and VC Associations confirm this ratio. As a result of such a stringent selection process, Kortum and Lerner (2000) find that increases in VC activity are associated with significant increases in patent rates in the US. Moreover, they show that VC investments are three times more effective in generating industrial innovation than are R&D expenditures. A similar study for Europe by Popov and Rosenboom (2009) finds that the impact of €1 of private equity[1] relative to €1 of industrial R&D expenditures is 2.6 times more effective in terms of producing innovations as measured by patents.

Hellmann and Puri (2000) find that a start-up company financed by VCs needs less time to bring a product to the market[2]. Empirical evidence shows that VC-backed firms grow much faster, at least in the beginning, than do non-VC-backed firms (Engel 2002, Engel and Keilbach, 2007). Berger and 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. Belke et al. (2004) reveal that VC spurs employment growth through the efficient screening of innovative start-ups.

In the existing literature, to explain the heterogeneity between countries with respect to (early-stage) VC investment volume, a distinction is made between the innovation capacities (Engel and Keilbach, 2007) and regulatory frameworks with particular regard to contractual relationships and hence corporate governance (Hege et al., 2009; Hellmann, 1998) but also for pension investment regulation (Gompers and Lerner, 1998), public support measures (Da Rin et al., 2006), institutions (Li and Zhara, 2011; Cherif and Gazdar, 2009; Bruton et al., 2005) and cultural aspects (Li and Zhara, 2011). There is scant empirical evidence regarding the role the financial system has in explaining the different amounts of early-stage VC investments within the OECD

[1] Beside VC, private equity also includes management buyins (MBI) and management buyouts (MBO). A management buyout (MBO) is a form of acquisition where a companys existing managers acquire an all or a large part of the company. An MBI raises the necessary finance, buys it, and becomes the companys 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 relatively stable cash flows, occurs when a manager or a management team from outside the company.

[2] 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.

countries. Black and Gilson (1998) are among the few who provide a remarkable contribution toward a theoretical basis for why VC in a bank-centered system provides less incentive for entrepreneurs to ask for VC and why less VC is provided on the supply side. The next section derives a hypothesis for why banks are, to some extent, substitutes for VCs and markets are complements for VCs. The following analysis adds a new puzzle piece to the existing empirical VC literature to augment the understanding of why early-stage VC investments in OECD countries differ enormously.

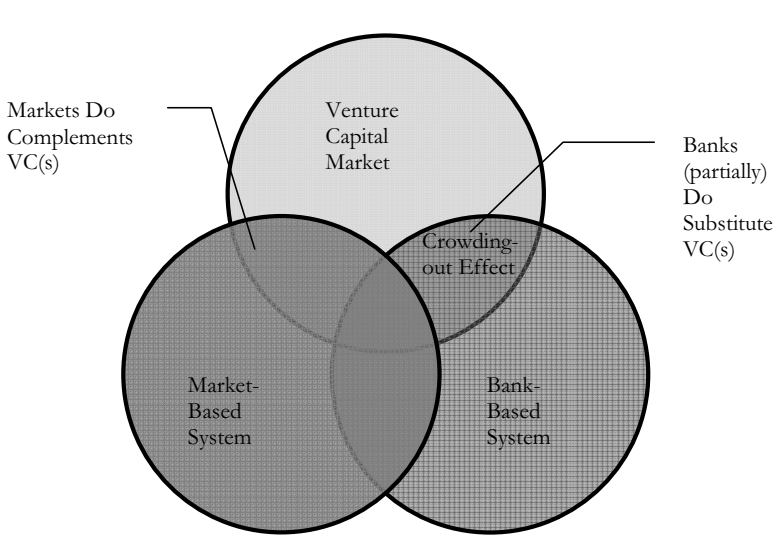
2. Venture capital investments and financial system

The traditional perfect market approach to the analysis of financial markets postulates that financial 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 and Miller (1958) that in such a world, the financial structure of a firm does not matter. Nevertheless, one can find many reasons in the literature for why the Modigliani and Miller theorem does not hold in the real world, especially in financing innovations (see e.g., Stoneman, 2001; Goodacre and Tonks, 1995). The role and the positive impact of VC in financing innovations are well-understood in the meantime. However there is a lack of empirical evidence for whether a bank-based financial system has a negative impact on early-stage VC investments. The development of the different financial systems (market- versus bank-orientated) "*reflects, at least in part, politics, history and path-dependent evolution rather than economic inevitability*" (Black and Gilson, 1998, p. 244), but the systems can be seen as given for each country.

A bank could crowd out early-stage VC in a bank-based system due to the similarities in their business models; although banks provide external capital and the VCs provide equity, they are, to some extent, substitutes rather than complements. Both provide capital and are able to generate economies of scale when monitoring firms. Stulz (2000) claims that banks are effective in financing innovative activities that require staged financing because banks can credibly commit to provide additional funding as the project develops (Beck and Levine, 2002). Nevertheless, the VC is obviously more specialized in financing innovative firms, and, through their equity stake and the associated level of control (as mentioned above), VCs are more effective than banks in financing innovations. Indeed, there are problems that banks particularly face when financing innovative projects. Due to fixed interest payments, banks would not participate in the high returns in the case of a successful outcome. Banks are, therefore, more concerned with the probability of failure when calculating the price of a loan. In this context, Stiglitz and Weiss (1981) analyze why credit rationing could result instead of a higher interest rate that 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 promising. Given asymmetrically 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 that clears the market because an increase in the interest rate induces 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 because of this moral hazard problem that equity rather than debt is considered to be the natural source of finance for firms investing in risky R&D projects (Kukuk and Stadler, 2001). Powerful banks use their close relationships with well-established firms to prevent the entrance of newcomers. Hence, established firms are protected, due to higher barriers to entry (Hellwig, 1991). The argument of Gerschenkron (1963) and Boot et al. (1993) that banks could mitigate the problem of moral hazard by building up long-run relationships with firms is not relevant in terms of innovative start-ups, which suffer particularly with regard to a lack of capital.

Audretsch and Lehmann (2004) empirically analyze whether debt and equity are complements or rather substitutes in financing young high-tech firms. Use of a dataset 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 exchange segments for fast-growing firms because venture capital and debt provided by banks are found to be substitutes rather than complements. This paper follows their approach and holds that banks and VCs are rivals in terms of their business models. Thus, the following empirical analysis includes the size of the banking sector in each country to investigate the first hypothesis.

Hypothesis 1: Bank-based systems prevent VC investments, as banks are, to some extent, substitutes.



Source: Own illustration.

Fig. 1. Venture capital embedded in the financial system

The aim of the VCs is to create value and to exit via a buyout or an initial public offering (IPO). An exit via an IPO is the most profitable exit option for the investor and the entrepreneur. This exit option could be one further reason why the VC industry has more weight in the US than in Europe. The stock market for new 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 2004 in comparison to 6.3% in Europe (EVCA, NVCA). A study by Hege et al. (2009, 2006) supports these results and shows that US venture capital firms show a significantly higher performance on average than their European counterparts both in terms of type of exit and rate of return. The study finds that US venture capitalists outperformed their market benchmark by a median annualized return of 63 percent, whereas their European counterparts underperformed their benchmark by 20 percent (Hege et al., 2006, p. 543). Black and Gilson point out the implicit contract between the outside investor who invests in a VC limited partnership. This implicit contract demands a successful exit strategy and a need to exhibit a better performance than other VCs and improve the reputation. This reputation has a signal effect on both the outside investor and potential portfolio companies. The outside investor recycles funds from less successful to more successful VCs.

The net present value of a portfolio firm, higher in a market-based economy, is higher ex ante, due the higher probability of a remunerative exit via an IPO. However, Black and Gilson also highlight the implicit contract over future control between the VCs and the entrepreneur, which is not imitable in a bank-based economy. An IPO ensures that the entrepreneur alienates the control rights he gives up as the VCs get on board. This incentive for the entrepreneur is much stronger in market-based financial system than in a bank-based system, as the core requirement for entrepreneurial activity is that an entrepreneur is free in his decision making:

"In short, the venture capital fund's special control rights end at the time of an IPO, leaving the fund with only the weaker control rights attendant to substantial stock ownership. Even this control will diminish over time as the venture capital fund reduces its remaining stock position. Control becomes vested in the entrepreneur, who often retains a controlling stock interest and, even if not, retains the usual broad discretion enjoyed by chief executives of companies without a controlling shareholder. The opportunity to acquire control through an IPO exit if the company is successful gives the entrepreneur a powerful incentive beyond the purely financial gain from the increased values of her shares in the firm. In effect, the prospect of an IPO exit gives the entrepreneur something of a call option on control, contingent on the firm's success. Contrast this outcome with what the entrepreneur receives when the venture capital provider exits through sale of the portfolio company to an established company. As in an IPO, the entrepreneur receives cash or the more liquid securities of a publicly traded acquirer. Control, however, passes to the acquirer, even if the entrepreneur remains in charge of day-to-day management. Thus, if an IPO exit is not available, the entrepreneur cannot be given the incentive of a call option on control exercisable in the event of success. Exit through an IPO is possible only

in the presence of a stock market; its role in the contract between the venture capitalists and the entrepreneur links the venture capital market and the stock market" (Black and Gilson, 1998, p. 261).

In this context, I state my second hypothesis.

Hypothesis 2: Market-based financial systems stimulate VC investments.

3. Empirical analysis

Empirical results from a macroeconomic perspective that explain the determinants of VC via panel analysis are relatively scarce. Jeng and Wells (2000), Schertler (2003, 2004), Romain and Van Pottelsberghe (2004a, 2004b) have done similar analysis but for different countries, time periods and, for the most part, using different variables. This analysis is the first which includes the size of the banking sector to determine whether a more bank-based financial system has a negative impact on early-stage VC investments.

3.1. Descriptive statistics. As mentioned above, early-stage VC capital investments made in Europe from 1995 to 2006 differ profoundly across European countries and with the US. In Sweden, early-stage VC investments in 2006 amount to upwards of 0.056 percent of GDP; in Greece, early-stage VC scarcely exists. I apply a GLS panel analysis to determine if the explanations formulated by the two hypotheses are, inter alia, responsible for such huge differences in the amount of early-stage risk capital in 15 European countries and the US. The analysis includes Austria, Belgium, Germany, Denmark, Finland, France, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States from 1995 to 2006. These countries have been selected because of their similar per capita income, available data and the fact that an analysis of this sample of countries has never been done before. In Eastern Europe, VC hardly played a role in the observed time period.

Table 1. Early VC investments in selected countries (in % of GDP)

TIME/GEO	Belgium	Denmark	Germany	Ireland	Greece	Spain	France	Italy	Netherlands
1995	0.003	0.002	0.005	0.002	0.003	0.004	0.002	0.005	0.024
1996	0.009	0.002	0.005	0.005	0.006	0.002	0.008	0.005	0.028
1997	0.014	0.002	0.01	0.002	0.004	0.004	0.007	0.007	0.045
1998	0.061	0.008	0.024	0.026	0.004	0.009	0.02	0.014	0.047
1999	0.089	0.019	0.05	0.045	0.015	0.016	0.038	0.013	0.089
2000	0.105	0.02	0.08	0.106	0.007	0.032	0.08	0.045	0.089
2001	0.038	0.085	0.055	0.032	0.021	0.016	0.038	0.023	0.041
2002	0.041	0.074	0.026	0.021	0.008	0.015	0.026	0.005	0.043
2003	0.014	0.05	0.014	0.024	0.007	0.007	0.025	0.004	0.007
2004	0.016	0.084	0.016	0.019	0.002	0.008	0.025	0.002	0.008
2005	0.02	0.052	0.014	0.022	0	0.013	0.027	0.002	0.002
2006	0.012	0.015	0.011	0.015	0.001	0.027	0.03	0.002	0.012
Austria	Portugal	Finland	Sweden	United Kingdom		Norway	United States	TIME/GEO	Austria
0	0.005	0.008	0.003	0.003		0.005	0.04	1995	0
0	0.001	0.009	0.003	0.004		0.005	0.05	1996	0
0.002	0.011	0.008	0.002	0.008		0.003	0.056	1997	0.002
0.006	0.012	0.053	0.011	0.014		0.009	0.076	1998	0.006
0.007	0.007	0.056	0.099	0.018		0.02	0.153	1999	0.007
0.029	0.024	0.103	0.085	0.101		0.057	0.268	2000	0.029
0.02	0.012	0.101	0.094	0.056		0.034	0.086	2001	0.02
0.013	0.007	0.069	0.093	0.035		0.036	0.038	2002	0.013
0.013	0.039	0.058	0.061	0.038		0.028	0.034	2003	0.013
0.007	0.024	0.026	0.08	0.046		0.015	0.036	2004	0.007
0.012	0.038	0.044	0.05	0.046		0.028	0.038	2005	0.012
0.003	0.009	0.027	0.056	0.218		0.013	0.041	2006	0.003

Source: Eurostat.

3.2. Variables[1]**.** The dependent variable is early-stage VC investments. The VC data are available from Eurostat[2]. 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 financial system, technological and growth opportunities, as well as the macroeconomic and entrepreneurial environments. Including the amount of VC investments in the later-stage (expansion and replacement

[1] For a more detailed data definition see Appendix.
[2] http://epp.eurostat.ec.europa.eu/tgm/web/table/description.jsp.

capital) also makes sense, considering the evolution of the VC markets. Evolution of a VC market means that 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-up expertise and confidence. Building a track record (e.g., building trust) is essential for convincing potential investors to commit money to a VCs (Schertler, 2002). Successful exits of portfolio firms enhance reputation and enable economies of scale and syndication with other VCs (Tykvova and Walz, 2006) thus allowing the VCs to invest in risky, early-stage investments. Zarutskie (2010) 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 such as the US, VC portfolios are on average larger and provide better options for diversification in early- and later-stage VC investments.

To measure the weight of the banking sector, I follow the approach of Levine and Zervos (1998). 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 (in % 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. An increase in interest rates should positively affect the demand from entrepreneurs for early-stage VC. Conversely, if the supply effect is higher – i.e., the VCs invest more when interest rates fall – the coefficient should be negative. I use the interest rates of ten year government bonds and expect a positive sign as Romain and Van Pottelsberghe (2004a) find in their analysis based on a panel data set of 16 OECD countries from 1990 to 2000. The expansion of an economy, measured as real GDP per capita growth, may affect the opportunities for firm growth and the survival rate of potential portfolio companies.

High-tech patent applications 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 the variable patent applications, using high-tech patent applications to the European Patent Office scaled by population assuming that the later delivers better results to explain early-stage VC investment because VCs are interested in investing in fast growing, high-tech sectors such as information and communication technologies, biotechnology and nanotechnology. R&D expenditures from the public and private sectors represent the creation of new knowledge. In the regression, high-tech patent applications and R&D expenditures represent the technological opportunities (TO) for each country.

I use self-employment rates as a percentage of total civilian employment to measure entrepreneurial activity or spirit. One has to handle this proxy with care because it includes all types of self- employment. Numerous entrepreneurs are not relevant in determining VC demand because of their less innovative business models. Moreover, becoming an entrepreneur can be triggered from the demand or the supply side of entrepreneurship. Being involved in an 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 negatively affect the supply side of VC. I also expect a similar negative effect for labor costs and employment protections for regular employment on early-stage VC investments. Annual unit labor costs (ULCs) are calculated as the ratio of total labor costs to real output.

3.3. Model. Following the model employed by Jeng and Wells (2000) and Romain and Van Pottelsberghe (2004a), I created a supply and a demand function for early-stage venture capital. I assume that the early-stage venture capital supply (equation (1)) is driven by the level of later-stage VC investments, the corporate tax rate, the relative size of stock market capitalization (relative to GDP), labor costs, the banking sector and GDP growth. Equation (2) shows the demand function. I expect later-stage VC, corporate tax rates, technical opportunities, stock market development, GDP growth, entrepreneurial activity and the growth of interest rates to influence the demand of early-stage VC. The variable technical opportunity is measured by high-tech patent applications and all R&D expenditures.

$$VC^{S}_{early_{it}} = a_0 + a_1 Returnpercentage + a_2 VC_{later_{it}} + a_3 Tax_{it} + a_4 Stockmarket_{it} + \\ + a_5 GDPGrowth_{it} + a_6 Laborconts_{it}\ , \tag{1}$$

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

where in the equilibrium

$$VC_{early\ it\ =} VC_{early\ it\ =} VC_{early\ it}\ funds \tag{3}$$

hence in the regression

$$VC_{early_{it}}\ funds = \gamma_0 + \gamma_1 VC_{later_{it}} + \gamma_2 Tax_{it} + \gamma_3 TO_{it} + \gamma_4 Stockmarket_{it} + \\ + \gamma_5 GDPGrowth_{it} + \gamma_6 Labor\ conts_{it} + \gamma_7 Banks_{it} + \\ + \gamma_8 Selfemployment_{it} + \gamma_9 Interest_{it} + \mu_t + \varepsilon_{it}. \tag{4}$$

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, *t* represents time and μ_t is a time specific unobserved fixed effect (see Wooldridge, 2002). The cross-section F-test and cross-section Chi-Square test do not reject the null hypothesis and indicate no country specific effect, unlike the F-Period test, which strongly rejects the null hypothesis. Therefore I use a one-way GLS model with time specific fixed effects. Taking first-differences (Δ) for each variable in equation (4) is necessary because different unit root tests indicate non-stationarity. Repeating the tests using first-differences variables leads to a strong rejection of the null hypotheses and hence indicates stationarity. Because the economic impacts of R&D expenditures and patent applications are not immediate, I include a one year time lag for each (-1).

$$\Delta\left(VC_{early_{it}}\ funds\right) = \gamma_0 + \gamma_1 \Delta\left(VC_{later_{it}}\right) + \gamma_2 \Delta\left(Tax_{it}\right) + \gamma_3 \Delta\left(TO_{it}\left(-1\right)\right) + \gamma_4 \Delta\left(Stockmarket_{it}\right) + \\ + \gamma_5 \Delta\left(GDPGrowth_{it}\right) + \gamma_6 \Delta\left(Labor\ conts_{it}\right) + \gamma_7 \Delta\left(Banks_{it}\right) + \\ + \gamma_8 \Delta\left(Selfemployment_{it}\right) + \gamma_9 \Delta\left(Interest_{it}\right) + \mu_t + \varepsilon_{it}. \tag{5}$$

Table 2. Descriptive statistics

	VC early stage[1]	VC later stage[1]	High-tech patents[2]	R&D expenditure[1]	Stock market cap[1]	Banking sector[4]
Mean	0.030411	0.087177	28.63113	1.868703	75.62451	0.923265
Median	0.018500	0.065000	23.60650	1.839000	66.58178	0.870028
Maximum	0.268000	0.737000	127.9930	4.250000	268.3272	1.922591
Minimum	0.000	0.000000	0.150000	0.433900	12.89032	0.306905
Std. dev.	0.035949	0.085254	27.17411	0.856612	44.82066	0.358782
Sum	5.839000	16.73800	5497.176	358.7910	14519.91	177.2669
Sum sq. dev.	0.246836	1.388248	141040.5	140.1528	383698.3	24.58639
Observations	192	192	192	192	192	192
Cross sections	16	16	16	16	16	16
	GDP growth[3]	Corporate tax rate[3]	Interests[3]	Labor costs[5]	Self-employment[7]	Strictness of employment protection
Mean	3.049316	33.87031	5.420858	0.597112	16.25625	2.215313
Median	2.869052	34.00000	4.973334	0.612636	13.10000	2.250000
Maximum	11.49460	56.80000	17.27000	0.726734	46.10000	4.330000
Minimum	-0.931428	12.50000	3.320833	0.338205	7.100000	0.210000
Std. dev.	1.835078	7.046597	1.899628	0.085724	8.935133	0.898967
Sum	585.4688	6503.100	1040.805	114.6455	3121.200	425.3400
Sum sq. dev.	643.1945	9484.016	689.2403	1.403575	15248.79	154.3552
Observations	192	192	192	192	192	192
Cross sections	16	16	16	16	16	16

Notes: [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 labor costs and real output; [6] % of active persons in the age class of 25-64 years; [7] % of total civilian employment.

3.4. Regression results. The results of the regressions are presented in the following table. Models 1 to 11 show the separate regression results for each variable. Models 12 and 13 include all of the variables that were statistically significant in models 1 to 11. I have separated R&D expenditures and high-tech patent applications, due high correlation.

Using the estimated generalized least squares panel method (EGLS) with time-specific fixed effects and a heterocsedasticity consistent covariance matrix estimator that provides the correct estimates of the coefficient covariances in the presence of heteroscedasticity, which is derived from White (1980), the estimation results support the two hypotheses derived in section 2. The most important estimation result is the negative impact of the banking sector on VC investments. Whether the banking sector is the sole explanatory variable (as in model 2) or is analyzed in conjunction with control variables (as in models 12 and 13), the corresponding coefficients from each model are significant. High-value loans made by banks to private enterprises seem to serve as substitutes for early-stage VC investments, which is similar to the results found by Audretsch and Lehmann. The incentive for a bank to provide a start-up capital to entrepreneurs such as Steve Jobs, Bill Gates or Mark Zuckerberg for a new business is quite weak. The risk of failure is high, and the bank's ability to participate in a successful deal is limited by the interest rate. A further reason for the negative coefficient could be an indirect effect of the structure of the VC market in Europe. One can observe an increasing number of bank-dependent VCs in Europe, but compared to independent VCs, they are less frequently involved in early-stage investments (Hirsch and Walz, 2006; Hellmann et al., 2008)[1]. Stock market capitalization, as a proxy for a market-based financial system, is positively associated with early-stage VC investments. The coefficients from each model that includes the market capitalization of listed companies are highly significant. This result conforms to Hypothesis 2 and the extant empirical results, which show that vibrant stock markets are important because of the greater chance of a lucrative exit strategy for VCs through an IPO.

Moreover, the average effort of the entrepreneur is a result of the implicit contract regarding future ownership in a market-based system is greater than in a more bank-based system. This empirical result supports the strand of the financial literature that postulates that a market-based financial system is more conducive to financial innovations, assuming that VCs are better at selecting and promoting young and innovative entrepreneurs. An increase in the ten-year interest rate is associated with an increase in VC investment levels. This finding supports the former empirical result that the demand effect is clearly stronger than the supply-side effect.

The panel analysis also supports the view that later-stage VC is essentially a precondition for early-stage VC, and path dependence is highly relevant. The adjusted R-squared of 0.5 is the highest of all of the models with one regressor.

For early-stage investors, a trade sale to a later-stage investor is the most common exit strategy. These two investment stages are complements and round out the VC business model. The track record of a VC company is crucial for attracting outside investors and entrepreneurs. Technological and innovation capacities, namely, R&D expenditures, are highly significant. Patents signal the innovation capacity of an entrepreneur to VCs and ensure legal certainty. Hence patent applications, particularly those of high-tech firms, are the first step in attracting VCs. One primary explanation of how R&D expenditures spur the demand of VC is that researchers working in firms and public entities entrain their acquired knowledge and use it to found their own start-ups. The results indicate that the self-employment rate, which reflects the entrepreneurial climate and institutional support and the accompanying low entrance barriers, matters. It is worth noting that the results for the self-employment rate are heterogeneous. While in model 6 the coefficient is significant, this effect disappears in models 12 and 13, which have fewer observations.

One can argue that employment protections increase entrance barriers. However, the estimation results do not support this view. Due to the nature of high-tech investments involving highly qualified staff, employment protections do not play a significant role because the risk of unemployment is negatively correlated with the level of education. Concerning labor costs, I concur with Schertler's argument that the capital ratio of potential portfolio firms is relatively high and explains why the coefficient of the variable is positive and significant.

The result concerning the GDP growth rate agrees with the results of Jeng and Wells, who find no impact, while Gompers and Lerner for the US and Romain, respectively, and Van Pottlesberghe for the OECD countries do observe such an impact. The coefficient of the corporate tax rate is negative but not significant. The results are robust in terms of significance with time lags of 1 for all variables. Additionally, in estimates of the models using panel GLS without period fixed effects the same variables are significant.

[1] Hellman et al. (2008) simply show that the probability is greater that independent VCs will invest in early-stage deals compared to bank dependent VCs. In absolute terms, early-stage VC deals or investments can increase with an increasing number of bank-depending VCs.

Conclusions

Young firms with between 10 and 49 employees face specific challenges in obtaining capital to realize their innovative ideas as marketable goods and services, due to moral hazard, adverse selection and lack of collateral, particularly in Europe. VC is an appropriate solution to alleviate these problems. However, in terms of relative volume, the differences in the amounts of early-stage VC investment attracted by various European countries is enormous.

This is the first analysis that includes the relative size of the banking sector to produce evidence regarding whether, as is suggested in the predominant theoretical financial literature, the negative impact of a more bank-based financial system can withstand the empirical evidence and thus provide an additional piece of the financial puzzle concerning VC. The fundamental argument supplied by Black and Gilson argues that banks are not able to duplicate the implicit contract regarding future control as a market-based system can. Additionally, a more market-based system provides more lucrative exits via IPOs. Whereas stock markets are complements for VC, banks are substitutes. The results in this paper support this view.

It is beyond question that the factors that stimulate early-stage VC are manifold and interdependent. However, the policy conclusion might be that bank-based economies, such as that of Germany, which has a broad knowledge base, need other policy instruments to stimulate VC (e.g., instruments similar to those employed in the US). Policy makers in more bank-based financial systems must focus their attention on instruments that are able to compensate for the lack of finance available to high-potential firms. To clear the way, public policy should enhance the incentives for banks to enter the early-stage VC market to loosen the financial constraints on innovative entrepreneurs seeking capital.

A further step to expand early-stage VC investment would be to support a single European stock market, which would enable an investment exit via IPO and achieve higher returns for VC investments in Europe. A European stock market segment, such as the AIM in the UK, where investors receive essential tax benefits if they invest in companies traded on AIM, is achievable. Moreover, the variables under consideration interact, and potential efficiency gains can be realized by improved networking between the institutions within the national innovation system, e.g., universities, green field investors (e.g., alumni) and VC companies. An interesting subject to be investigated in terms of stimulating early-stage venture capital markets is to examine the role of government programs or publicly dependent VCs. Are publicly funded VCs capable of stimulating the VC market? If publicly funded VC is required to develop VC markets, at what time would public assistance 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 behavior and government structures to protect investors. More research may be done on this subject. A comprehensive analysis of the policy instruments used in European countries in the past may be useful to find the best approach. Such an analysis should include cost-benefit comparisons and take relevant country specific terms into account. Europe, with its heterogeneous conditions between its different countries, may be helpful for finding the most appropriate solutions.

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Appendix

Table A1. Data definitions and sources

Variable	Description	Source
Early-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 divided 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
Later-stage venture capital in % of GDP		
Research and development expenditures (R&D) in % of GDP	Research and experimental development (R&D) comprise creative work undertaken on a systematic basis 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) in 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).	Eurostat
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

Table A1 (cont.). Data definitions and sources

Variable	Description	Source
Banking sector (Loans/GDP)	To measure the weight of the banking sector, I follow the approach of Levine and Zervos (1998). 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	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 the 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. GDP is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Development Indicators CD 2007
High-tech 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
Annual unit labor costs (business sector excl. agriculture)	Annual unit labor costs (ULCs) are calculated as the quotient of total labor costs and real output. For more information on the OECD System of Unit Labor Cost, see http://stats.oecd.org/mei/.	OECD statistics
Self-employment rates as a percentage of total civilian employment	Self-employment jobs are those jobs in which 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 delegate 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 %	The yield of long term (in most cases 10 year) government bonds are used as the representative ‘interest rate’ for each country. Generally, the yield is calculated at the pre-tax level before deductions for brokerage costs and commissions and is derived from the relationship between the present market value of the bond and the value at maturity, also taking into account interest payments paid through maturity.	OECD statistics
Strictness of employment protection (regular employment)	The OECD indicators of employment protection measure the procedures and costs involved in dismissing individuals or groups of workers and the procedures involved in hiring workers on fixed-term or temporary work agency contracts.	OECD statistics

Table 3. VC early stage (endogenous variable)

GLS model	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Exogenous variable													0.1728***	0.156***
Δ VC later stage	0.1723*** (17.49)											(19.13)	(17.36)	
Δ Banking sector		-0.0084*** (-2.19)										-0.010** (-2.03)	-0.013*** (-2.37)	
Δ Stockmarketcap			0.0001*** (3.29)									(5.34)	0.0001*** (10.94)	0.0002***
Δ Interests				0.0037*** (8.37)								(11.50)	0.0032*** (12.82)	
Δ R&Dexpenditure (-1)					0.037*** (6.09)								0.037*** (7.87)	
Δ Self-employment						0.002*** (5.44)						0.0001 (0.23)	0.0001 (0.23)	-0.0001 (-0.10)
Δ High-tech patents (-1)							0.00047*** (12.38)					(6.19)	0.0002***	
Δ GDP growth								-0.0002 (-0.52)						
Δ Corporate tax rate									0.0021 (-0.63)					
Δ Strictness of employment protection										0.009 (1.48)				
Δ Laborcosts											0.095****			
Constant 0.0009		0.0011***	0.0025***	0.0016***	0.0039***	0.0023***	0.0021***	0.0022***	0.0021***	0.0021***	0.0013***	0.0012*		
F-statistics	38.15***	5.99***	6.56***	14.85***	5.63***	6.43***	5.49***	5.71***	5.89***	8.81***	7.47***	115.30***	71.74***	
Durbin-Watson stat	1.9413	1.9525	1.9501	2.004	1.989	2.231	1.989	1.988	1.979	2.014	2.048	1.930	2.014	
Adjusted R-squared	0.700	0.287	0.259	0.499	0.225	0.255	0.220	0.228	0.235	0.232	0.289	0.920	0.889	
Observations	176	176	176	176	176	176	176	176	176	176	176	160	160	
Period fixed dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: ***, **, * denote significance at the 1, 5 and 10 per cent level, respectively. Absolute *t*-values are given under the coefficients.