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The Impact of Venture Capital on Business Dynamics in Europe and the United States

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Abstract: The venture capital industry is seen to be favourable for an economy's business dynamics. Using a panel of 23 countries over 2004 – 2012, the thesis explores the linkage of venture capital with firm births, employment in newly born firms and survival rates. The aggregate approach allows considering the implicit multiplier effect of VC. The thesis proposes a reconsideration of venture capital for economic policy. Venture capital appears not to drive firm births and the effect on employment is rather weak. However, a strong linkage with firm survival in a country is found. This indicates that venture capital is rather important for late stage finance and the abatement of failures of young firms than for finance in the early stage and business creation.

Key words: Venture capital, business dynamics, multiplier effect, firm birth, employment, firm survival

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1 INTRODUCTION

Stories of outstanding entrepreneurial success, of which Google and Apple are only two of the most popular examples (NVCA, 2014), have directed the attention of economists and policymakers around the world towards venture capital as an instrument for economic policy. The creation and promotion of a large risk capital market has since long been identified as a policy instrument for employment generation (EU Commission, 1998) and is nowadays part of the EUROPE 2020 strategy of the European Commission (EU Commission, 2010). To name a concrete example, the European Investment Bank provides through intermediaries venture capital to small and medium-sized firms in the industries of life science or information and communication technology (EIB, 2015).

1.1 RESEARCH PROBLEM

Although there is no unique common definition of venture capital, it is widely seen as a form of private equity (OECD, 2014). Providers of venture capital, or venture capitalists, are financial intermediaries that invest mainly on behalf of institutional financiers into young and innovative firms with a highly risky business model (Hellmann, 2000). These firms have otherwise only limited or no access to the capital market (Sahlman, 1990). The supply of venture capital (henceforth VC) to this kind of firms becomes possible through the specialization of the venture capitalists in the technology industries they invest. Moreover, venture capitalists exploit various techniques to limit the consequences of information asymmetries. Most importantly, VC thereby overcomes problems of adverse selection and moral hazard. In the course of these measures, they create access to finance for young firms and generate positive externalities. An example of such externalities are knowledge spillovers that occur through the interaction of venture capitalists, portfolio firms and other agents involved. The beneficial effects work at the early stages of a young firm from its foundation up to later development and the expansion of the young firm. Consequently, innovation and economic activity is enhanced and VC is beneficial to the economy as a whole.

Assessing the effects of VC helps determining whether VC is an efficient instrument for the economic policy or a waste of effort. Predominantly in the United States, VC investment spawned a number of globally leading companies in highly innovative industries. Microsoft, Intel and Medtronic could be added to the two examples mentioned already above. For policymakers the success of these companies is one of the most popular arguments to endorse the promotion of the venture capital industry in the economic policy agenda. However, it is by far not sufficient to capture the effect of VC in the entirety. Historically, the development of the industry in Europe has been much slower than in the United States, which led to a gap in the relative significance of VC regarding both economic regions (Bottazzi & Da Rin, 2002, Hege,

Palomino, Schwienbacher, 2009, OECD, 2013). As a percentage of GDP, VC reaches not even 0.04 % in most European countries, whereas it represents 0.17 % of the US-American GDP in 2013 (OECD, 2013).[1]

1.2 AIM AND SCOPE

The aim of the present thesis is to analyse whether the VC industry has a positive effect on the generation of economic activity, its enhancement and the abatement of failure of entrepreneurial projects. Theoretical models show that VC matters for business creation and innovation based growth (Keuschnigg, 2004, Michelacci and Suarez, 2004). Previous empirical research suggests that VC has a positive effect on macroeconomic outcomes, such as aggregate income, firm births, employment and patents (e.g. Kortum, & Lerner, 2000, Samila, & Sorenson, 2010, 2011, Popov and Roosenboom, 2013). Only a single aspect of the effects of VC is analysed by most of the previous research. Furthermore, a large part of the scientific work in the field deals with the effects of VC at the firm level, in particularly the linkage of VC and innovation. Thereby, the macroeconomic dimension cannot be captured.

This study aims to expand the empirical body of research on VC by taking into account the *multiplier* effect of VC and analyses the linkage of VC with a more ample scope than previous studies.[2] It is hence possible to identify which of the effects of VC is most pronounced and to derive the main function of VC in the economy. In order to gain these insights, the effects of VC on three different measures, that is firm births, employment in newly born firms and survival rate of young firms, are analysed and compared. The thesis aims to contribute to the literature by answering the question: How does the VC industry affect business dynamics? Does it help the most for the generation of economic activity, for its enhancement or for the abatement of failures of young firms? In order to assess these questions, the thesis applies a cross-country approach and considers measures of the size of the VC industry in the United States, 21 European countries and the aggregated Baltic countries during 2004 -2012. Not in scope of the study is the quality of a VC industry, as represented for example by the incorporated human capital in the VC funds or by the quality of the network between funds.

1.3 DISPOSITION

Part 2 presents previous research dealing with the linkage of VC with economic outcomes, such as innovation, economic growth, and productivity and, most relevant to the present study, business dynamics and employment. A theoretical description of how VC works, as already shortly outlined above, is given

[1] The crisis of 2008 led to a sharp decrease of VC investment globally. Whereas the United States' VC industry quickly recovered, Europe's VC industry had not reached pre-crisis investment by the year 2013 (OECD, 2014).
[2] By *multiplier* effect, the effect of VC on the economy as a whole is meant. Thus, not only the direct effect of VC, e. g. the provision of capital to founders and thereby on the rate of business creation in an economy, but also the indirect effect through networking and spill-overs also on other agents involved in the investment process is taken into account. The concept of the *multiplier* effect is described more in detail in part 3.

more in detail in part 3. Moreover, this part derives the expected effects on business dynamics. The data used for the empirical analysis is explained in part 4 and the empirical methodology is developed in part 5. Part 6 provides the results of the regressions and the checks of robustness. Finally, part 7 concludes by discussing the results.

2 PREVIOUS RESEARCH ON THE ROLE OF VC FOR THE ECONOMY

Investment in the form of VC has been the subject in many studies of the recent economic literature and analysed from a variety of angles. Da Rin, Hellmann and Puri (2011) present in their review different strands of recent academic work dealing with VC. One of the largest strands in the field discusses the question why there is VC and reaches back to the widely seen basic motivation for VC (e.g. Amit, Brander & Zott, 1998, Gompers & Lerner, 2001). Capital provisions to young firms in the form of VC represents an instrument of financial intermediation that can overcome the problems of information asymmetry arising in particular in highly innovative industries (Magri, 2009). Although founders of young firms in these industries are mostly equipped by valuable technological expertise, they often lack entrepreneurial experience, which amplifies the problems of adverse selection and moral hazard (Keuschnigg, 2004). Screening of investment candidates, syndication with other capital providers, monitoring of portfolio firms, staging of capital and the use of specialized compensation systems are some of the important mechanisms by which the market of VC is functioning (Sahlman, 1990). Kaplan and Strömberg, (2001) give an overview of empirical research dealing with contracting, screening and monitoring. The theoretical background of VC and the reasons why VC adds value to firms and to the economy as a whole is discussed more in detail in part 3. The remainder of this chapter concentrates on research that shows how these fundamental principles are related to aggregate outcomes and assesses the macroeconomic dimension of VC empirically.

It has already been mentioned that the share of VC in the GDP of Europe's economies is much lower than in the United States. Before summarising the literature dealing with the effects of VC, the variety of determinants of VC supply brought forward in the literature is introduced shortly. Jeng and Wells (2000) put forward a broad range of aspects: labour market rigidities, regulations of financial reporting and governmental contributions to the VC market. Initial public offerings (IPOs) as the "most attractive mechanism" (Jeng & Wells, 2000, p. 254) of liquidation after a VC investment, have a large impact especially on the supply of late stage VC, whereas regulatory policies concerning capital influence the provision of VC in general. Some scholars argue that the taxation of capital gains is an important factor for the size of the VC (e.g. Gompers & Lerner, 1999). On the demand side, higher output and larger expenditures for R&D lead to more fundraising and to a larger supply of VC. In addition, special interest is given to the importance of private pension funds in a country and their restrictiveness in the investment selection, as pension funds are often the most important capital sources for VC funds (Jeng & Wells, 2000, Gompers & Lerner, 1999, 2001). Schertler (2007) focusses on another aspect that affects the amount of

VC supply. According to her, innovation and knowledge capital are key factors in the evolution of VC industries. As a complement to the supply of VC in general, governmental suppliers of VC have attracted the interest of numerous researchers (for instance, see Brander, Egan, & Hellmann, 2010, Bulevska, 2014, Leleux & Surlemont, 2003).

What impact VC has at large, for instance, on innovation, economic growth, and employment has been discussed in the literature predominantly from an empirical point of view and to a smaller extent theoretically (for reviews see Parhankangas, 2012 or Wright, Gilligan, and Amess, 2009). From a theoretical perspective, Michelacci and Suarez (2004) and Keuschnigg (2004) show how the VC industry affects the economy as a whole. As these two studies and other theoretical analyses are used in the theoretical framework described in part 3, the next section proceeds with the review of empirical research. As there is a quite extensive amount of studies looking on the linkage of VC and innovation the review of existing literature in the field starts with an overview of the research in this field. Before turning to the core interest of the present study, the linkage between VC and business dynamics, an outline of adjacent research related to VC and its various macroeconomic effects on a firm, industry and country level is given.

2.1 VC AND INNOVATION

One of the most discussed fields of interest is the relationship of VC and innovation. Table 1 gives a certainly incomplete but as far as possible representative overview of empirical research on this linkage.

2.1.1 Firm level

At the firm level, there is some controversy about the direction of causality between VC and innovation. The question addressed by some studies is whether it only works from VC to innovation ("VC first" hypothesis as suggested by Arqué-Castells, 2012, Bertoni, Croce & D'Adda, 2010, Dushnitsky & Lenox, 2005). Others argue that it works exclusively in the other way ("innovation first" hypothesis as suggested by Caselli, Gatti & Perrini, 2009, Engel & Keilbach, 2007, Peneder, 2010, Schertler, 2007) or in both ways (Baum & Silvermann, 2004, Chemmanur, Krishnan & Nandy, 2011). Several studies examine patenting as an indicator of innovation. Bertoni et al. (2010) conduct a firm level analysis and show that patenting activity increases with VC investment. This result remains significant when they control for other factors such as existing patent stock, technological or economic education as well as for accounting variables. The conclusion is that VC promotes the activity in R&D at the firm level. Highlighting another function of VC, some studies stress out that VC helps in the commercialization of innovation rather than in its generation (Baum & Silverman, 2004, Engel & Keilbach, 2007). Similarly, Caselli et al. (2009) support the view, that VC increase sales by improving management and commercial processes. Beside of patenting, total factor productivity (TFP) or product novelty (e.g. Peneder, 2010) are used as an indicator of innovation. Chemmanur et al. (2011) concentrate solely on the effect of VC on TFP growth. In their study on the firm level, they find a positive effect of VC on the efficiency of firms. They discuss how this positive influence

is achieved. It could be, that venture capitalist choose the most efficient firms by their screening activity or that the provided post-investment services by the venture capitalists, such as monitoring boosts the efficiency of the backed companies. After testing these two hypotheses by various methods, they argue that both mechanisms are at work.

2.1.2 Industry and country level

Another strand of the literature examines the linkage at a macroeconomic level, considering industries or countries as the unit of observation. In a study by Kortum and Lerner (2000) about US manufacturing industries, the authors assume an innovation production function with the factors VC and business R&D expenditures. They show that more investment in the form of VC leads to a higher innovation output as measured by patents. In comparison to R&D, the impact of a dollar invested through VC is more than three times larger. The stronger positive effect of VC persists when they apply a different way of measuring VC investment by regressing on the number of firms that received VC. Furthermore, they check for technological shifts, as a factor that could affect both patenting as well as VC and R&D. Using instrumental variables, the positive impact of VC remains robust. Building on this study, Hirukawa and Ueda (2008) extend the analysis in terms of years covered and in terms of dependent variables considered. Besides patents, they estimate the effect of VC on the growth of TFP and labour productivity. For the former, the effect is positive but not significant, whereas for the latter, they find a positive and significant effect. For the result on labour productivity, they clarify that it is via factor substitution, that VC comes into effect. Concerning patents, they provide evidence that VC matters for the patenting activity, as Kortum and Lerner (2000) suggested before.

Similarly, Tang and Chyi (2008) endorse this view and support the hypothesis of a positive effect on TFP. According to them, knowledge spillovers via venture capitalists are responsible for the higher TFP rates. In a later study, Hirukawa and Ueda (2011) further explore the linkage by focussing on the direction of the linkage between VC and innovation. Using again a panel of industry specific data on VC, patenting and TFP in the United States, they promote the "Innovation-first hypothesis" (Hirukawa, & Ueda, 2011, p. 21), given that they find stronger support for the direction of innovation as represented by TFP influencing VC and not the other way round. Concerning patenting, the direction remains unclear. However, the linkage between VC and patents is, in contradiction to their earlier results, negative. Popov and Roosenboom (2012) conduct for the first time a cross-country cross-industry study of the effect of VC on innovation. In their approach, they consider manufacturing industries in 21 European countries from 1991 to 2005. As previous approaches, they use the number of patents as the dependent variable, VC and R&D expenditures as independent variables. Conformingly with studies at the firm level (e.g. Engel & Keilbach, 2007), they support the view that VC rather helps in professionalizing the commercial activities of young and innovative firms instead of generating innovative output. Hence, they only find a weak linkage between VC and innovation as measured by patents.

Only little research has been conducted that deals with the linkage of VC and innovation at a country level. Schertler (2007) shows that more knowledge capital in a country attracts and promotes VC investments. Thus, she supports rather the "innovation first" hypothesis. In contrast to this finding, the study by Samila and Sorenson (2010) stress out, that both public funds and private venture capital contribute in a complementary way to the innovative output in a country. After checking for endogeneity, this finding remains robust. Faria and Barbosa (2014) specify a dynamic panel and use patent applications to measure innovation. In their model, they regress the ratio of patent applications to the country's GDP on the lagged ratio, VC and some control variables, such as the R&D expenditures to GDP ratio. Another particularity of the study is that they distinguish between VC in early stages from VC in a later stage of the young firm. Their conclusion is that especially later stage VC has an impact on innovation, by promoting its commercialization instead of its generation.

TABLE 1: PREVIOUS EMPIRICAL LITERATURE ON VC AND INNOVATION

Author(s)	***Coverage***	***Main findings***
Arqué-Castells (2012)	Sample of firms in Spain, 2003 – 2005	• VC investment leads to an increase in patenting • The effect is robust when accounting for the selection of innovative firms by venture capitalists
Baum and Silverman (2004)	Sample of biotechnology firms in Canada, 1991 – 2000	• Venture capitalists pick "winners" with promising technological concept (patents increase the propensity to receive VC) • VC does not lead to a higher patenting activity • Added value by venture capitalists leads to professionalization in the commercial development
Bertoni,et al. (2010)	Sample of *new technology based* firms in Italy, 1994 – 2003	• VC leads to a higher activity of patenting • Controlling for other determinants changes the results only slightly
Caselli et al. (2009)	Sample of firms in Italy, 1995 - 2004	• No positive impact of VC on innovation • Improvements from VC are achieved rather in the managerial practice and in the commercial operations of the VC backed firms
Chemmanur et al. (2011)	Firm level in the United States, 1972 – 2000	Higher efficiency in terms of TFP of VC backed firms due to selection (pre-investment) and to value adding services (post-investment)
Dushnitsky and Lenox (2005)	Sample of US public firms, 1969 – 1999	Corporate VC has a positive impact on patenting output
Engel and Keilbach (2007)	Firm level in Germany, 1995 – 1998	• Venture capitalists tend to select firms that hold patents • patenting does not differ after VC provision in comparison to firms without VC backing
Faria and Barbosa (2014)	Country level in Europe, 2000 – 2009	• Later stage VC has positive impact on patent applications • Check for endogeneity → *VC first*
Hirukawa and Ueda (2008)	Industry level in the United States, 1968 – 2001	• VC has a stronger effect on patents than R&D • No support for an effect of VC on TFP • positive effect on labour productivity via factor substitutions
Hirukawa and Ueda (2011)	Industry level in the United States, 1968 – 2001	• Negative impact of VC on patents • Negative impact of VC on TFP growth • Linkage of TFP and VC argues for *Innovation first*
Kortum and Lerner (2000)	Industry level in the United States, 1965 - 1992	• VC has a larger impact on innovation as measured by patent grants than R&D expenditure • Results hold after check for causality with instrumental variables
Peneder (2010)	Sample of Austrian firms, 1996 - 2005	• VC has a positive impact on innovation but is not causal for higher innovative output • The positive effect stems from the firm selection by the venture capitalist
Popov and Roosenboom (2012)	Industry level in Europe, 1991 – 2005	• VC accounts for 9.7 % of industrial innovation as measured by patent grants, but the effect is not significant • Lower potency of VC versus R&D in Europe than in the US
Samila and Sorenson (2010)	Regional level in the United States, 1993 - 2002	VC fosters innovation by acting as an "catalyst for commercialization"
Schertler (2007)	Country level in Europe, 1991 – 2001	• "Knowledge capital" has a positive impact on VC • *Innovation first*
Tang and Chyi (2008)	Industry level in Taiwan, 1984 – 2002	• VC has a positive impact on aggregate total productivity growth • Effect through knowledge spillovers via venture capitalists

2.2 VC, ECONOMIC GROWTH AND PRODUCTIVITY

Besides the linkage of VC and innovative output, scholars have analysed other measures for the effects of VC. Table 2 summarizes studies that look on the effects of private equity in general or VC in particular on various macroeconomic outcomes.

2.2.1 Firm level

At the firm level, the empirical research compares mainly the growth of sales in VC backed firms to firms without VC backing. Several studies support the hypothesis that VC has a positive impact on sales (Alemany & Martí, 2005, Casselli et al., 2009, Peneder, 2010, Puri & Zarutskie, 2012). However Bürgel, Fier, Licht and Murray (2000) find that this effect is not significant. In contrast to the findings on innovative output, Peneder (2010) supports the view that VC is causal for the growth of sales after checking for robustness with a two-stage matching procedure. Alemany and Martí (2005) look on a broader range of economic impacts of VC in a sample of Spanish firms and apply two estimation techniques. On the one hand side they match VC-backed companies with a control group and on the other hand side they conduct a panel estimation. Besides sales growth, they analyse the gross margin, total and intangible assets and find that VC has a positive effect on all these economic measures.

The study by Puri and Zarutskie (2012) differs from the aforementioned studies, as the authors do not use a sample of firms but the universe of employer firms in the United States. They conduct an analysis of VC-backed firms with a matched and a non-matched sample. From both cases, the evidence suggests that VC has a positive impact on sales growth. However, VC-backed firms are in average less profitable than the matched and the non-matched group of firms, which indicates that the large scale of the investee matters more than profitability for venture capitalists. Bottazzi and Da Rin (2002) describe the development of VC in Europe and contrast it to the evolution of VC in the United States, where VC has a much longer history. From the analysis of a sample of European VC backed firms, they conclude that VC does not necessarily lead to a better performance of the firms backed when they are offered publicly or in terms of measures recorded after the IPO. According to them, one of the reasons for this finding is that the European VC industry is still young and therefore lacks experience. However, in their approach, they do not take into account spillover effects and positive externalities on other companies, which could lead to an underestimation of the impact of VC.

2.2.2 Country level

Only a few studies looked on the macroeconomic impact of VC in terms of aggregate measures at the country level. A report published by the European Venture Capital Association (EVCA, 2013) summarizes methodological approaches of research on private equity in Europe and gives an overview of statistics and analyses that look on the impact of private equity on innovation, productivity and competitiveness in

Europe. The conclusion of the report states a positive impact of private equity on these macroeconomic outcomes. Only one study examining the effect of VC on economic growth could be found. Zhang, Zhang, Wuang and Huang (2013) assume an economic growth model with endogenized VC. They conduct a time series analysis of the Israeli VC industry, which is one of the largest and most successful worldwide (Zhang et al., 2013). They show that there is a significant positive effect of VC both when there is technological progress as represented by R&D expenditures included in the model and when it is not. The contribution of VC amounts to about 3 % in terms of its elasticity to GDP.

TABLE 2: PREVIOUS EMPIRICAL LITERATURE ON PRIVATE EQUITY, VC AND VARIOUS ECONOMIC MEASURES

Author(s)	***Coverage***	***Main findings***
Alemany and Martí (2005)	Sample of firms in Spain, 1989 - 1998	Sales, gross margin, total assets, intangible assets and corporate taxes grow faster in VC backed firms
Bottazzi and Da Rin (2002)	Sample of European firms, 1996 - 2000	• VC has no impact on the time-to-listing of a firm, but increases the amount of funds raised at IPO • After IPO, VC backed companies do not generate more sales and more employment than companies that are not backed by VC
Caselli et al. (2009)	Sample of firms in Italy, 1995 - 2004	Positive impact of VC on the growth of sales
Bürgel et al. (2000)	Sample of High-tech firms in Germany and the UK, 1997	No significant effect of VC on sales growth
EVCA (2013)	Meta-study based on research mostly on Europe, up to 2012	• Private equity leads to higher productivity in the investee firms and thus to a raise in the competitiveness of the company as a whole • Private equity promotes new business and job creation
Peneder (2010)	Sample of Austrian firms, 1996 - 2005	Sales grow faster in VC backed firms
Puri and Zarutskie (2012)	Firm level in the United States, 1981 - 2005	• VC-backed firms show a faster growth of sales and of payrolls than equivalent firms without VC • However, VC-backed firms are less profitable
Zhang et al. (2013)	Country study of Israel, 1995 - 2008	• Time series analysis of an economic growth model with endogenized VC • Positive and significant impact of VC on economic growth

2.3 VC AND BUSINESS DYNAMICS

Finally, and most interestingly for the present study, some scholars analysed in which way business dynamics and employment growth are linked to VC.

2.3.1 Firm level

Some studies look on the effect of VC at the firm level. Considering Germany and the United Kingdom, Bürgel et al. (2000) do not support the view, that involvement of VC in start-ups leads to a significant increase in employment. In contrast to this, Audretsch and Lehmann (2004) observe significant employment growth in VC-backed firms during the year before initial public offering (IPO) and during the year after IPO when comparing to a control group of firms without VC backing. As already mentioned above for other measures, Alemany and Martí (2005) also show for employment that VC has a positive significant effect and Engel and Keilbach (2007) corroborate the hypothesis that receiving VC leads to a significantly higher employment growth rate. In regard to US-American evidence, Puri and Zarutskie (2012) show in their study that VC-backed firms not only show generally a higher average employment than a peer group of non-VC-backed firms, but also exhibit higher growth rates of employment. According to them, the ratio of VC backed firms amounts to only 0.05 to 0.16 % of the total firm population whereas the share of the employment in VC-backed companies is at least 2.7 % and reaches up to 7.3 % during the period in question. The study by Davila, Foster and Gupta (2003) underpins this finding by describing employment patterns of VC backed firms. They point out that receiving VC has a signalling effect and increases employment growth after the investment. Regarding firm survival, when comparing failure rates of firms that received VC to firms that did not receive VC, Puri and Zarutskie (2012) find that the former showed a much lower rate than the later (34.1 % versus 66.3 % as of 2005).

Empirical research looking on firm survival in the context of VC is particularly scarce. The study by Manigart, Byens and Van Hyve (2002) is the only example found that addresses this topic explicitly. They argue that it is rather the type of the investor that matters for the survival rate of young firms than the the fact that a firm receives VC. The rationale behind this is that the objective of investors differs by its type. The aim of private-sector VC funds is to maximize the returns of the investment at the liquidation of the investee, whereas governmental investors aim for a maximization of the social payoff, e.g. in terms of employment generation or innovation output. Thus, they find that firms receiving capital from two of the large governmental VC provider in Belgium have the highest chances to survive.

2.3.2 Industry and country level

Zucker, Darby and Brewer (1998) were one of the earliest to conduct an empirical study that examines the impact of regional existence of VC on the birth of firms in the Biotech industry in comparison to other factors. With inclusion of human capital in the regression, they find a negative impact of VC. Belke, Fehn

and Foster-McGregor (2003) conduct a study that examines the effect of VC on employment. By controlling for seasonal effects via GDP and for a number of institutional variables of the labour market, the authors find a significant and positive impact of VC investment on employment. In order to exclude endogeneity they use the second lag of the dependent variable as an instrument for VC.

Furthermore, the creation of new firms were analysed in the studies by Samila and Sorenson (2010, 2011) and by Popov and Roosenboom (2013). The former look on the effects of the number of companies backed and the amounts of VC invested at the regional level in the US. The results of the panel analysis shows that VC has a positive significant effect on the creation of new firms, on employment and on the aggregate income (Samila & Sorenson, 2011). More specifically, the main mechanism behind this effect of VC is that VC fosters the development of entrepreneurial activity and is a "catalyst for commercialization" (Samila & Sorenson, 2010, p. 1358). One drawback of this approach is that the entire effect of VC cannot be captured when looking on regional levels. There might be considerable interregional effects, as, for instance a firm birth in a region fosters the employment or the aggregate income in another region. Furthermore, to address the question of the causality direction, they use instrumental variables. Thereby, VC supply continues to be positive and significant for the variables of firm births and aggregate income. The study of Popov and Roosenboom (2013) supports these findings after examining a country industry panel of 21 European countries by a number of different estimation approaches. Depending on the method applied, they conclude that the ratio of new firms in an industry increases between 3 % and 19 % when the amount of investment is raised by the factor of 7.2, which represents the difference between the set of industries where VC investment is the strongest and the weakest.

TABLE 3: PREVIOUS EMPIRICAL LITERATURE ON VC, EMPLOYMENT AND BUSINESS DYNAMICS

Author(s)	*Coverage*	*Main findings*
Achleitner and Kloeckner (2005)	Europe, 1997 - -2004	Employment in VC backed companies increases by 30.5 % per year between 1997 and 2004
Alemany and Martí (2005)	Sample of firms in Spain, 1989 – 1998	VC has a positive impact on employment in VC backed firms
Audretsch and Lehmann (2004)	Sample of firms in Germany, 1997 – 2002	Growth in terms of employment is higher in VC backed firms
Belke et al. (2003)	Country level (20 OECD countries), 1986 – 1999	VC has a positive and significant impact on employment
Bürgel et al. (2000)	Sample of High-tech firms in Germany and the UK, 1997	No significant effect of VC on employment growth
Davila et al. (2003)	Sample of Silicon Valley based Start-Ups, 1994 – 2000	VC has a positive and significant effect on employment at the firm level
Engel and Keilbach (2007)	Firm level in Germany, 1995 – 1998	Employment of VC backed companies grows faster than employment of companies that are not backed by VC
Manigart, et al. (2002)	Sample of Belgian firms, 1987 – 1997	• VC backed companies do not exhibit a higher survival rate • The question is not whether young firms are backed by VC, but by which type pf VC (governmental, private)
Peneder (2010)	Sample of firms in Austria, 1996 – 2005	VC has a positive impact on employment in VC backed firms
Popov and Roosenboom (2013)	Country industry level in Europe, 1998 – 2008	• VC has a positive and significant impact on firm births • Results hold after check for endogeneity via instrumental variables
Puri and Zarutskie (2012)	Firm level in the United States, 1981 – 2005	• Failure rate of VC backed firms is only half as high as the failure rate of firms without VC backing • Average employment is higher and grows faster for VC-backed firms in comparison to firms without VC-backing
Samila and Sorenson (2010)	Regional level in the United States, 1993 – 2002	VC has a positive impact on firm births by acting as an "catalyst for commercialization"
Samila and Sorenson (2011)	Regional level in the United States, 1993 – 2002	VC has a positive impact on firm births, aggregate income and employment
Zucker et al. (1998)	Industry level in regions in the United States, 1976 – 1989	• In contrast to human capital, VC is a negatively significant factor for the development of new firms • When it is not accounted for human capital, the coefficient of VC is positive

There are some shortcomings of the previous research presented. For instance, by the studies at the firm level, the multiplier effect of VC, that is further explored in part 3, are not captured. In addition, in terms of business dynamics, only a few aspects have been analysed so far at an aggregate level, the most prominent of which is the aspect of employment creation. Business creation in terms of newly born firms has only been addressed by a few and firm survival by only one study. Finally, the inclusion of the *multiplier* effect and the effect of VC on a more ample range of measures has only attracted little attention so far. The present study aims to contribute to the closure of this gap by using the most recent data available for 21 European countries, the Baltic region and the United States.

3 THEORETICAL FRAMEWORK

The theoretical framework is divided into three steps. In part 3.1, the fundamental principles of the functions of VC at a microeconomic level are presented synoptically and expanded to the macroeconomic dimension. Part 3.2 shows the theoretical expectations of the effects of VC by means of the measures of business dynamics used in the present study. In order to illustrate the functioning, the main derivations of two formal models dealing with VC are described briefly in part 3.3.

3.1 THEORETICAL PRINCIPLES OF VC

The theoretical motivation for VC at the microeconomic level relies on the phenomena that Akerlof (1970) described and that is known as *lemon problem* in economic science. The problem arises when the information between two economic agents is asymmetric. Consequently, adverse selection and moral hazard paralyse or even disable the market mechanism. In the context of firm financing and capital provision one of the major contributions was made by authors arguing that financial intermediation could solve this problem. For instance, the study by Sahlman (1990) examines the mechanisms of VC that help to overcome the problem of adverse selection and moral hazard. Especially young firms in innovative industries such as biotechnology or information technology face the challenge of not having access to bank loans due to the uncertainty and specificity of their entrepreneurial projects (Amit et al., 1998). Investment by VC funds can thus provide capital to young firms as the specialization of the fund to certain industries and the monitoring of the investee reduces the information gap that causes the limitations of access to capital (for a literature review see Gompers & Lerner, 2001). In line with this, Kaplan and Strömberg (2001) stress out that the mitigation of the principal-agent problem bases on three pillars: specificity of the VC contracts, screening and monitoring.

A by-product of VC investment is a networking, spillover, disciplinary and incentivizing effect, which is beneficiary to both the individual investee firm as well as to connected firms. Avnimelch and Teubal (2006) provide probably one of the most comprehensive study on this topic. Taking the Israeli VC industry as an example, they describe the indirect or often called *multiplier* effects of VC. For instance, they depict interactive and collective learning as one example among other effects of networking via the VC market. Thus, the whole economy benefits from this effect. As VC funds not only provide capital but also value added services to the backed companies, managerial and technological expertise is exchanged between the backed companies and the venture capitalists. In an analogous way, contacts to business partners help the young firms to develop their operations and to grow. The qualification process for funding and the provision of capital in subsequent investment rounds is often designed as a competition, which represents an incentive for the founders. Depending on the size of the VC industry in a country, this *multiplier* effect of VC on the economy is expected to be more or less pronounced.

3.2 RATIONALES OF THE IMPACT ON BUSINESS DYNAMICS

The following section provides the theoretical rationales for the expectation of a positive influence of VC on business dynamics. For the study, the effects of VC on three different areas of influence in terms of business dynamics are considered: Firstly, the rationale of the impact of VC on the generation of economic activity is based on firm births as a measure of business dynamics. Secondly, the rationale for the impact of VC on the enhancement of economic activity of young firms is based on employment in newly born firms. Thirdly, the rationale for the impact of VC on the promotion of the success of young firms is based on firm survival rates.

3.2.1 Generation of economic activity: Firm births

Central to the rationale why VC leads to more business creation is the argument that VC provides financing to young and innovative firms that would otherwise not eligible for external funding, e.g. from banks. Generally, business creation depends on the development of the financial sector in a country (Aghion, Fally & Scarpetta, 2007, Rajan & Zingales, 1998) and finance is a crucial matter for innovative enterprises (Canepa & Stoneman, 2008, Magri, 2009). Greenwood and Jovanovic (1990) formally showed this in a more general context. Their model describes how financial intermediation and economic growth stimulate each other. Based on this, the direct effect of VC on the generation of economic activity in the form of firm births can be described.

The reasons why VC helps to increase firm births rely predominantly on the view that VC provides capital to young firms that would not be able to receive capital from banks or on the stock market. The superiority of VC over finance from banks and other institutions of capital provision manifests in its complementary virtues for financing of young innovative firms. Financial intermediation as the fundamental principle of VC becomes particularly effective in the case of VC because of its ability to select worthy projects and to promote the innovative character of the business it finances. VC is a form of financial intermediation with the particularity of being equipped with managerial and technological expertise. This enables venture capitalist to select valuable projects and to support the development of newly born innovative firms. During the very early phase, VC helps to realize ideas and to found a firm by providing capital and expertise (Audretsch & Lehmann 2004, Popov & Roosenboom, 2013). The selection of promising ideas and the provision of funding by venture capitalists is an instrument to overcome the difficulties that young firms face when they seek for external capital. Furthermore, entrepreneurs may only be willing to found a firm when they know that there will also be funding provided at a later stage of the firm (Popov & Roosenboom, 2013). VC is able to provide this funding by subsequent investments into the firm, when the initial targets are met. Thus, the supply of VC is expected to matter for the creation of new enterprises in that sense.

Depending on the entrepreneurial and technological experience of the founder, the provision of so-called value added services by the venture capitalists contributes to the success of the enterprise to a more or less

crucial part (Hellmann, 2000). For instance, they help to build a network, create contacts with suppliers and clients and give strategic advices (Sahlman, 1990, Bottazzi & Da Rin, 2002). According to the theoretical model by Michelacci and Suarez (2004), the character of VC as *informed capital* leverages the creation of business, as

> *"the stock market promotes growth through business creation rather than savings. Specifically, [they] assume that the innovations introduced by successful young firms generate technological spillovers on future firms and, thus, feed the rate of technological progress. Technological progress, in turn, raises the profitability of new businesses and the value of informed capital, so it encourages firms to go public early. But, then, the rate of business creation rises, spillovers boost technological progress, and a virtuous circle is completed."* (Michelacci and Suarez, 2004, p 461)

This captures already another, possibly even more ample rationale for VC being beneficial for firm births, the indirect or *multiplier* mechanism of VC. Firstly, the success of a newly born firm may encourage other not-yet entrepreneurs or employees of VC backed firms to start a business (Samila & Sorenson, 2011, Popov & Roosenboom, 2013). Secondly, the newly born firm itself creates a demand for new enterprises. Innovative ideas can create a new value chain or way of doing business in an industry, which could also imply the creation of new firms in the supplier's business. Direct and indirect effect of VC lead to hypothesis 1:

> *Venture capital has a positive effect on firm births.*

3.2.2 Enhancement of economic activity in young firms: Employment in newly born firms

Concerning the enhancement of economic activity of young firms, the mechanism of the effect is analogous to the effect on then generation of economic activity. Again, a direct and an indirect effect can be distinguished. VC acts as a solution for the financing problem of young and innovative firms (Rajan & Zingales, 1998). As the birth of a firm entails employment as well as when the firm is growing, the theoretical linkage between VC and employment is straightforward. The growth of young firms in terms of employment may depend particularly on the supply of capital. Financial markets and VC supply in particular represents thus as a complement to the labour market as it engenders the resolution of a "bottleneck for job creation" (Belke et al., 2003, p. 28). In addition to this direct effect, VC enhances economic activity of young firms and increases employment in the economy via equivalent indirect and *multiplier* mechanisms as described above for firm births. Direct and indirect effect of VC lead to hypothesis 2:

> *Venture capital has a positive effect on employment in newly born firms.*

3.2.3 Abatement of failure of young firms: Firm survival

Firm survival rates at a macroeconomic level are enhanced primarily through the value added services by venture capitalists (Sapienza, Manigart & Vermeir, 1996). The larger a VC industry in a country is the more young firms can benefit from the services provided by venture capitalists. Depending on the contract design between venture capital fund and investee, value added services of the VC provider comprehend the intervention or the advice in the actual operations of the young firm. Due to the expertise of venture capitalists in the area of finance, venture capitalist can provide financial consulting or serve with their network of financiers (Fried & Hisrich, 1995, Sahlman, 1990). According to Sapienza et al. (1996), operational and financial advice is the most valuable contribution for young firms. Furthermore, the network of venture capitalist can help in several ways: to find employees with specific technological expertise, to mediate for the occupation of management positions and to establish contacts to suppliers, service providers and costumer. Another important aspect is the discipline that a VC requires from the investee and that this pays-off not only for the venture capitalist but also for the young firm. Fried and Hisrich (1995) name two ways by which discipline bears a beneficial outcome of the relationship between the young firm and the venture capitalist. On the one hand side, venture capitalist require the managers of the young firm to stick to the goals formulated in the business plan and on the other hand side to exert pressure on the managers via the threat of replacement of the management and the staged provision of capital (Fried & Hisrich, 1995, Bottazzi & Da Rin, 2002). Finally, receiving VC acts as a signal for reputation towards potential personnel, suppliers, customers and investors (Manigart et al., 2002, Megginson & Weiss, 1991). Considering spillover and *multiplier* effect, the mechanisms not only affect the VC backed firms directly but also other young firms that are in contact with these firms. Altogether, the size of the VC industry and the degree of its professionalization in a country is expected to abate the failure of entrepreneurial projects and raise the survival rates of young firms. This leads to hypothesis 3:

Venture capital has a positive effect on survival rates.

3.3 MODELS ABOUT VC AND BUSINESS DYNAMICS

The following section briefly outlines the propositions of the models developed by Keuschnigg (2004) and by Michelacci and Suarez (2004). Otherwise, only few theoretical studies (for a summary see Parhankangas, 2012) have modelled the macroeconomic implications of VC explicitly. Certainly, given the particularities of the VC industry and mechanisms by which they effect business creation, employment and business dynamics, a single model can hardly capture all aspects. Nevertheless, the two models help to explain the theoretical expectations of the macroeconomic effects of the VC industry.

The overlapping generations model by Keuschnigg (2004) deals with the macroeconomic effect of VC. It explains how the particularities of VC, i.e. the provision of value added services and managerial advices to young firms by venture capitalist, lead to innovation driven growth in the economy as a whole. The

failure probability of entrepreneurial projects, which is due to the lack of commercial expertise of the firm founders, can be reduced by the involvement of a commercially experienced venture capitalist. Venture capitalists assist the founders and encourage the growth and the professionalization of the entrepreneurial project. A further aspect of the model is the inclusion of knowledge spillovers among firms. The combination of technological expertise from the founder and commercial knowledge from the venture capitalist lead then to innovation driven growth.

Michelacci and Suarez (2004) present a model where "informed capital" (p. 459), as provided by venture capitalists stimulates business dynamics. The scarcity of this capital determines the ratio of new business created in an economy. For the determination of the steady state rate of business creation, they assume a matching function $h(e,m)$ between capital searching entrepreneurs e and capital offering *monitors* m (Michelacci & Suarez, 2004, p. 462). The *monitors* provide venture capital, value added services and require a share of the enterprise. Given this, the Poisson rate $q(\theta)$ by which an entrepreneur finds an investor that provides him *informed capital* can be derived. This rate depends negatively on the scarcity of *informed capital*, as represented by the index $\theta = e/m$. Rewriting $q(\theta)$, they get

$$q(\theta) = \frac{h(e,m)}{e} = h\left(1, \frac{1}{\theta}\right)$$

The steady state rate of business creation depends on the stock of free *informed capital* m_0 and the rate at which the capital is reused $\theta q(\theta)$. Furthermore, λ, the rate at which a firm discovers that it is successful is part of the equation and can be replace by the total stock of *informed capital*, M. They derive the steady state rate of business creation n (for the derivation of this equation see appendix A.1). [3]

$$n = \theta q(\theta) \lambda m_0 = \frac{\theta q(\theta) \lambda M}{\lambda + [1 + (\lambda\gamma/\mu)(1-f)]\theta q(\theta)}$$

Thus the steady state rate of business creation increases with the stock of *informed capital*, M, as predicted by the theoretical considerations above.

4 DATA

To assess the research question, a panel was constructed covering 21 European countries, the Baltic countries as an aggregate and the United States from a number of publicly accessible sources, as summarized by the Table 15 in appendix A.2. The period covered by the panel is 2004 – 2012. These nine years were chosen due to data availability and comparability constraints. As the sources use different

[3] As presented in the model by Michelacci and Suarez (2004, p. 465), the remaining parameters are described as follows: λ represents the Poisson rate at which a firm discovers whether it is successful, γ the probability that a firm is successful, μ the Poisson rate at which a successful firm matures and f the probability that a non-mature successful firm goes public.

industry definitions, the most consistent way to match the figures on VC, business dynamics and for the control variables is to use the country level. Therefore, the observation unit is the country year. A convenience of this approach is that it allows capturing the multiplier effect of VC within an economy as described in part 3.2. Although it is not possible to distinguish between the direct effect of VC and the indirect effect, this is an advantage of the aggregate data as the *multiplier* effect is implicitly included. In order to make the data comparable and to conduct the estimations a number of data transformation had to be done which this section describes.

4.1 MEASURES OF THE SIZE OF THE VC INDUSTRY

Most of the previous literature uses firm level data from proprietary databases, such as the Thomson VentureXpert Database (e.g. Popov, & Roosenboom, 2013, Samila, & Sorenson, 2011). The present study relies on publicly accessible sources for the data on VC. The data about VC stems from the National Venture Capital Organization (NVCA) for the United States and from the European Venture Capital Organization (EVCA) for Europe. The amount of VC and the number of companies backed by VC funds per country and year represent the size of the countries' VC industries. EVCA distinguishes three stages at which VC is invested: Seed, start-up and late stage venture. NVCA reports four stages of investment: Seed, early stage, expansion stage and late stage. For the study the aggregate of the respective subdivisions are used as they are in both cases reported as venture capital and coincide when comparing the definitions of the stages (OECD, 2014).

Although the data are comparable, it has to be noted that there are some differences in the definitions and the methods of data collection between EVCA and NVCA (EVCA, 2015, NVCA, 2014). In the European case, the figures are published by EVCA as industry statistics, which means that the investment made by funds in the country are counted and not the investment a country received from any fund in Europe. Thus, the figures were multiplied by a coefficient of the domestic investment in order to exclude outgoing cross-country investment that will not affect the business dynamics within the country. The inflow of VC into a country was not taken into account, because no information on the destinations of cross-country investment was available.[4] In average 79.46 % of the amount invested was invested domestically, as well as 81.45 % of the companies backed by VC were firms within a country.[5] As a further transformation, all data on European VC was extrapolated, given that EVCA estimates their coverage of the total market in their survey for 2013 at 90 % (EVCA, 2014).[6] The data on the United States from NVCA covers only the domestic market, which means that no modification of the data was necessary (NVCA, 2015). Regarding the question to what extent, the NVCA covers the total market, no estimation could be found. Thus, it was

[4] As it is described in part 6.2, it has been checked whether this influences the results.
[5] The figures are own calculation based on the data from EVCA.
[6] The figures of European VC were divided by 0.9 in order to extrapolate them to the total market. The extrapolation factor is according to the estimated coverage of the VC data collected by EVCA.

assumed, that the total market is reflected by the reported data. Finally, the invested VC amounts were deflated to constant 2005 prices and the European VC amounts were transformed to US Dollar.

4.2 MEASURES OF BUSINESS DYNAMICS

Concerning business dynamics, firm births and employment in the population of newly born firm were considered.[7] The present study uses data on business dynamics from Eurostat (2015a). The industry aggregate consists here of the NACE codes B-N with exclusion of holding companies (sector code K642).[8] Thus, the *business economy*, as published by Eurostat, is included. Not included is the sector of agriculture as well as sectors that are typically provided publicly, such as education and health services. For the United States, business dynamics statistics from the United States Census Bureau are used (USCB, 2015). The USCB uses the Standard Industrial Classification (SIC) system. As the data was otherwise coherent, the numbers were only modified by excluding the agricultural sector. For the purpose of the study, only employer enterprises, that is firms with at least one employee, were considered in order to exclude holding companies and as this measure is seen to be best comparable internationally (Eurostat & OECD, 2007). A birth of an employer enterprise is defined as an enterprise birth that has at least one employee in the year of birth.[9] In addition, the population of firm births comprises enterprises that existed already and employed for the first time at least one person in the year of the observation. Survival rates of newly born firms after three years were retrieved from Eurostat and the rates were calculated in the case of the United States following the Eurostat methodology. The reason for the analysis of the three-year survival rate will further be explored in the results. One drawback of this data is that also typically non-innovative firms and thus firms that are usually not in the investment scope of VC are included in the data on business dynamics (e.g. hairdressers). As these kinds of business are included in the data throughout all the countries, no bias should be expected from this. Despite some far-reaching harmonisation throughout European data on business dynamics, there are some differences between the countries in the collection of the data and the definition of a firm birth as counted in the statistics and as considered by national legislations (Eurostat & OECD, 2007, Eurostat, 2015b). Most importantly, the differences derive from inconsistencies in the need of legal registration of an enterprise across the countries. For instance, the thresholds to register a business depend in some countires on the turnover of the enterprise and the treatment of self-employment differ across countries. As the data delivered by Eurostat are, qualitatively and in terms of comparability, the best data available, the study uses this data on business dynamics.

[7] The notion *employment* in the parts 5, 6 and 7 refer to the employment in the population of newly born firms.
[8] NACE refers to the *Statistical classification of economic activities in the European Community*.
[9] The notion *firm births* in the parts 5, 6 and 7 refers to this definition.

4.3 CONTROL VARIABLES

Further components of the panel are gross fixed capital formation and patent applications. Both data sets are retrieved from the World Development Indicators (World Bank, 2015a). Gross fixed capital formation reflects aggregate investment in a country. It serves thus as a proxy for the financing of the business activities via debt and equity and captures macroeconomic shocks. The expectation is that a growth of the aggregate investment in a country will stimulate entrepreneurship and the creation of new firms. Accordingly, it promotes employment and the survival of firms.

Taking patent applications as a way to capture innovation in a country follows the approach of some studies on VC (Samila & Sorenson, 2011, Schertler, 2007, Faria & Barbosa, 2014). In opposition to patent grants, the convenience of patent applications is that there is no or only a small time lag between the occurrence of innovation and its measurement. Certainly, there are some drawbacks of patents as a measure of innovation. It is often stated, that patents only reflect inventions and not innovation (Smith, 2006). On the one hand, they do hence not completely capture the innovative activity, as some technological advances are not patentable. On the other hand, patents are filed without incorporating a true novelty. Despite these drawbacks, it is a widely used method to measure innovation in the economic. This dependent variable is expected to increase when there are more innovative ideas and technological opportunities in an economy. Table 4 shows the summary statistics for the variables used for the regressions. Table 16 and Table 17 in appendix A.1 show more detailed descriptive statistics of the data.

TABLE 4: SUMMARY STATISTICS OF THE VARIABLES USED FOR THE REGRESSIONS

Variable	***Mean***	***Std. Dev.***	***Between Std. Dev.***	***Within Std. Dev.***	***Obs .***
Amount of VC in 2005 US$ per one million inhabitants	20.4 Mill.	2.69E+07	2.04E+07	1.79E+07	196
Number of companies backed by VC per one million inhabitants	11.09	11.93	10.83	5.31	196
Number firm births per one million inhabitants	1,446.03	769.80	749.91	246.41	194
Number of employees in the population of births per one million inhabitants	4,033.78	2,670.78	2,627.76	957.54	178
Rate of survival: Number of firms newly born in t-3 having survived to t divided by number of firms newly born in t	0.67	0.08	0.07	0.03	108
Gross fixed capital formation in 2005 US$ per one million inhabitants	7,790 Mill.	4.27E+09	4.26E+09	9.48E+08	205
Patent applications per one million inhabitants	197.61	178.49	179.26	23.51	204

All variables except the survival rate were transformed to numbers per one million inhabitants in order to adjust for the size of the countries. For the estimation of the models the logarithmed form are used for all of the variables except for the rates of survival.

4.4 FURTHER DATA

In order to point out for further relevant factors for business dynamics, R&D expenditures and an indicator for the institutional environment for starting a business in a country were considered. Concerning R&D expenditures, the total intramural R&D expenditures from Eurostat was used. The *distance to frontier factor* for the category of *Starting a Business* is provided by the Doing Business Index project of the World Bank (2015b). This factor measures the distance of the institutional setting in a country to the best case among the countries, the *frontier*. The construction of the factor comprises the number of procedures that has to be taken to start a business, the necessary time in days, the cost and the minimum mandatory paid-in capital into the new firm. Thus, the *distance to frontier factor* reflects the diversity of institutional preconditions across the countries, devoting the highest value to the country with the smallest distance to the best case expressed as a percentage average of the four component indicators.

5 EMPIRICAL METHODOLOGY

The econometric part follows the methodology of the studies by Popov and Roosenboom (2013) and by Samila and Sorenson (2011). Thus, the regressions of the business dynamics variables on VC are conducted as suggested by Popov and Roosenboom (2013). In addition, a panel model is considered which takes into account the control variables. This model is similar to the basic model presented by Samila and Sorenson (2011), who estimated the impact of VC on a regional level in the United States during 1993 - 2002. For firm births and employment, the model is specified as follows:

$$\ln Y_{i,t} = \beta_0 + \beta_1 \ln VC_{i,t} + \beta_2 \ln C_{i,t} + \beta_3 \ln I_{i,t} + \nu_{i,t}$$

Y represents firm births and employment in the population in the newly born firms respectively. Table 5 gives an overview of the variables used for the main results. VC is the determinant of interest and represents the size of the VC industry. VC, the determinant of the size of the venture capital industry, is represented by two different measures, by the amount of VC invested and the number of firms that were backed by VC. Both measures can be interpreted as a proxy for the size of the VC industry in a country. The VC variables reflect to a certain extent also the maturity of the industry, the incorporated expertise in the industry, the quality of the network and the amount of the capital providing services. However, these aspects can certainly not fully be captured by the two mentioned measures. *C* represents macroeconomic investment and is thus a proxy for the supply of other forms of capital in a country. *I* captures innovation by using the number of patent applications. The standard models are estimated by OLS with country fixed effects. Country fixed effects capture country idiosyncrasies in dependent the variables. Another reason for the choice of OLS Fixed Effects as estimation method is that the variance between the countries is larger than within the countries, as Table 4 has shown. Thus, for instance firm births might depend on the sector composition of an economy. Countries with economic activity concentrated in large firms, for

instance in the manufacturing industry, may show a lower birth rate and less employment in the population of newly born firms. Throughout the regressions, the inclusion of year dummies are tested. These year dummies capture temporal events, such as the financial crisis of 2008.

TABLE 5: COMPONENTS OF THE EMPIRICAL MODELS

Variable type	*Determinant*	*Variable name (short name)*
Dependent	**Y -** Business dynamics	Number firm births per one million inhabitants (Firm births)
		Number of employees in the population of births per one million inhabitants (Employment)
		3-year rate of survival (3Y Survival)
Independent	**VC –** Size of the VC industry	Amount of VC in 2005 US$ per one million inhabitants (VC Amount)
		Number of companies backed by VC per one million inhabitants (Companies)
Control	**C** – Macroeconomic investment	Gross fixed capital formation in 2005 US$ per one million inhabitants (Capital)
	I – Innovation	Patent application per one million inhabitants (Patents)

In the case of firm survival, the empirical model is slightly different. Survival rates are not logarithmed and a time lag is assumed, thus the equation becomes:

$$Y_{i,t+3} = \beta_0 + \beta_1 \ln VC_{i,t} + \beta_2 \ln C_{i,t} + \beta_2 \ln C_{i,t+3} + \beta_3 \ln I_{i,t} + \nu_{i,t}$$

Another modifications is that not only C in the year t, but also in t+3 and thus the same year which the survival rate refers to, are considered. Assuming a three-year lag of the effect is plausible, as it takes some years for VC to have an effect on the success of a firm. The benefits of the value added services provided by VC discussed in the section on the theoretical framework unfolds with some lags between the different actions of the agents involved.

6 RESULTS

The following section reports the results for the effects of VC in terms of amounts invested and in terms of number of companies backed per country and year on the number of born firms, employment in the population of newly born firms and the survival rates.[10] As the availability of data is better for the first two measures of business dynamics, the analysis concentrates on firm births and employment and only shortly discusses firm survival. Besides the main results from the OLS Fixed Effects regressions, the results are checked for robustness and the endogeneity issue is addressed. The choice of the model specifications and the assessment of possible alternative approaches follow previous macroeconomic studies of VC, in particular the studies by Samila and Sorenson (2011) as well as by Popov and Roosenboom (2013).

[10] *Effect* and other expressions that signify a causal relationship are used in this part of the analysis. However, these statements shall be treated cautiously, as far as endogeneity and the question of causality are not explicitly addressed.

6.1 MAIN RESULTS FOR THE LINKAGE OF VC AND BUSINESS DYNAMICS

6.1.1 Firm births

Column (i) of Table 6 gives the coefficient of the amount of VC from the regression on firm births and column (ii) the coefficient of the number of companies backed by VC. The columns (iii)-(vi) provide the coefficients with consideration of each of the control variables. The last two columns, column (vii) and (viii) show the results of the regression by taking into account all control variables jointly. All the regressions include country fixed effects. Year dummies were included depending on a Wald test.[11] Resulting from these tests, no year dummies were included in all the estimations in which *Capital* was included. The importance of *Capital* as an explanatory determinant for firm births stands out. Concerning the variables of interest, *VC amount* and *Companies*, Table 6 reports a clear positive correspondence with firm births. However, only the coefficient of *VC amount* are significant for the estimation including *Patents*, as shown in column (v). The coefficients express elasticities and the interpretation is as follows: Using the example of column (vii), an increase of VC amount by one percent comes with an increase of firm births by 0.026 %. This coefficient is significant using standard errors that are not adjusted for heteroskedasticity, but becomes insignificant when adjusted.[12] The value of the coefficient is relatively small in comparison to the highly significant coefficient of *Capital*, which corresponds to an increase of firm births by 0.464 %. The effect of a one percent increase of VC as represented by *Companies* on firm births is not much larger than *VC amount* with an increase of 0.045 %. However, this coefficient is not significant either when adjusting the standard errors for heteroskedasticity. Assuming a doubling of the VC amount or the number of companies backed gives a more meaningful interpretation. This would correspond to an increase of firm births by 1.8 % based on *VC amount* and 3.1 % based on *Companies*. In average, a country has 1,446 firm births per year and one million inhabitants. Consequently, doubling of VC would lead to 26 firm births per million inhabitants depending on VC amount or 43 depending on the number of companies backed by VC. Given to the relatively small size of the VC industry in some European countries, the provision of VC can thus be seen as an economically significant factor.

[11] For each of the regression, Wald-tests were conducted. Wald tests were performed with the null-hypothesis that all the year dummies are jointly equal to zero. When this was not the case, the year dummies were included.
[12] The results not adjusted for heteroskedasticity are not reported.

TABLE 6: RESULTS FOR FIRM BIRTHS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Firm births							
VC amount	0.014		0.011		0.029*		0.026	
	(0.02)		(0.03)		(0.01)		(0.02)	
Companies		0.020		0.016		0.045		0.045
		(0.04)		(0.04)		(0.03)		(0.03)
Capital			0.435**	0.450**			0.464**	0.497***
			(0.18)	(0.18)			(0.17)	(0.17)
Patents					-0.083	-0.082	-0.133*	-0.134*
					(0.07)	(0.07)	(0.07)	(0.07)
Obs.	183	183	181	181	180	180	178	178
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 6 reports the estimates from the FE OLS regression. The dependent variable is firm births and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

From this first regression analysis and except for the regression of column (v), no evidence for the hypothesis that VC promotes the births of firms was found. Remarkable is the negative linkage between firm births and *Patents*. The average of patent applications throughout the countries were almost stable over time, whereas firm births were decreasing. This leads to the indication that stability in the measure of technological opportunities did not sustain the number of firm births. Half of the period covers the crisis years after 2008, where a decreasing number of firm births was recorded. Contrariwise, patent applications did not show a downshift during the crisis years. Patent applications might thus be less attractive for newly born firms during the crisis years and the majority of applications may not come from newly born firms but from large corporations. As already discussed in the section on data, patent applications are not an optimal measure for innovation in general and for innovation in the way, it is relevant for the creation of new firms. As an alternative measure, regressions with R&D expenditures as a measure for innovation are run. The coefficients in this case were, again, negative, probably due to similar reason. The results of these regressions are reported in appendix A.3.

6.1.2 Employment in the population of newly born firms

Parallel to the results on firm births, Table 7 shows the results from the regression of employment in the population of newly born firms on VC. The coefficients can again be interpreted as elasticities. Testing for the significance of year dummies indicates that these should be included in all the regressions conducted for employment.

TABLE 7: RESULTS FOR EMPLOYMENT

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Employment							
VC amount	0.038		0.029		0.049**		0.039**	
	(0.02)		(0.02)		(0.02)		(0.02)	
Companies		0.035		0.030		0.053		0.049
		(0.04)		(0.04)		(0.03)		(0.03)
Capital			0.334	0.367			0.443	0.484*
			(0.27)	(0.28)			(0.26)	(0.27)
Patents					-0.078	-0.074	-0.103	-0.102
					(0.09)	(0.09)	(0.11)	(0.11)
Obs.	169	169	168	168	166	166	165	165
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 7 reports the estimates from the FE OLS regression. The dependent variable is employment in the population of firm births and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

Column (i) shows that a one percent change of *VC amount* corresponds to a change of *Employment* by 0.038 %. The columns (i) – (iv) show that the coefficients of VC solely and of both VC variables with consideration of *Capital* are positive but not statistically significant. The only significant coefficients are the coefficients of *VC amount* when controlling for innovation by means of *Patents* in column (v) and with all the control variables in column (vii). When controlling for both, capital and patents, a one percent increase of *VC amount* corresponds to an increase of 0.039 % and a one percent increase of *Companies* to an increase of employment by 0.049 %. However, the coefficient of companies is not statistically significant when the heteroskedasticity robust standard errors are used. Repeating the exercise from before and given that the average employment in the population of newly born firms throughout the countries is 4034 employees in the population of newly born firms per million inhabitants, a doubling of the *VC amount* would lead to an increase of employment by 2.7 % or by 118 employees per million inhabitants. Taking the coefficient of *Companies*, a doubling of the number of firms backed by VC relates to 3.5 % more employment or an upshift by 142 employees in the population of newly born firms per million inhabitants.

6.1.3 Survival rates

The third dependent variable of interest is survival rates. Table 8 shows the results for *3Y Survival*, the survival of newly born firm over three years. Based on the theoretical considerations and after checking with other lags, the 3-year survival rate appeared to be the most plausible linkage. Appendix A.4 shows alternative specifications of the models with the 1-year and 2-year survival rate. The interpretation of the coefficients is different from the other two dependent variables. As *3Y Survival* is not logarithmed, a one percent change of VC corresponds to a change in percentage points as given by the coefficient in the table.

TABLE 8: RESULTS FOR 3-YEAR FIRM SURVIVAL

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	3-year firm survival rate in t+3							
VC am. in t	0.009*		0.013***		0.013***		0.014***	
	(0.00)		(0.00)		(0.00)		(0.00)	
Comp. in t		0.014		0.018***		0.019*		0.021***
		(0.01)		(0.01)		(0.01)		(0.01)
Capital in t			-0.151***	-0.137***			-0.148***	-0.132***
			(0.05)	(0.05)			(0.05)	(0.05)
Capital in t+3			0.087	0.095			0.066	0.077
			(0.05)	(0.06)			(0.05)	(0.06)
Patents in t					-0.033***	-0.030***	-0.023**	-0.023**
					(0.01)	(0.01)	(0.01)	(0.01)
Obs.	103	103	101	101	101	101	99	99
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 8 reports the estimates from the FE OLS regression. The dependent variable is the rate of survival of firms born 3 years before and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

The pattern of the results differs a lot from the results received from the regressions of firm births and employment. Except for the result of *Companies* in column (ii), the coefficients for VC are all significant and the linkage is positive. The coefficient of *VC amount* and *Companies* are significant at the 1 % level when considering capital as control variables, as reported by column (iii), (iv), (vii) and (viii). In addition, *VC amount* is highly significant when controlling for innovation, as described by column (v). The interpretation of column (vii) is that a one percent increase of VC amount corresponds to an increase of the survival rate by 0.014 percentage points. If the number of firms backed by VC increases by one percent, the survival rate is raised by 0.021 percentage points. The average 3-year survival rate is 67 %, that means 67 out of 100 born firms in a year still exist three years later. From a doubling of VC amount, corresponds then to a raise of this rate by one percentage point. In the case of a two times larger number of firms backed by VC, the survival rate would increase by 1.5 percentage points up to a rate of 68.5 %.

6.2 ADDRESSING VARIOUS DATA ISSUES

Certainly, there are a number of issues that should be addressed in order to see whether the estimates are robust. As described in the section on data, a number of transformations to the data on VC have been undertaken. In order to check how these transformations influenced the results, regressions without the application of the transformations are conducted. Without the extrapolation of the data to the estimated total market and without adjusting to the amount of VC invested domestically and the number of companies that are backed by VC within a country by domestic VC sources does not change the results profoundly. Furthermore, Popov and Roosenboom (2013) suggest some checks of robustness. In their study, the strongest and weakest countries are excluded from the estimations. This issue, the question of the temporal structure and the issue of endogeneity are discussed in the following.

6.2.1 Exclusion of outlier countries

For this study, the United States as the country with the largest VC in relation to inhabitants and Hungary, Romania, the Baltics, Poland, Bulgaria and the Czech Republic as the countries with the smallest VC

industry are excluded.[13] Table 9 presents the results of the estimations with the remaining 16 European countries. The coefficients are positive and significant values are given in columns (vi) and (v). Remarkable is that the significant coefficients become larger. The coefficient of the linkage of companies and firm births raise from 0.045 % to 0.08 %. Similarly, the coefficient of the linkage between companies and employment nearly doubles, increasing from 0.049 % to 0.093 %. For firm births and employment, this indicates that with the present country selection, it is rather the number of companies backed that has a larger impact than the amount of VC invested. In the case of survival rates as reported by column (v) and (vi), the coefficient of *VC amount* is slightly larger compared to the results that include all the countries.

TABLE 9: RESULTS WITH 16 COUNTRIES

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Variable	Firm births in t		Employment in t		3-year firm survival rate in t+3	
VC am. in t	0.016		0.037		0.017*	
	(0.03)		(0.04)		(0.01)	
Comp. in t		0.080		0.093*		0.018
		(0.05)		(0.05)		(0.01)
Capital in t	0.840***	0.815***	0.836***	0.805***	-0.112	-0.098
	(0.21)	(0.20)	(0.24)	(0.22)	(0.08)	(0.07)
Capital in t+3					0.081	0.109
					(0.07)	(0.09)
Patents in t	-0.096	-0.085	-0.059	-0.047	-0.017	-0.014
	(0.07)	(0.07)	(0.08)	(0.08)	(0.01)	(0.01)
Obs.	128	128	121	121	67	67
Country FE	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO

Table 9 reports the estimates from the FE OLS regression. The dependent variables are firm births, employment and the rate of survival of firms born 3 years before. The independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 16 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

Consequently, the deductions remain largely the same as before. VC is not a significant factor for firm births, but seems to matter for employment and firm survival. However the magnitudes of the coefficient change, which shows that the country circumstances seem to matter for the linkage between VC and business dynamics.

6.2.2 Temporally distributed linkage of VC and business dynamics

Table 10 shows the temporal structure of the effect of VC on firm births. Both leads and lags of the VC variables show positive coefficients. Significant results are only obtained for regressions considering *Companies* with a lead, as shown by columns (v) and (vi). This indicates that the causal relationship might run in the other direction and firm births stimulate VC investment.

[13] Figure 2 and Figure 3 in appendix A.5 show the different sizes of the VC industry of the countries by means of VC amount invested.

TABLE 10: TEMPORAL STRUCTURE OF VC AND FIRM BIRTHS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Firm births							
Lead / lag	of VC amount				of Companies			
2-year lead	0.018				0.061**			
	(0.02)				(0.03)			
1-year lead		0.031				0.071*		
		(0.02)				(0.04)		
1-year lag			0.029				0.060	
			(0.02)				(0.04)	
2-year lag				0.034				0.065
				(0.03)				(0.05)
Capital	0.480**	0.422**	0.430**	0.375*	0.533**	0.475**	0.450**	0.392**
	(0.20)	(0.18)	(0.18)	(0.19)	(0.19)	(0.18)	(0.17)	(0.18)
Patents	-0.124	-0.114	-0.203*	-0.224*	-0.115	-0.118	-0.198	-0.208*
	(0.08)	(0.07)	(0.12)	(0.12)	(0.08)	(0.08)	(0.12)	(0.11)
Obs.	162	181	177	176	162	181	177	176
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	NO	NO	NO	NO

Table 10 reports the estimates from the FE OLS regression. The dependent variable is firm births and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

The temporal assessment of the linkage between VC and employment is presented in Table 11. Similarly, to the case of firm births, the estimates of the leads and lags of VC are positive but non-significant coefficients. Hence, the only significant result for the linkage of VC on employment is thus obtained by the variable of *VC amoun*t and without assuming a temporal lead or lag of the effect as shown in part 6.1.2.

TABLE 11: TEMPORAL STRUCTURE OF VC AND EMPLOYMENT

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Employment							
Lead / lag	of VC amount				of Companies			
2-year lead	0.004				0.042			
	(0.02)				(0.04)			
1-year lead		0.038				0.078		
		(0.02)				(0.05)		
1-year lag			0.016				0.023	
			(0.01)				(0.03)	
2-year lag				0.006				0.022
				(0.02)				(0.04)
Capital	0.511***	0.463***	0.471***	0.380***	0.528***	0.502***	0.475***	0.385***
	(0.16)	(0.13)	(0.13)	(0.13)	(0.16)	(0.13)	(0.13)	(0.13)
Patents	-0.092	-0.074	-0.165**	-0.162**	-0.076	-0.077	-0.166**	-0.158**
	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)
Obs.	151	170	165	164	151	170	165	164
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 11 reports the estimates from the FE OLS regression. The dependent variable employment in the population of firm births and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered. The standard errors are reported in parentheses and are heteroskedasticity adjusted.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

6.2.3 The endogeneity problem

A major concern in the type of regressions conducted in part 6.1 is the issue of endogeneity between VC and firm births as well as VC and employment. It could be that firm births and employment, the dependent variables, influence the VC variables or the VC and the dependent variables are simultaneously influenced by a third factor, which leads to too high values of the coefficients and to a possibly false conclusion concerning the significance. The problem of endogeneity has been addressed in the literature for firm births (Popov & Roosenboom, 2013) and in the case of employment (Belke et al., 2003). One suggested approach comprises the usage of the liberalization of pension fund investment as an instrument (see, for instance,

Kortum & Lerner, 2000, Popov & Roosenboom, 2013). For the purpose of this study, the panel structure of the data is exploited and the lagged dependent variable is instrumented by itself with two lags.

Following the procedure as suggested by Belke et al. (2003), lagged firm births (employment) is instrumented by using the second lag of firm births (employment). Table 12 reports the results of the two stage least square regression (2SLS) for VC and firm births. The results for firm births underpin the indication found from the assessment of the temporal structure. As none of the VC coefficients is significant, the results suggest that VC is endogenous and either affected by firm births in a country or both measures are commonly influenced by an omitted factor.

TABLE 12: RESULTS FOR INSTRUMENTED FIRM BIRTHS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Firm births in t							
Births in t-1	0.658***	0.691***	0.488***	0.484***	0.613***	0.654***	0.438***	0.434***
	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.14)	(0.13)	(0.14)
VC am. in t	-0.003		0.007		0.001		0.010	
	(0.01)		(0.01)		(0.02)		(0.01)	
Comp. in t		-0.036		0.009		-0.030		0.014
		(0.03)		(0.02)		(0.03)		(0.02)
Capital in t			0.458***	0.477***			0.509***	0.534***
			(0.14)	(0.13)			(0.14)	(0.14)
Patents in t					-0.058	-0.060	-0.150***	-0.151***
					(0.06)	(0.06)	(0.06)	(0.06)
Obs.	144	144	142	142	143	143	141	141
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 12 reports the estimates from the 2SLS regression with fixed effects. The lagged firm births are instrumented by two-lagged firm births. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

Table 13 reports the results of the same exercise applied to the variable of employment. The only significant coefficient is given by *VC amount* in column (vii). It has roughly the magnitude of the coefficients found in the OLS FE regressions and is significant at the 5 % level. This suggests only a very weak evidence for VC being an exogenous variable for the explanation of employment. The first stages of the estimation procedures are reported in appendix A.5.

TABLE 13: RESULTS FOR INSTRUMENTED EMPLOYMENT

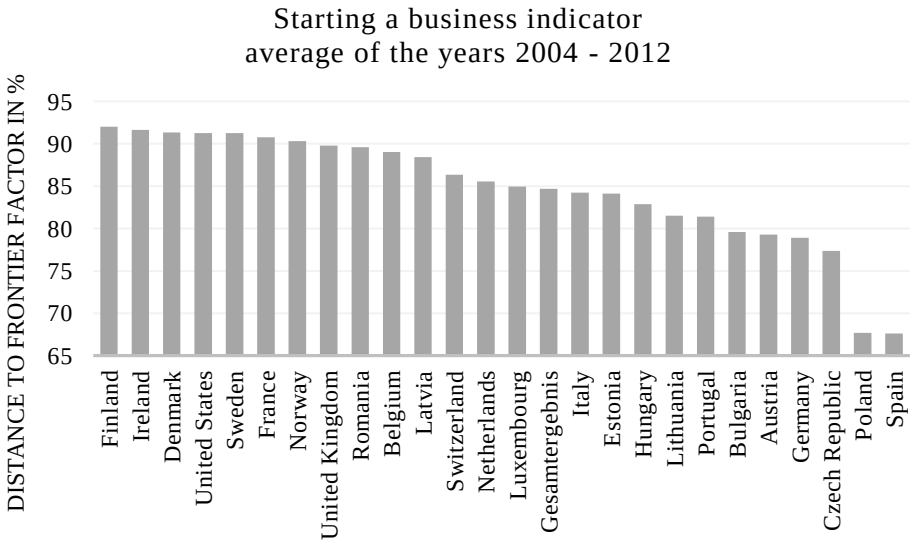
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Employment in t							
Empl. in t-1	0.311	0.304	0.229	0.203	0.251	0.256	0.087	0.088
	(0.19)	(0.21)	(0.20)	(0.22)	(0.21)	(0.23)	(0.17)	(0.17)
VC am. in t	0.029		0.026		0.032		0.042**	
	(0.02)		(0.02)		(0.02)		(0.02)	
Comp. in t		0.011		0.025		0.015		0.047
		(0.04)		(0.04)		(0.04)		(0.03)
Capital in t			0.457**	0.514**			0.901***	1.001***
			(0.19)	(0.21)			(0.19)	(0.21)
Patents in t					-0.171*	-0.188**	-0.282***	-0.310***
					(0.09)	(0.09)	(0.09)	(0.09)
Obs.	120	120	120	120	119	119	119	119
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 13 reports the estimates from the 2SLS regression with fixed effects. The lagged employment are instrumented by two-lagged employment. Capital and patents are control variables. For the regressions, 22 countries and the years from 2004 to 2012 are considered (in this case the Baltic country aggregate is excluded due to missing data).
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

6.2.4 Further factors for business dynamics

There are certainly a number of further aspects that matter for business dynamics and for young firms in particular. One important determinant is the ease of founding a firm in a country based on legal and financial requirements. Indeed, the pattern in terms of the number of newly born firms differs from country to country, as Figure 4 and Figure 5 on firm births in appendix A.5 illustrate. Figure 1 shows the indicator of starting a business and illustrates that there are some differences across the countries.

FIGURE 1: STARTING A BUSINESS INDICATOR FROM EASE OF DOING BUSINESS PROJECT (OWN GRAPH USING DATA FROM WORLD BANK, 2015B)



The composition of this indicator has been explained in part 4.4. In order to illustrate the disparities among the countries concerning the ease of starting a business, a few examples are depicted. With three procedures in average over the years 2004 - 2012, registering a new firm required the lowest numbers of procedures in Finland among the countries in scope (own calculations using data from World Bank, 2015b). In terms of days that it takes for the registration of firms, Denmark is the leading country with an average of six days over the sample period. In contrast to this, it took the most procedures and days in order to register a

new firm in Spain with ten procedures and 74 days. The costs of registration was lowest in Denmark. There, no official fees or fees for legal services arise, whereas in Italy, a founding entrepreneur had to deal with average costs of almost 20 % of the country's per capita income. Ireland and the United Kingdom have no minimum amount to be paid in into a bank account before the registration of a firm. However, in Poland the average of the percentage based on the country's income per capita that was required to be paid in by a founder amounted to an average of 147 %. For 2012, this minimum deposit decreased to 14 percent though. These country idiosyncrasies in the legal and financial requirements for the founding of a firm reflect that the institutional background of the countries differs severely. As this may influence the rate of firm births, it is of importance to acknowledge these country idiosyncrasies. Appendix A.3 shows an alternative regression model with consideration of the *Starting a business* indicator.

7 CONCLUDING REMARKS

The purpose of this study was to explore how the size of the VC industry in a country affects business dynamics. The hypotheses were that VC has a positive influence on the generation of economic activity, on its enhancement and on the abatement of failures of young firms. Therefore, the variables of business dynamics analysed were firm births, employment in the population of newly born firms and survival rate of young firms over three years. In terms of VC, the variables assessed were amount of VC invested in a country domestically and number of backed companies by domestic VC. In contrast to earlier studies as conducted by Samila and Sorenson (2011) as well as Popov and Roosenboom (2013), no evidence could be found for VC as a factor for firm births from OLS Fixed effects regressions. A weak effect has been found for the linkage of VC on employment, as the coefficients were significant in three out of eight cases. In order to demonstrate the magnitude of the impact of VC on business dynamics in a concrete way, percentage increases were calculated by assuming that the VC supply doubles. Table 14 summarizes these increases measured in percent for firm births and for employment in newly born firms, as well as in percentage points for the 3-year survival rate.

TABLE 14: EFFECT OF DOUBLING THE SUPPLY OF VC

	VC amount			Companies		
Effect on	Firm births in %	Employment in %	3Y Survival in % points	Firm births in %	Employment in %	3Y Survival in % points
OLS FE	0.98	2.67	0.63*	1.40	2.46	0.98
OLS FE with Capital	0.77	2.03	0.91***	1.12	2.10	1.26***
OLS FE with Patents	2.03*	3.45**	0.91***	3.17	3.74	1.33*
OLS FE with all control variables	1.82	2.74**	0.98***	3.17	3.45	1.47***
2SLS FE	-0.21	2.03	-	-2.46	0.77	-
2SLS FE with Capital	0.49	1.82	-	0.63	1.75	-
2SLS FE with Patents	0.07	2.24	-	-2.06	1.05	-
2SLS FE with all control variables	0.70	2.95**	-	0.98	3.31	-

Table 14 summarizes the results obtained by the different estimation approaches. The figures show the percentage increase assuming a doubling of the VC amount or the number of companies backed by VC the variables of firm births and employment. For the variables 3Y survival, the survival rate of newly born firms over three years, the increase in terms of percentage points of the survival rate is shown.
Respective regression results were significant at * the 10 % level, ** the 5 % level, *** the 1 % level

Thus, the increase for firm births amounts to 3.17 % at its maximum. Some negative values have been found by the 2SLS regressions, of which -2.46 % is the smallest. For employment, the increase lies between 0.77 and 3.74 % when VC supply doubles. Regarding thee-year survival, the survival rate increases

between 0.63 and 1.47 percentage points. Whereas the effect of VC on firm births is not significant and the effect on employment of weak significance. The coefficients are in both cases of an economically significant size. Although an immediate comparison is not possible, the magnitude of the coefficient appears to be roughly of the same size as the effects shown by Samila and Sorenson (2011), who found an increase of 0.77 % of firm births when the amount of VC is doubled. As the average of firm births throughout the 323 metropolitan statistical areas in the United States, the observation unit in their study, is 1,425 firms, the increase amounts to 11 firms. This is half of the effect the present study has observed. However, their study applies a broader definition of firm births, not only taking into account employer enterprises but also firms with zero employees. This and the different unit of observation explains the deviation in the results. In the case of firm survival, the results indicate that there is a strong linkage of VC and the ratio of firms surviving over three years in a country. This contradicts the conclusions derived by Manigart et al. (2002), who do not support the view that VC matter for firm survival in general. However, this difference in the results could be due to the different study design and to the particularity of the present study, which takes into account the multiplier effect of VC. The findings indicate, that the function of VC is to support young firms via the managerial and commercial expertise venture capitalists can contribute during the development and to the abatement of the failure of young firms. It is not that important for the stimulation of business creation.

Some limitations of this study and of the data used have to be acknowledged. Due to restraints in the data availability, other forms of capital supplies to young firms, such as investments by business angels, corporate VC and through government grants were not considered explicitly and only domestic VC was part of the study. Hence, inflows of VC from foreign sources were neglected. On years where respective data on the actual amount of VC investment domestically were available, checks have been conducted whether this changes the findings. The results did not change severely and these limitations can thus be seen as minor shortcomings of the study. The results of firm survival could not be checked for endogeneity due to missing data. As discussed in OECD (2014), country idiosyncrasies in the attitude towards entrepreneurship and in the functioning of the financial market, could cause biased regressions. For this study, only the size of the VC industries in the countries was considered. A variable that is partly captured by the used measures but not considered explicitly is the quality of VC, as Bottazzi and Da Rin (2002) point out. Finally, concerning the empirical methodology other models, for instance with another time structure or an autoregressive component could be considered.

Given the finding that VC does not matter that much for generation of economic activity but for the support of young firms, the attention that VC receives by policymakers with regard to the promotion of business creation should be reconsidered. The findings argue for the view that the most beneficial effect of VC unfolds in the later stages of a young firm. VC provides a valuable contribution during the expansion of firms and helps to abate firm failures through its value added services. Policymakers should thus concentrate on the supply of late stage VC. This is in line with authors who promote the view that VC is

rather an instrument for the commercialization and professionalization of innovative entrepreneurial projects and that the effect of VC at the late stage is more pronounced (e.g. Faria & Barbossa, 2014). The focus of policy should consequently be put on the design of policy instruments aiming at the promotion of VC that concentrates rather on the growth stage than on the seed stage.

For future research, there is still a large range of open questions on the the topic on how VC and business dynamics are interconnected. How does the type of VC matter for business dynamics and how does VC matter in comparison the conditions of its specific environment? As it has been shown in the analysis, the country environment matters, how does the impact of VC differ across countries? Similarly, how does industry specific effects matter? What is the exact mechanism of the linkage and through which channels of the value added services is VC beneficial for firm births, employment and the survival of firms? And finally, how does the quality of these services matter and how can it be increased? With data on the extent, the form and the quality of the value added services by different types of venture capitalists and by different types of recipients, these questions could be explored further.

REFERENCE LIST

Achleitner, A.-K. & Kloeckner, O. (2005). Employment Contribution of Private Equity and Venture Capital in Europe, Available Online: http://dx.doi.org/10.2139/ssrn.1113782 [Accessed 23 April 2015]

Aghion, P., Fally, T., & Scarpetta S. (2007). Credit Constraints as a Barrier to the Entry and Post-entry Growth of Firms. *Economic Policy*, vol. 22, no. 52, pp. 732-779

Akerlof, G. A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*, pp. 488-500

Alemany, L., and Martí, J. (2005). Unbiased Estimation of Economic Impact of Venture Capital Backed Firms, EFA 2005 Moscow Meetings Paper Available Online: http://www.efmaefm.org/0EFMAMEETINGS/EFMA%20ANNUAL%20MEETINGS/2005-Milan/papers/6-alemany_paper.pdf [Accessed 24 April 2015]

Audretsch, D. B. & Lehmann, E. E. (2004). Financing High-tech Growth: The Role of Banks and Venture Capitalists. *Schmalenbach Business Review*, vol. 56, pp. 340-357

Amit, R., Brander, J., & Zott, C. (1998). Why Do Venture Capital Firms Exist? Theory and Canadian Evidence, *Journal of Business Venturing*, vol. 13, no. 6, pp. 441-466

Arqué-Castells, P. (2012). How Venture Capitalists Spur Invention in Spain: Evidence from Patent Trajectories, *Research Policy*, vol. 41, no. 5, pp. 897-912

Avnimelech, G., & Teubal, M. (2006). Creating Venture Capital Industries That Co-evolve with High Tech: Insights from an Extended Industry Life Cycle Perspective of the Israeli Experience, *Research Policy* vol. 35, no. 10, pp. 1477-1498

Baum, J. A. C., & Silverman, B. S. (2004). Picking Winners or Building them? Alliance, Intellectual, and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Startups, *Journal of business venturing*, vol. 19, no. 3, pp. 411-436

Belke, A. H., Fehn, R., & Foster-McGregor, N. (2003). Does Venture Capital Investment Spur Employment Growth?, working paper no. 930, CESifo

Bertoni, F., Croce, A., & D'Adda, D. (2010). Venture Capital Investments and Patenting Activity of High-tech Start-ups: A Micro-econometric Firm-level Analysis, *Venture Capital: An International Journal of Entrepreneurial Finance*, vol. 12, no. 4, pp. 307-326

Bottazzi, L., & Da Rin, M. (2002). Venture Capital in Europe and the Financing of Innovative Companies. *Economic Policy*, vol. 17 no. 34, pp. 229-270

Brander, J. A., Egan, E., & Hellmann, T. F: (2010). Government Sponsored versus Private Venture Capital: Canadian Evidence in J. Lerner & A. Schoar, (eds), *International Differences in Entrepreneurship*, Chicago: University of Chicago Press, pp. 275-320

Bulevska, A. (2014). Can Economic Growth Be Enhanced by Venture Capital Employment?, *Journal of Sustainable Development*, vol. 5, no. 10, pp. 50-69

Bürgel, O., Fier, A., Licht, G., & Murray, G. C. (2000). Internationalisation of High-tech Start-ups and Fast Growth - Evidence for UK and Germany, working paper, no. 00-35, ZEW, Mannheim

Canepa, A. & Stoneman, P. (2008). Financial Constraints to Innovation in the UK: Evidence from CIS2 and CIS3, *Oxford Economic Papers*, vol. 60, pp. 711-730

Caselli, S., Gatti, S., & Perrini, F. (2009). Are Venture Capitalists a Catalyst For Innovation?, *European Financial Management*, vol. 15, no. 1, pp. 92-111

Chemmanur, T. J., Krishnan, K., & Nandy, D. K. (2011). How Does Venture Capital Financing Improve Efficiency in Private Firms? A Look Beneath the Surface. *Review of financial studies*, vol. 24, no. 12, pp. 4037-4090

Da Rin, M., Hellmann, T. F., & Puri, M. (2011). A Survey of Venture Capital Research, working paper, no. 17523, National Bureau of Economic Research

Davila, A., Foster, G., & Gupta, M. (2003). Venture Capital Financing and the Growth of Startup Firms, *Journal of Business Venturing*, vol. 18, no. 6, pp. 689-708

Dushnitsky, G., & Lenox, M. J. (2005). When Do Incumbents Learn From Entrepreneurial Ventures?: Corporate Venture Capital and Investing Firm Innovation Rates, *Research Policy*, vol. 34, no. 5, pp. 615-639

Engel, D., & Keilbach M. (2007). Firm-level Implications of Early Stage Venture Capital Investment - An Empirical Investigation. *Journal of Empirical Finance*, vol. 14, no. 2, pp. 150-167

EU Commission (1998). Risk Capital – A Key to Job Creation in the European Union. Available Online: http://ec.europa.eu/economy_finance/publications/publication_summary1138_en.htm [Accessed 28 April 2015]

EU Commission (2010). Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth. Available Online: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF [Accessed 30 May 2015]

European Investment Bank (EIB, 2015). What InnovFin Products Are Available and Who Can Benefit from Them? Available Online: http://www.eib.org/products/blending/innovfin/products/index.htm?lang=en [Accessed 29 May 2015]

Eurostat & OECD (2007). Eurostat − OECD Manual on Business Demography Statistics, Available Online: http://ec.europa.eu/eurostat/documents/3859598/5901585/KS-RA-07-010-EN.PDF/290a71ec-7a71-43be-909b-08ea6bcdc521?version=1.0 [Accessed 15 May 2015]

Eurostat (2015a). Business Demography by Size Class (from 2004 onwards, NACE Rev. 2), Available Online: http://ec.europa.eu/eurostat/data/database [Accessed 10 April 2015]

Eurostat (2015b). Country Specific Notes in Business Demography, Available Online: http://ec.europa.eu/eurostat/cache/metadata/Annexes/bd_esms_an2.pdf [Accessed 13 May 2015]

European Venture Capital Association (EVCA, 2013). Exploring the Impact of Private Equity on Economic Growth in Europe, Frontier Economics, London, Available Online: http://www.evca.eu/media/61219/Frontier_Economics_Report.pdf [Accessed 2 February 2015]

European Venture Capital Association (EVCA, 2014). Annual Activity Statistics, Available Online: http://www.evca.eu/research/activity-data/annual-activity-statistics/ [Accessed 19 November 2014]

European Venture Capital Association (EVCA, 2015). Activity Data Methodology. Available Online: http://www.evca.eu/research/activity-data/data-methodology/ [Accessed 14 April 2015]

Faria, A. P., & Barbosa, N. (2014). Does Venture Capital Really Foster Innovation?, *Economics Letters*, vol. 122, no. 2, pp. 129-131

Fried, V. H., & Hisrich R. D. (1995). The Venture Capitalist: A Relationship Investor, *California Management Review*, vol. 37, no. 2, pp. 101-113

Gompers, P. A., & Lerner, J. (1999). What Drives Venture Capital Fundraising?, working paper, no. 6906, NBER

Gompers, P. A., & Lerner, J. (2001). The Venture Capital Revolution. *The Journal of Economic Perspectives*, vol. 15, no. 2, pp. 145-168

Greenwood, J., & Jovanovic, B. (1990). Financial Development, Growth, and the Distribution of Income, *The Journal of Political Economy*, vol. 98 no. 5, pp. 1076-1107

Hege, U., Palomino, F., & Schwienbacher A. (2009). Venture Capital Performance: The DisparityBetween Europe and the United States, *Revue de l'association française de finance*, vol. 30, no. 1, pp. 7-50

Hellmann, T. (2000). Venture Capitalists: the Coaches of Silicon Valley in L. Chong-Moon Lee, W.F. Miller, M. Gong Hancock, & H.S. Rowen, (eds), *The Silicon Valley Edge: A Habitat for Innovation and Entrepreneurship*, Stanford: Stanford University Press, pp. 276-294

Hirukawa, M., & Ueda M.(2008). Venture Capital and Industrial "Innovation", working paper, no. 7089, Centre for Economic Policy Research

Hirukawa, M., & Ueda M.(2011). Venture Capital and Innovation Which is First?, *Pacific Economic Review*, vol. 16, no. 4, pp. 421-465

Jeng, L. A., & Wells, P. C. (2000). The Determinants of Venture Capital Funding: Evidence Across Countries. *Journal of corporate Finance*, vol. 6, no. 3, pp. 241-289

Kaplan, S. N., & Strömberg P. (2001). Venture Capitalists as Principals: Contracting, Screening, and Monitoring, *American Economic Review*, vol. 91, no. 2, pp. 426-430

Kortum, S., & Lerner, J. (2000). Assessing the Contribution of Venture Capital to Innovation. *RAND Journal of Economics*, vol. 31, no. 4, pp. 674-692

Keuschnigg, C. (2004). Venture Capital Backed Growth, *Journal of Economic Growth*, vol. 9, no. 2, pp. 239-261

Leleux, B., & Surlemont, B. (2003). Public Versus Private Venture Capital: Seeding or Crowding out? A Pan-European Analysis, *Journal of Business Venturing*, vol. 18, no. 1, pp. 81-104

Manigart, S., Baeyens, K., & Van Hyfte, W. (2002). The Survival of Venture Capital Backed Companies, *Venture Capital: An International Journal of Entrepreneurial Finance*, vol. 4, no. 2, pp. 103-124

Magri, S. (2009). The Financing of Small Innovative Firms: The Italian Case. *Economics of Innovation and New Technology*, vol. 18, no. 2, pp. 181-204

Megginson, W. L. & Weiss, K. A., 1991, Venture Capitalist Certification in Initial Public Offerings, *Journal of Finance*, vol. 46 no., pp. 879–903

Michelacci, C., & Suarez, J. (2004). Business Creation and the Stock Market. *The Review of Economic Studies*, vol. 71, no. 2, pp. 459-481

National Venture Capital Association (NVCA, 2014). National Venture Capital Association Yearbook 2014, Available Online: http://nvca.org/research/stats-studies/ [Accessed 23 February 2015]

National Venture Capital Association (NVCA, 2015). Venture Investment, Available Online: http://nvca.org/research/venture-investment/ [Accessed 23 February 2015]

Organisation for Economic Cooperation and Development (OECD, 2013). Science, Technology and Industry Scoreboard 2013 – Innovation for Growth, OECD Publishing, Available Online: http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2013_sti_scoreboard-2013-en [Accessed 9 March 2015]

Organisation for Economic Cooperation and Development (OECD, 2014), Entrepreneurship at a Glance 2014, OECD Publishing, Available Online: http://dx.doi.org/10.1787/entrepreneur_aag-2014-en [Accessed 22 April 2015]

Parhankangas, A. (2012). The Economic Impact of Venture Capital in H. Landström, C. Mason, (eds), *Handbook of Research on Venture Capital. Volume 2: A Globalizing Industry*, Cheltenham: Edward Elgar, pp. 124-158

Peneder, M. (2010). The Impact of Venture Capital on Innovation Behaviour and Firm Growth, *Venture Capital*, vol. 12, no. 2, pp. 83-107

Popov, A. & Roosenboom P. (2012). Venture Capital and Patented Innovation: Evidence from Europe, *Economic Policy*, vol. 27, no. 71, pp. 447-482

Popov, A. & Roosenboom P. (2013). Venture Capital and New Business Creation, *Journal Banking & Finance*, vol. 37, no. 12, pp. 4695-4710

Puri, M., & Zarutskie, R. (2012). On the Life Cycle Dynamics of Venture-capital- and Non-venture-capital-financed Firms, *The Journal of Finance* vol. 67, no. 6, pp. 2247-2293

Rajan, R. G., & Zingales L. (1998). Financial Dependence and Growth. *The American Economic Review*, vol. 88, no. 3, pp. 559-586

Sahlman, W. A. (1990). The Structure and Governance of Venture Capital Organizations, *Journal of Financial Economics*, vol. 27, no. 2, pp. 473-521

Samila, S., & Sorenson, O. (2010). Venture Capital as a Catalyst to Commercialization. *Research Policy*, vol. 39 no. 10, pp. 1348-1360

Samila, S., & Sorenson, O. (2011). Venture Capital, Entrepreneurship, and Economic Growth, *The Review of Economics and Statistics*, vol. 93, no. 1, pp. 338-349

Sapienza, H. J., Manigart, S., & Vermeir, W. (1996). Venture Capitalist Governance and Value Added in Four Countries. *Journal of Business Venturing*, vol. 11, no. 6, pp. 439-469

Schertler, A. (2007). Knowledge Capital and Venture Capital Investments: New Evidence from European Panel Data, *German Economic Review*, vol. 8, no. 1, pp. 64-88

Smith, K. (2006). Measuring Innovation in J. Fagerberg & D. C. Mowery, (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 149-178

Tang, M.-C., & Chyi, Y.-L. 2008). Legal Environments, Venture Capital, and Total Factor Productivity Growth of Taiwanese Industry. *Contemporary Economic Policy*, vol. 26, no. 3, pp. 468-481

United States Census Bureau (USCB, 2015). Business Dynamics Statistics. Available Online: http://www.census.gov/ces/dataproducts/bds/ [Accessed 11 April 2015]

World Bank (2015a). World Development Indicators, Available Online: http://databank.worldbank.org/data [Accessed 13 April 2015]

World Bank (2015b). Doing Business – Historical Data Sets and Trends Data, Available online: http://www.doingbusiness.org [Accessed 7 April 2015]

Wright, M., Gilligan, J., & Amess, K. (2009). The Economic Impact of Private Equity: What We Know and What We Would Like to Know. *Venture Capital*, vol. 11, no. 1, pp. 1-21

Zhang, B., Zhang, D., Wang, J., & Huang, X. (2013). Does Venture Capital Spur Economic Growth? Evidence from Israel, *Romanian Journal for Economic Forecasting*, vol. 2, pp. 115-128

Zucker, L. G., Darby, M. R., & Brewer, M. B. (1998). Intellectual Human Capital and the Birth of US Biotechnology Enterprises, *American Economic Review*, vol. 88, no. 1, pp. 290-306

APPENDIX

A.1 THE STEADY RATE OF BUSINESS CREATION ACCORDING TO MICHELACCI AND SUAREZ (2004)

The mass of searching monitors m_{0t} represents the stock of free *informed capital*. The first step of the derivation is to assume that m_{0t} and the rate at which informed capital gets reused, $\theta q(\theta)$ constitutes the rate of business creation n_t, thus $n_t = \theta q(\theta) m_{0t}$ where $q(\theta)$ is defined as

$$q(\theta) = \frac{h(e,m)}{e} = h\left(1, \frac{1}{\theta}\right)$$

m_{1t} is the stock of *informed capital* in firms in the start-up stage, i. e. in the stage at which a firm does not know yet whether it will be successful. At the development stage, is becomes clear whether a firm will be successful but no income is generated yet. Capital bound in these firms is described as m_{2t}. m_{0t} is determined by the the total stock of *informed capital M*, and the two masses of *informed capital* bound in firms. Thus, the equation $m_{0t} = M - m_{1t} - m_{2t}$ has to hold. The change of the masses, $\dot{m}_{1t}$ and $\dot{m}_{2t}$ are determined as follows.

$$\dot{m}_{1t} = n_t - \lambda m_{1t}, \dot{m}_{2t} = \lambda\gamma(1-f)m_{1t} - \mu m_{2t}$$

Thus, $\dot{m}_{1t}$ depends on the rate of business creation and λ, the exit of firms transferring to the development stage. $\dot{m}_{2t}$ is determined by the flow of successful firms that are not going public minus the exits of capital bound in firms that transfer to the stage of maturity. For the steady state, setting $\dot{m}_{1t}$ zero, it can be obtained $m_{1t} = \frac{n_t}{\lambda}$. Similarly, $\dot{m}_{2t} = 0$ yields and using m_{1t}

$$m_{2t} = \frac{\lambda\gamma}{\mu}(1-f)m_{1t} = \frac{\lambda\gamma}{\mu}(1-f)\frac{n_t}{\lambda}$$

Both masses of *informed capital* are used for the equation of m_{0t}, which results in

$$m_{0t} = M - \frac{n_t}{\lambda} - \frac{\lambda\gamma}{\mu}(1-f)\frac{n_t}{\lambda}$$

Solving for n using the equation from above yields final the steady state rate of business creation n

$$n = \theta q(\theta)\lambda m_0 = \frac{\theta q(\theta)\lambda M}{\lambda + [1 + (\lambda\gamma/\mu)(1-f)]\theta q(\theta)}$$

A.2 DETAILED DESCRIPTION OF THE DATA

TABLE 15: OVERVIEW OF USED DATA

Retrieved data and source	*Used for variable*	*Country and time scope*	*Online accessible*	*Explanation*
Business dynamics from Eurostat	**Firm births, Employment, Firm survival**	European countries in scope, 2004 – 2012	Yes	SIC1 Indutries Mining, Construction, Manufacturing, Transportation and Public Utilities, Wholesale Trade, Retail Trade, Finance, Insurance, and Real Estate, Services. Excluded are Self–employed, Domestic service workers, Railroad employees, Agricultural production workers, Most government employees, Employees on ocean–borne vessels, Employees in foreign countries. For detailed information see Eurostat and OECD (2007).
Business dynamics from United States Census Bureau	**Firm births, Employment, Firms survival**	United States, 1977 – 2012	Yes	NACE Rev. 2 industries with codes B to N excluding K642 (activities of holding companies). Thus, firms of the agricultural sector were excluded. Firm survival rates were constructed from the data following the Eurostat methodology using statistics on firm deaths.
VC industry from EVCA	**VC amount, Companies**	European countries in scope, 2007 – 2013	Yes	Included are about 1200 private equity firms located and investing mainly investing in Europe. According to EVCA (2015), "the funds included in the statistics are: private equity funds making direct private equity investments, mezzanine private equity funds, co-investment funds, rescue / turnaround funds. The following funds are excluded from the statistics: infrastructure funds, real estate funds, distress debt funds, primary funds-of-funds," secondary funds-of-funds. The values are interpolated to the amount of domestic investment by using the value specific ratio of domestic investment as given by the statistics on the geographic distribution of investments. Furthermore, the statistics were extrapolated to the total market figure by using the estimation of coverage as published by EVCA.
		1989 – 2006	No[14]	
VC industry from NVCA	**VC amount, Companies**	United States, 1985 – 2014	Yes	"The report includes the investment activity of professional venture capital firms with or without a US office, SBICs, venture arms of corporations, institutions, investment banks and similar entities whose primary activity is financial investing. Where there are other participants such as angels, corporations, and governments in a qualified and verified financing round the entire amount of the round is included. Qualifying transactions include cash investments by these entities either directly or by participation in various forms of private placement. All recipient companies are private, and may have been newly-created or spunout of existing companies. The report excludes debt, buyouts, recapitalizations, secondary purchases, IPOs, investments in public companies such as PIPES (private investments in public entities), investments for which the proceeds are primarily intended for acquisition such as roll-ups, change of ownership, and other forms of private equity that do not involve cash such as services-in-kind and venture leasing." (NVCA, 2014, p. 105). The values are only transformed to constant 2005 prices and otherwise not changed as no further transformations were seen to be necessary for the United States.

[14] Data are available on request from EVCA or from the author of the thesis.

TABLE 15: OVERVIEW OF USED DATA

Retrieved data and source	*Used for variable*	*Country and time scope*	*Online accessible*	*Explanation*
Gross Fixed Capital Formation from World Bank	**Capital**	All countries[15]	Yes	"Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. Data are in constant 2005 U.S. dollars." (World Bank, 2015a)
Patent Applications from World Bank	**Patents**	All countries	Yes	"Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years." (World Bank, 2015a)
R&D Expenditures from Eurostat	**R&D**	All countries	Yes	The values were retrieved in 2005 constant prices and transformed to US$.
Ease of Doing Business Indicator from World Bank	**Sab**	All countries	Yes	Percentage of Distance To Frontier for "Starting a business" indicator[16]
Population from World Bank	**VC amount, Companies, Firm births, Employment, Capital, Patents**	All countries	Yes	Population statistics are used for transformation to per capita values of VC, patent, gross fixed capital formation and business dynamics statistics
Self-calculated exchange rates using data on the Gross Fixed Capital Formation from World Bank	**VC amount**	All countries in scope except United States	Yes	Exchange rates are used for transformation of the different currencies to US Dollar
Self-calculated deflator using data on the Gross Fixed Capital Formation from World Bank	**VC amount**	All countries in scope	Yes	Price indices are used for transformation from current to constant prices with the basic year 2005

[15] All countries in scope: Austria, Baltic countries as an aggregate, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, United Kingdom, United States

[16] The methodology of the indicator is described online: http://www.doingbusiness.org/methodology [Accessed on 14 May 2015]

TABLE 16: SUMMARY STATISTICS: MEAN BY COUNTRY FOR 2004 - 2012[17]

Country	*VC amount in million*	*Compa-nies*	*Births*	*Employ-ment*	*Survival*
Austria	6.9	9.919	1,140	3,632	0.757
	(9)	(9)	(9)	(9)	(6)
Baltics	1.4	2.934	2,467	7,727	0.679
	(9)	(9)	(6)	(2)	(3)
Belgium	18.5	11.33	553.5	1,385	0.761
	(9)	(9)	(7)	(7)	(4)
Bulgaria	0.3	0.411	2,134	8,721	0.682
	(5)	(5)	(9)	(9)	(5)
Czech Republic	0.4	0.255	1,103	4,234	0.764
	(9)	(9)	(9)	(6)	(5)
Denmark	51.6	22.96	741.9	1,284	0.673
	(9)	(9)	(4)	(4)	(1)
Finland	22.2	33.88	1,253	1,192	0.692
	(9)	(9)	(8)	(8)	(4)
France	19.9	9.139	475.6	1,422	0.733
	(9)	(9)	(9)	(9)	(5)
Germany	11.9	11.55	882.2	1,721	0.590
	(9)	(9)	(9)	(9)	(5)
Hungary	4.2	2.600	2,318	5,923	0.586
	(9)	(9)	(9)	(9)	(5)
Ireland	14.6	15.42	568.5	1,176	0.677
	(9)	(9)	(7)	(7)	(4)
Italy	5.9	1.372	892.7	2,256	0.689
	(9)	(9)	(9)	(9)	(5)
Luxembourg	31.2	6.280	2,340	6,950	0.750
	(6)	(6)	(9)	(6)	(5)
Netherlands	18.3	11.53	1,066	3,958	0.583
	(9)	(9)	(9)	(8)	(5)
Norway	44.2	26.01	1,071	2,377	0.669
	(9)	(9)	(9)	(9)	(5)
Poland	0.5	0.501	936.6	3,345	0.652
	(9)	(9)	(9)	(9)	(5)
Portugal	9.8	8.022	2,067	5,339	0.675
	(9)	(9)	(9)	(8)	(6)
Romania	0.7	0.323	1,933	6,361	0.614
	(5)	(5)	(9)	(9)	(5)
Spain	13.6	5.326	1,485	4,364	0.609
	(9)	(9)	(9)	(9)	(5)
Sweden	42.9	40.64	1,477	2,975	0.825
	(9)	(9)	(9)	(9)	(5)
Switzerland	21.1	7.644	921.0	2,023	0.668
	(9)	(9)	(9)	(9)	(1)
United Kingdom	32.4	10.71	3,440	8,249	0.571
	(9)	(9)	(9)	(5)	(5)
United States	83.1	5.291	1,526	9,018	0.630
	(9)	(9)	(9)	(9)	(9)

[17] Number of non-missing values in ()

TABLE 17: SUMMARY STATISTICS: MEAN BY YEAR[18]

Year	*VC amount in million*	*Companies*	*Births*	*Employ-ment*	*Survival*
2004	28.1	16.55	1,491	4,287	0.650
	(20)	(20)	(19)	(16)	(1)
2005	35.3	15.41	1,477	4,351	0.648
	(21)	(21)	(19)	(17)	(1)
2006	33	13.15	1,462	4,246	0.640
	(21)	(21)	(21)	(20)	(1)
2007	19.3	10.44	1,614	4,980	0.701
	(22)	(22)	(22)	(20)	(3)
2008	21.1	9.511	1,564	4,133	0.686
	(23)	(23)	(22)	(19)	(19)
2009	12.8	8.913	1,335	3,687	0.695
	(23)	(23)	(23)	(21)	(20)
2010	12.2	8.726	1,296	3,452	0.659
	(22)	(22)	(23)	(22)	(21)
2011	12	8.751	1,428	3,802	0.658
	(22)	(22)	(23)	(23)	(21)
2012	12.3	9.363	1,371	3,579	0.671
	(22)	(22)	(22)	(20)	(21)

[18] Number of non-missing values in ()

A.3 RESULTS FOR ALTERNATIVE CONTROLS: R&D EXPENDITURE AND INDICATOR FOR STARTING A BUSINESS

TABLE 18: RESULTS WITH R&D EXPENDITURES INSTEAD OF PATENT APPLICATIONS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Variable	Firm births in t		Employment in t		3-year firm survival rate in t+3	
VC am. in t	-0.005		0.017		0.009***	
	(0.03)		(0.02)		(0.00)	
Comp. in t		-0.007		0.007		0.013**
		(0.04)		(0.04)		(0.00)
Capital in t	0.485***	0.478***	0.717***	0.745***	-0.115***	-0.105***
	(0.15)	(0.16)	(0.18)	(0.18)	(0.04)	(0.03)
Capital in t+3					0.012	0.020
					(0.06)	(0.06)
R&D in t	-0.276**	-0.272**	-0.504**	-0.538***	-0.103**	-0.103***
	(0.11)	(0.11)	(0.18)	(0.18)	(0.04)	(0.03)
Obs.	175	175	162	162	100	100
Country FE	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	NO	NO

Table 18 reports the estimates from the FE OLS regression. The dependent variables are firm births, employment and the rate of survival of firms born 3 years before. The independent variables of interest are VC amount and Companies. Capital and R&D expenditures are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

TABLE 19: RESULTS WITH STARTING A BUSINESS INDICATOR (SAB) INSTEAD OF PATENT APPLICATIONS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Variable	Firm births in t		Employment in t		3-year firm survival rate in t+3	
VC am. in t	0.004		0.025		0.011***	
	(0.02)		(0.02)		(0.00)	
Comp. in t		0.007		0.022		0.017**
		(0.04)		(0.04)		(0.01)
Capital in t	0.440**	0.446**	0.336	0.366	-0.147**	-0.133**
	(0.17)	(0.17)	(0.24)	(0.24)	(0.06)	(0.05)
Capital in t+3					0.060	0.066
					(0.06)	(0.06)
SAB in t	-0.299	-0.305	-0.684	-0.701	-0.103*	-0.103*
	(0.33)	(0.35)	(0.51)	(0.52)	(0.06)	(0.06)
Obs.	181	181	168	168	98	98
Country FE	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO

Table 19 reports the estimates from the FE OLS regression. The dependent variables are firm births, employment and the rate of survival of firms born 3 years before. The independent variables of interest are VC amount and Companies. Capital and starting a business indicator are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

A.4 RESULTS FOR ALTERNATIVE TIME STRUCTURE OF THE MODELS ON SURVIVAL RATES

TABLE 20: RESULTS FOR 1-YEAR FIRM SURVIVAL

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	1-year firm survival rate in t+1							
VC am. in t	-0.003		-0.001		-0.003		-0.002	
	(0.00)		(0.00)		(0.00)		(0.00)	
Comp. in t		-0.005		-0.001		-0.005		-0.001
		(0.01)		(0.01)		(0.01)		(0.01)
Capital in t			-0.032	-0.037			-0.028	-0.034
			(0.05)	(0.04)			(0.05)	(0.04)
Capital in t+1			0.088*	0.089*			0.082	0.085*
			(0.05)	(0.05)			(0.05)	(0.05)
Patents in t					-0.008	-0.009	-0.004	-0.004
					(0.02)	(0.02)	(0.02)	(0.02)
Obs.	117	117	115	115	117	117	115	115
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 20 reports the estimates from the FE OLS regression. The dependent variable is the rate of survival of firms born 1 years before and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

TABLE 21: RESULTS FOR 2-YEAR FIRM SURVIVAL

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	2-year firm survival rate in t+2							
VC am. in t	0.004		0.004		0.005		0.004	
	(0.01)		(0.00)		(0.01)		(0.00)	
Comp. in t		0.008		0.005		0.009		0.005
		(0.01)		(0.01)		(0.01)		(0.01)
Capital in t			-0.073*	-0.065*			-0.071*	-0.064*
			(0.04)	(0.04)			(0.04)	(0.04)
Capital in t+2			0.145***	0.145***			0.137***	0.137***
			(0.04)	(0.04)			(0.04)	(0.05)
Patents in t					-0.015	-0.013	-0.011	-0.011
					(0.02)	(0.02)	(0.02)	(0.02)
Obs.	111	111	109	109	110	110	108	108
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 21 reports the estimates from the FE OLS regression. The dependent variable is the rate of survival of firms born 2 years before and the independent variables of interest are VC amount and Companies. Capital and patents are control variables. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

A.5 GRAPHS ON VC AMOUNT AND FIRM BIRTHS[19]

FIGURE 2: VC AMOUNT BY COUNTRY (OWN GRAPH)

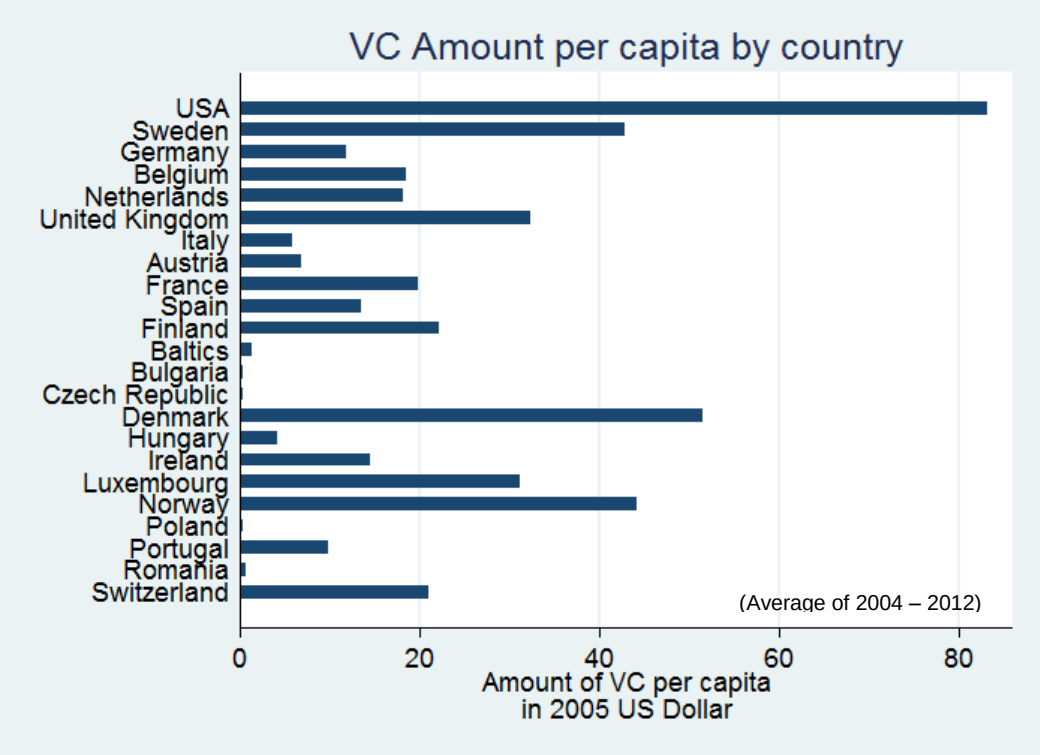
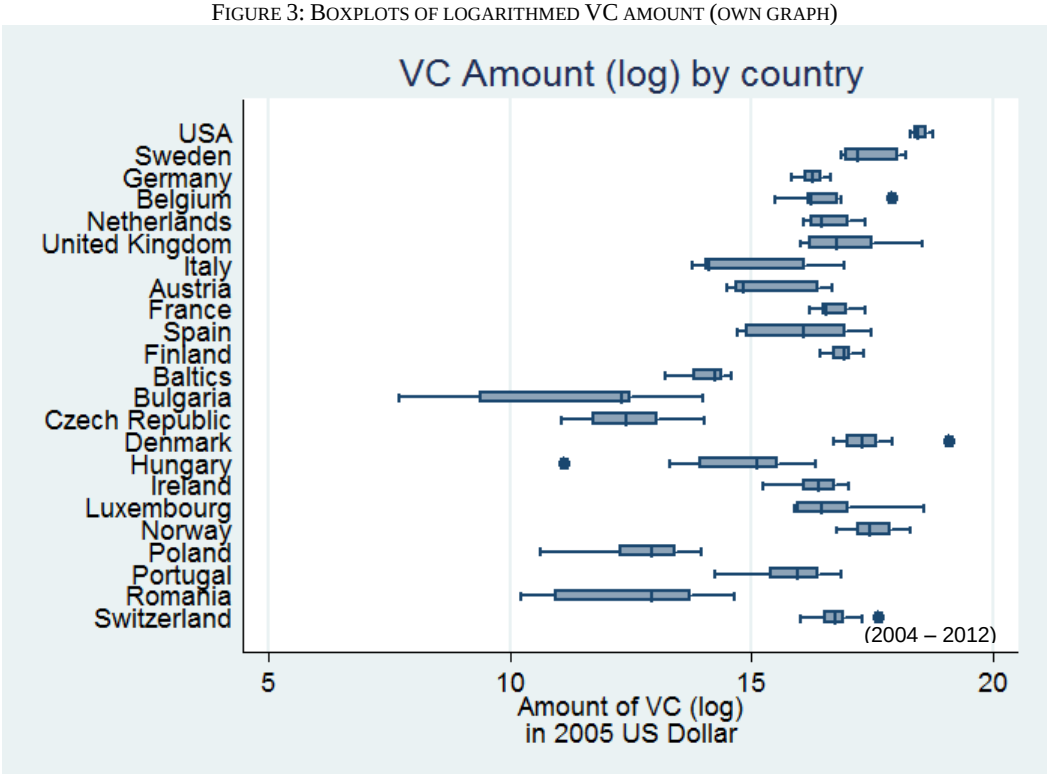


FIGURE 3: BOXPLOTS OF LOGARITHMED VC AMOUNT (OWN GRAPH)



[19] All graphs are own graphs using data as described in part 4 and appendix A.2. All four graphs illustrate all 23 countries in scope and for the years of 2004 – 2012.

FIGURE 4: FIRM BIRTHS BY COUNTRY (OWN GRAPH)

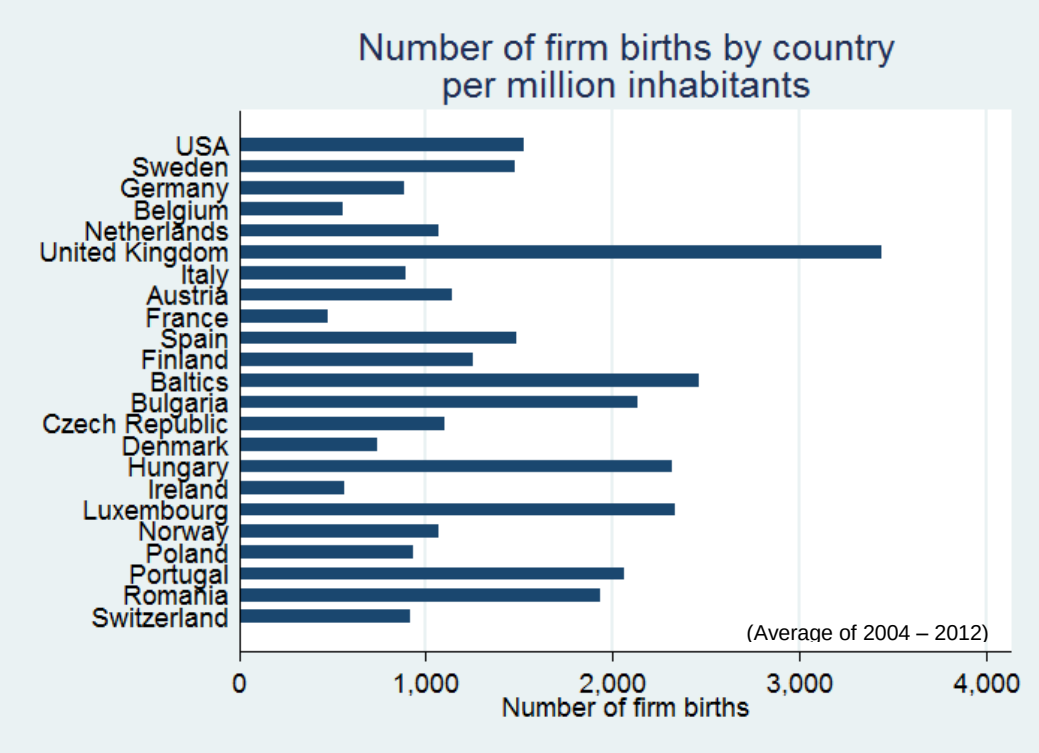
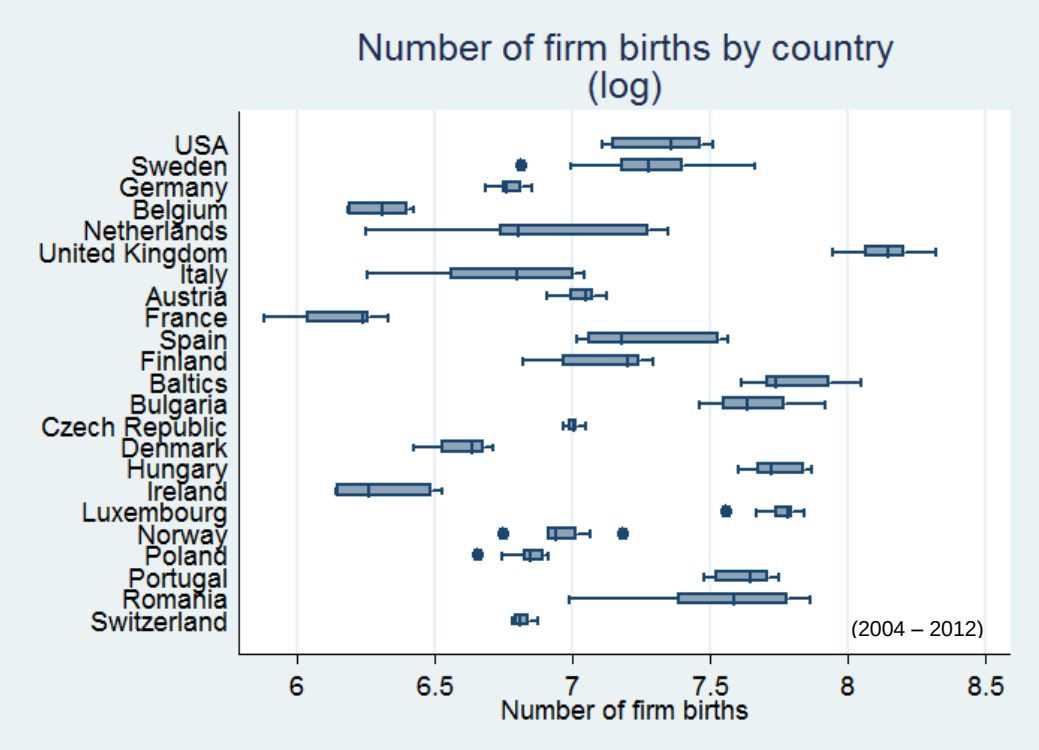


FIGURE 5: BOXPLOTS OF LOGARITHMED FIRM BIRTHS BY COUNTRY (OWN GRAPH)



A.6 RESULTS FOR THE FIRST STAGE OF THE 2SLS REGRESSIONS

TABLE 22: RESULTS FOR THE FIRST STAGE OF THE 2SLS REGRESSION OF FIRM BIRTHS

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Firm births in t-1							
Births in t-2	0.653***	0.628***	0.604***	0.598***	0.620***	0.594***	0.566***	0.556***
	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
VC am. in t	0.03***		0.015		0.032***		0.020*	
	(0.01)		(0.01)		(0.01)		(0.01)	
Comp. in t		0.048**		0.0341*		0.054**		0.042**
		(0.02)		(0.02)		(0.02)		(0.02)
Capital in t			0.382***	0.413***			0.400***	0.0443***
			(0.11)	(0.10)			(0.11)	(0.10)
Patents t					-0.028	-0.023	-0.046	-0.043
					(0.05)	(0.05)	(0.05)	(0.05)
Obs.	144	144	142	142	143	143	141	141
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 22 reports the estimates from first stage of the 2SLS regression of firm births with fixed effects. For the regressions, 23 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level

TABLE 23: RESULTS FOR THE FIRST STAGE OF THE 2SLS REGRESSION OF EMPLOYMENT

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Variable	Empoyment in t-1							
Empl. in t-2	0.438***	0.410***	0.414***	0.377***	0.415***	0.387***	0.433***	0.433***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)
VC am. in t	0.055***		0.050***		0.058***		0.050***	
	(0.018)		(0.02)		(0.02)		(0.02)	
Comp. in t		0.099***		0.102***		0.103***		0.081***
		(0.03)		(0.03)		(0.03)		(0.03)
Capital in t			0.311*	0.413**			0.649***	0.769***
			(0.19)	(0.18)			(0.15)	(0.15)
Patents t					-0.018	-0,029	-0.025	-0.045
					(0.10)	(0.10)	(0.10)	(0.10)
Obs.	120	120	120	120	119	119	119	119
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 23 reports the estimates from first stage of the 2SLS regression of employment with fixed effects. For the regressions, 22 countries and the years from 2004 to 2012 are considered.
* significance at the 10 % level, ** significance at the 5 % level, *** significance at the 1 % level