Turning European new technology-based firms into "gazelles": the role of public (and private) venture capital

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Abstract

In this work, we compare sales, employees and total assets growth of Venture Capital (VC)-backed and non VC-backed New Technology-Based Firms (NTBFs). Our focus is on the type of investor, and in particular on the treatment effect that public venture capitalists (PUVCs), further distinguished into governmental and university funds, exert on the growth performances of European NTBFs. We consider a unique and recently constituted longitudinal dataset composed of 8391 NTBFs from seven European countries (Belgium, Finland, France, Germany, Italy, Spain, UK) and observed from 1984 (or subsequent foundation year) to 2009. The results of econometric estimates indicate that overall NTBFs financed by PUVCs underperform with respect to firms invested by private venture capitalists (PRVCs) in terms of growth (of any type), but that the impact of PUVC is still positive and significant when it comes from governmental rather than university sources and it is provided to very young NTBFs. This evidence highlights that "hands-on" governmental intervention in the venture capital market can be extremely valuable for NTBFs in the early stages of their lives.

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1. Introduction

Young and high tech start-ups (often referred to as "New Technology-Based Firms", NTBFs)[1] represent an important engine in increasing the dynamic efficiency of the economic system through the provision of new products/processes to the market (Audretsch, 1995). However, these firms allegedly suffer from financial constraints (Carpenter and Petersen, 2002a; Colombo and Grilli, 2007) and lack of commercial and managerial competences (Teece, 1986; Gans and Stern, 2003) that limit their growth and even threatens their survival (Carpenter and Petersen, 2002b).

Two theoretical reasons are often invoked in order to justify the need of public support measures by NTBFs. First, firm expenditures in R&D activities may be lower than the social optimum. Since new knowledge created through privately funded R&D activities is not rival (Arrow, 1962; Nelson, 1959), R&D spillovers may prevent firms from defending their technological innovations in the product market and profiting from them. This circumstance is likely to be extremely realistic for young and small entities (Teece, 1986; Gans and Stern, 2003). The second economic rationale points to the presence of capital market imperfections in financing R&D investments. The access to external financing is especially problematic for NTBFs (Westhead and Storey, 1997; Freel, 1999). Because of the technology-intensive nature of their activity, their lack of a consolidated track record, the nature of their assets which are firm-specific and/or intangible (e.g. founders' human capital) and hence cannot be pledged as collateral, they are very likely to face severe adverse selection and moral hazard problems in raising external capital (Berger and Udell, 1998; Carpenter and Petersen, 2002a; Denis, 2004). With regard to debt financing, many of the obstacles stem from the inability of banks and other similar financial institutions to identify good projects from "lemons" in sectors usually characterized by highly skewed returns, ex-ante (i.e. hidden information) and ex-post (i.e. hidden action) asymmetric information and a lack of inside collateral

[1] This study adheres to the *gold standard definition* of a 'new technology-based firm' originally due to Arthur D. Little that identifies an NTBF as a less than 25 years old independent firm active in high technology industries.

to secure debt (Carpenter and Petersen, 2002a; Freel, 2007). New equity finance in the form of initial public offerings, although presenting several advantages over debt, is still subject to capital market imperfections (Carpenter and Petersen, 2002a). In this respect, private venture capital (PRVC, henceforth)[2] is generally considered by both academics and practitioners as the most suitable external financier for NTBFs (e.g. Sahlman, 1990; Gompers and Lerner, 2001; Kaplan and Strömberg, 2001; Denis, 2004; Croce et al., 2010). However, PRVC has also shown some limitations in financing NTBFs (Lerner, 1999; Hall, 2002). Even though PRVCs are able to overcome information asymmetry problems by developing accurate context-specific screening procedures and monitoring portfolio firms, they generally focus on specific industries and back only a small fraction of firms in high-technology industries (Gompers and Lerner, 1998; Bottazzi and Da Rin, 2002).

In this respect, it is perhaps not surprising that national governments often seek to support and expand the venture capital industry as a means of promoting innovation and economic growth. This is particularly true in the European context where half of the gap in R&D spending suffered with respect to US is reputed by the European Commission (see Europe 2020 Agenda, p. 10) to be due to the smaller share of high-tech firms active in Europe, and in turn, to a relatively less developed venture capital market. Policy-makers across Europe have consistently stressed that the European market is fragmented and insufficiently innovator-friendly (see European Commission, 2009) and a crucial means by which Europe can achieve its objective of becoming a knowledge-based economy is by "making an efficient European venture capital market a reality" in order to "make financing available for start-up companies, and for innovative SMEs" (European Commission, 2010, p. 20). Accordingly, producing a higher number of "gazelles" (i.e. rapid growth firms) in high-tech markets is a clear European policy's objective.

[2] This study adopts the prevailing criterion usually followed by the most known commercial databases in the field (e.g. Venture Expert) that characterize different typologies of venture capitalists by the diverse nature of the management company responsible for the investing process. In particular, here we focus our attention on two basic different types of '*general partners*': private corporations (we include in this category both *independent* and *captive* venture capitalists) and public entities (where we distinguish governmental from university bodies, see *infra* in the main text).

From this perspective, the lack of a sufficient flow of VC investments in early-stage knowledge-based firms has led European governments to make significant efforts to expand venture capital activity through a variety of different policy schemes. In particular, public sector-related VC investors have been playing an important role in shaping the European VC landscape. According to our data (provided by the VICO database, see Section 3), they were involved in almost 20% of the VC investments that occurred in 10 years old (or younger) European high-tech firms in the 1994-2004 period. However, whether and when these measures have been effective is questionable. The evaluation of such programs is difficult due to the differences among public VC programs located in different geographical contexts. The heterogeneity of public VC interventions is a critical issue in Europe. Thus, the creation of a shared framework on the role of public VC is necessary to make an efficient European VC market real, in accordance with the abovementioned European Commission's objectives. In the extant literature, overall results are still considered largely unsatisfactory (see for a review Wright et al., 2006; Bertoni and Croce, 2011). Obviously, the playing field is extremely vast. Citing Leleux and Surlemont (2003, p.82):

> "Legislatures and governments play a number of roles in energizing private equity markets. First, they define both the legal and fiscal environments in which investors operate, providing various degrees of protection and/or taxation to different constituencies, flows (capital gains, dividends, etc.) and structures (partnerships, sole proprietorships, etc.). […] Second, they sometimes intervene directly in the venture capital process by funding and managing public venture funds […]. Third, they provide incentives or impediments to private equity investments by regulated private companies such as banks, pension funds or insurance companies".

The present study focuses on the second type of public intervention cited by Leleux and Surlemont, i.e. the "hands-on" approach based on direct participation of public operators in the venture capital market (public venture capital, PUVC henceforth), where we also distinguish between governmental (GVC, henceforth) and university (UVC, henceforth) funds. In so doing, we aim at shedding light on the following three separate research questions: is there any difference in the treatment effect on firm growth between PRVC and PUVC investors and, more generally, is PUVC beneficial to the growth of NTBFs? Is the PUVC impact on firm growth different according to the NTBF's age at the reception of the first round of financing? Do different typologies of public venture capital (GVC and UVC) investors play a differential role in determining NTBFs growth performances?

To capture the effect of VC financing on firm growth, we estimate an augmented Gibrat law type panel data model on a longitudinal dataset of European NTBFs. In order to control for the potentially endogenous nature of VC financing we resort to instrumental variables techniques. The VICO dataset (built up through the support of the 7th EU Framework Programme) includes 8,391 companies from seven European countries (Belgium, Finland, France, Germany, Italy, Spain and the UK) out of which 761 were VC-backed between 1994 (or subsequent firm's foundation year) and 2009. The results indicate that the overall treatment effect of PUVC is negligible, while investments by PRVCs spur the growth performances of NTBFs. Nevertheless, for both typologies of VCs, the entry of the external investor is more beneficial if it occurs in the early stages of a firm's life (when the investee is less than or equal to 5 years old). Moreover, when we further distinguish PUVC into its two components, venture capital provided from governmental sources is found to have a positive and statistically significant impact on the growth of young NTBFs, especially in terms of employment growth. This finding is clearly not at odds with the rationale of a direct public intervention in the VC industry with the aim of targeting and sustaining early-stage and high-risk technological intensive new business ventures.

So the paper adds to the entrepreneurial finance literature in three different aspects. First, due to the novelty and richness of the database at our disposal, we provide evidence on the effects of venture capital investments on the growth of European NTBFs at an unparallel level with respect to extant studies in the field, that generally have a national focus or analyze limited samples (in size, time-span or scope).[3] Second, this work differentiates the typology of venture capital operators, and in particular it analyses a category, public venture capital, including governmental and university funds, that has been taken very rarely into consideration by the extant empirical studies in the field,

[3] See Bertoni et al. (2011) for a discussion on data limitations suffered from the extant empirical literature studying the impact of venture capital on the performances of investee firms.

especially those based on European countries. Conversely, an empirical assessment of the actual capacity of the public venture capital segment in fostering NTBFs growth is extremely needed at the pan-European level in order to increase the information set of policy makers on the effectiveness of the existing “hands-on” approach in accomplishing the European goal of increasing the number of high-tech gazelles. Finally, most previous studies in this field suffer from methodological weaknesses. First, some of these studies focus on IPO firms only, the reason being that information about these firms is easier to collect. However, focussing on samples composed only of IPO firms may create biases with respect to the outcome of the investment, the type of investor, the type of company, and the sectors which are represented in the sample. Moreover, the analysis of firm performance in the period following the IPO does not allow disentangling the effect of VC financing from that of the IPO. Second, many studies include only a population of firms which survived as independent firms up to a certain date. This gives rise to survivorship bias due to lack of control for bankruptcy and mergers and acquisitions. Third, many studies addressing the impact of VC investors on different aspects of performance suffer from a lack of a proper control for the counterfactual and for the potential endogeneity of VC financing.[4]

The paper is structured as follows. In the next Section we survey the literature on the effects of VC financing on firm growth, and focus in particular on the specific characteristics of different types of venture capital investors. In Section 3 we describe the VICO dataset that will be used in the empirical analysis. Section 4 illustrates the empirical methodology. Section 5 reports the results and several checks performed to test the robustness of our findings. Finally, Section 6 concludes and provides some hints for future research.

2. Literature background

[4] See Bertoni et al. (2011) for a discussion on the methodological weaknesses suffered from the extant empirical literature studying the impact of venture capital on the performances of investee firms.

All of the literature on the public support to NTBFs and, more generally, to firms' R&D activities adheres to an 'ideal' vision of the functioning of markets, where the public policy mission should aim at sustaining those projects that bring benefits to the social welfare but that are presently dominated in private value by other projects that receive attention by private investors (see e.g. Link and Scott, 2010). Therefore, the objective pursued by policy makers should be to select projects with social benefits that are below the private hurdle rate and would remain unexpressed without the public intervention. Bad quality business projects are unlikely to fall in this category, and it is very unlikely that direct participation in a long-stagnant NTBF might be regarded as a successful policy intervention. The point is made clear by Lerner (2002, p.78):

"If government programmes can identify and support neglected (by private financing sources) firms, they might provide the "stamp of approval" these high potential, underfunded firms need to succeed. But if government officials are going to address these problems, they will need to be able overcome the many information asymmetries and identify the most promising firms. Is it reasonable to assume that government officials can overcome these problems while private sector financiers cannot? Certainly, this possibility is not implausible. For instance, specialists at the National Institute of Health or Department of Defense may have considerable insight into which biotechnology or advanced materials companies are the most promising, while the traditional financial statement analysis undertaken by bankers would be of little value".

The natural consequence is that if it is legitimate to expect that well-behaved financial markets should imply a private venture capital industry able to propel NTBFs growth performances, also public risk capital, although targeting riskier and more embryonic projects, should *ceteris paribus* still produce a positive and significant impact on the growth performance of investee firms. Reasons underlying these supposed beneficial effects (but also the drawbacks) of both types of VC are detailed in the next two sub-paragraphs.

2.1. Private venture capitalists

PRVC investors are recognized by both academics and practitioners as the most suitable financiers for NTBFs. The financial literature highlights several motives explaining why the access to PRVC financing should result in a higher growth rate for NTBFs.

First of all, PRVC investors generally focus on specific industries (Gompers, 1995; Amit et al., 1998; Bottazzi and Da Rin, 2002). Due to their industrial specialization, they allegedly develop context-specific screening capabilities that make them able to judge quite accurately the commercial value of entrepreneurial projects and the entrepreneurial talent of the proponents (Chan, 1983; Amit et al., 1998). Therefore, they are able to deal effectively with asymmetric information problems that would otherwise prevent great hidden value firms from obtaining the financing they need. Furthermore, the relaxation of financial constraints leads to higher firm growth.

Second, PRVC firms are active partners (Gorman and Sahlman, 1989; Barry et al., 1990). On the one hand, they monitor portfolio companies. On the other hand, PRVC investors make use of specific financial instruments and contractual clauses (e.g. stage financing) that protect their investments from opportunistic behaviors on the part of entrepreneurs and create high powered incentives for them (Sahlman, 1990; Gompers, 1995; Hellmann, 1998; Kaplan and Strömberg, 2003, 2004).

Third, PRVC investors allegedly perform a key coaching function to the benefit of portfolio firms (Gorman and Sahlman, 1989; MacMillan et al., 1989; Bygrave and Timmons, 1992; Sapienza, 1992; Barney et al., 1996; Sapienza et al., 1996; Casamatta, 2003; Inderst and Muller, 2004; Kaplan and Strömberg, 2004; Repullo and Suarez, 2004; Colombo and Grilli, 2010). In fact, they provide advising services to portfolio companies in fields such as strategic planning, marketing, finance and accounting, and human resource management, in which these firms typically lack internal competencies. Accordingly, Hellmann and Puri (2002) document that PRVC investors favor the recruitment of external managers, the adoption of stock option plans, and the revision of human resource policies by portfolio firms, thus contributing to their managerial "professionalization".

Moreover, portfolio companies take advantage of the network of social contacts of PRVC investors with potential customers, suppliers, alliance partners, and providers of specialized services like legal, accounting, head hunting, and public relation services (Lindsey, 2003; Colombo et al., 2006; Hsu, 2006).

Finally, PRVC financing signals the good quality of a NTBF to third parties; therefore VC-backed companies find it easier to get access to external resources and competencies that would be out of reach without the endorsement of the PRVC investor (Stuart et al., 1999).

Despite all of the abovementioned arguments point to a positive treatment effect of PRVC towards investee NTBFs, it is important to acknowledge that the agency relation between the VC investor and the entrepreneurs of portfolio companies may also engender conflicts (Gompers and Lerner, 2001; Colombo et al., 2010). In fact, entrepreneurs and external investors may have different strategic visions; disagreements may absorb the entrepreneurs' effort and attention to the detriment of the pursuit of business opportunities. Even if no conflict arises, the need of PRVC investors to monitor managerial decisions may increase bureaucracy and formalization of decision processes, hampering flexibility and the ability of firms to timely grasp business opportunities. Furthermore, as PRVC investors are competent investors, they might be able to expropriate entrepreneurs of their innovative business ideas and exploit them also in their absence (Ueda, 2004). The associated appropriability hazards may induce entrepreneurs to take decisions aimed at protecting their firm's technological knowledge that are detrimental to firm growth. Thus, if it is legitimate to expect a positive impact of PRVC on NTBFs growth, this cannot be taken for granted. The available empirical evidence confirms the statement (see Bertoni et al., 2011 for a comprehensive review) pointing to a positive association between VC finance and growth, although the results are not completely unanimous (see e.g. Bottazzi and Da Rin, 2002).

2.2. Public VC: governmental and university funds

GVC programs should attempt to finance primarily those entrepreneurial projects that still at an infancy stage, officials recognize as very promising but at the same time they repute not capable to obtain enough private resources in order to be realized. As highlighted before, the argument relies to a great extent on the presumption that public operators are able to "pick future winners". If this is not totally implausible using the words of Lerner (2002), in the real world there are many arguments that may be invoked for sustaining the opposite thesis (and the same article of Lerner furnishes a temptative list).

In a nutshell, informational problems might be amplified and governmental venture capitalists might select wrong projects. Or politicians may endeavor in “cherry picking” behavior and simply end up crowding out more efficient PRVCs (see also on this point Cohen and Noll, 1991; Wallsten, 2000). Furthermore and more simply, at the playing level field, GVC funds might also lack managerial competencies. First, managers of governmental funds may not have the experience and the skills necessary to support and manage entrepreneurial high-tech companies. Government officials are probably unable to match the quality level of value-added activities, expertise and advice to portfolio firm’s management of specialized (private) investment companies (Leleux and Surlemont, 2003). Second, the incentive structures governmental managers often face differ markedly from the traditional private fund arrangement, where managers benefit from a performance-related bonus. So talented managers are likely to be more attracted by private rather than governmental funds; and, secondly, governmental funds managers are not even greatly stimulated to increase their skills, given the unresponsiveness of their wages to realized performances.

Accordingly, anecdotical evidence suggests that individual fund managers are typically less experienced and less remunerated in governmental rather than private funds. Again, it is much more likely to observe managers move from governmental funds to private funds, rather than the other way round. Then it is likely that the “survivor” principle – good fund managers are retained and poor managers are fired or reassigned – operates more vigorously in the private sector.

In sum, the question of the impact of GVC on the growth performances of NTBFs is very much open at the empirical level. Following the arguments explained above, a positive impact of GVC is much less likely than the one hypothesized for PRVC; nevertheless, a positive treatment effect would clearly represent a signal for European policy makers that an “hands-on” approach in this field may still produce effective results in sustaining the high-tech sector. Available empirical evidence on this issue is extremely thin. Brander et al. (2008), using a large sample of all US VC-backed companies, analyze the moderating role of GVC on different than growth performance measures (e.g. investor's exit, patents) and find a positive impact of GVC only if the government's stake in the partnership is sufficiently small. At the European level, few sporadic studies have analyzed the role of GVC and its impact on investees growth performances. These studies focus on nation-specific samples and overall suggest a positive albeit statistically weak and inferior impact of the public type of investment with respect to the private one (e.g. Manigart and Beuselinck, 2001 for Belgium; Balboa et al., 2007 for Spain).

The second PUVC category we consider is represented by university-sponsored VCs (UVCs). UVC funds represent the most direct participation by academic institutions in investing through equity capital in new ventures based on technologies that are close to the scientific fields of faculty members. Universities usually operate in the VC market through their technology transfer offices. Their objective is twofold: i) create a VC fund to commercialize the technology developed by faculty members, that is similar to that used by portfolio NTBFs, in order to get significant revenues from this investment process; ii) use the additional funding collected through the UVC fund to speed-up the commercialization process of technologies developed by university scientists through 'more conventional' means: relationships with corporations (technology licensing and university/industry collaborations) and the creation of university spin-out companies. It is worth noting that many faculty members are very interested in having their endowment create a UVC fund in a manner that increases the flow of capital to their university. Conversely, other academics are strongly reluctant to any type of investment done for economic purposes only.

On the one hand, all the above exposed arguments on GVC clearly relate to UVCs. On the other hand, these two typologies of PUVC funds may also differ in some relevant dimensions. Despite of the fact that the first ever modern venture capital firm had as founders academic personnel from MIT and the Harvard Business School (Lerner, 2005), UVC is a relatively new and surely under researched phenomenon. Few scientific articles of argumentative nature exist on this type of venture capital funds (e.g. Atkinson, 1994) but there is a total lack of systematic evidence on the impact that this typology of VC exerts on the investee companies. In line with the increasingly relevant third mission that higher education systems are embracing (Laredo, 2007), UVCs are expected to play a progressively more important role in the next future. As suggested by Lerner (2005, p. 87):

> "University administrators see new firms as having several key benefits: they can generate considerable revenue for the institution, make the university more attractive to current and potential faculty members, and benefit the community and the nation as a whole. Faculty members often view these ventures as potential sources of both personal wealth and career fulfillment".

University technology transfer offices typically focus on NTBFs with promising technologies. However, these NTBFs are also characterized by either uncertainty or informational gaps, which make it difficult for the university-affiliated investors to evaluate their technology. While university managers, i.e. technology transfer office staff, have very deep knowledge of their respective fields, often lack realistic expectations about their target investments. The effectiveness of investment process is likely to depend critically on the experience level of the technology transfer office staff. But retaining experienced staff has been difficult for many universities. Few university technology transfer offices can offer compensation approaching the levels that either corporate venture capital investors or independent venture capital firms guarantee to their managers. As a result, many offices have experienced a 'revolving door' phenomenon (Lerner, 2005): new staff, most often Ph.D. candidates remain at the organization long enough to develop some familiarity with both the licensing process and the business experience, but then leave for the private sector. Reasonably, this latter aspect may increase the gap in managerial skills suffered from UVC funds with respect to PRVC funds, and make UVC investors less effective in enhancing firm's growth than not only PRVCs but also GVC investors.

3. Data

3.1 VICO dataset

The VICO dataset has been built thanks to the joint effort of nine universities throughout Europe

(Ecole des Mines de Paris, Politecnico di Milano, Libera Università Carlo Cattaneo, Research Institute of the Finnish Economy, Centre for European Economic Research (ZEW), Universidad Complutense de Madrid, University College London, Vlerick Leuven Management School, and University of Gent) with the support of the 7th European Framework Program (Grant agreement no.: 217485). The objective of the data collection process was to build a large sample of high-tech firms in order to provide a comprehensive picture of VC activity in high-tech sectors in seven European countries: Belgium, Finland, France, Germany, Italy, Spain and the United Kingdom.

All companies included in the sample were founded after 1984, were independent at foundation, and operate in the following high-tech sectors: pharmaceuticals, biotechnology, electronic components, telecommunication equipment, computers, electronic, medical and optical instruments, robotics and automation equipment, aerospace, telecommunication services, internet, software, R&D and engineering services. The dataset includes two strata of companies: the first includes a sample of VC-backed companies and the second a control group of non-VC-backed companies. All VC-backed companies received their first round of VC between 1994 and 2004 and were less than 10 years old at that time.

The data collection process was performed by eight teams, seven of which were responsible for gathering a given number of companies responding to the abovementioned criteria in the two strata, and one in charge of the central collection and construction of the overall dataset. The number of companies to be collected by each country-specific team in the VC-backed stratum was initially set to be approximately proportional to the size of the VC market in the country, while the control group was set to be 10 times larger than the VC-backed stratum. Each local team started the identification of the VC-backed sample from a query on VentureXpert and then complemented the list by accessing other, often country-specific, sources such as: VC investor websites, local VC associations, Press releases, Press clippings, IPO Prospectuses, Stock exchange records, Zephyr, the Library House, the ZEW Foundation Panel, VCPro-Database, BVK Directory, the Research on Entrepreneurship in Advanced Technologies (RITA) directory, Private Equity Monitor, José Martí

Pellón's VC Database, and webcapitalriesgo.com. The use of several sources of information allows the dataset to embrace a set of VC investors which is usually largely underrepresented by more customary commercial data providers (e.g. GVCs, UVCs). Moreover, the sample includes both successful and non-successful deals and both surviving and non-surviving (e.g. bankrupt, acquired) companies.

The second stratum of the dataset is composed of non-VC-backed companies mainly deriving from a random extraction (conditional on the criteria reported above) from different calendar year versions of Bureau Van Dijk's Amadeus dataset and complemented by other country-specific sources such as: industry associations, Chambers of Commerce, commercial firm directories, Zephyr, Creditreform, the ZEW Foundation Panel, and the Research on Entrepreneurship in Advanced Technologies (RITA) directory. The extraction procedure of the control group ensures the inclusion of both surviving and non-surviving companies, to avoid the emergence of survivorship bias (see the robustness checks in Section 5.2).

For each company in the sample an in-depth information set was collected, including: general company information (name, year of foundation, NACE rev. 1.1 and NACE rev. 2 industrial classification, and NUTS2 geographic area), contact information (address, phone, fax, name and email address of a manager or founder), accounting information (an average of eight years of accounting data are available for each company), patenting history (from European Patent Office), status in 2009 (active, liquidated, acquired, inactive), and listing (if the company went through an IPO and, if so, when). All VC investors involved in companies in the VC-backed stratum across all stages were identified and information was collected about their typology, the date on which the investments occurred, the fund(s) (if any) which carried out the transaction. Finally, time and mode of exit (if any) by each investor in each VC-backed company was also collected.

Information collected at local level was checked for reliability and internal consistency by each national team and regularly sent to the central data collection unit, which ensured that information was consistent and comparable across countries and its availability balanced. An increase in the target number of firms was requested when the information set in a country turned out to be sparser than average, to compensate for a higher expected loss of usable firm-year observations in the econometric analyses.

3.2. Descriptive statistics

The dataset consists of 8,391 companies, 761 of which are VC-backed. The breakdown by country, foundation period and sector is provided in Table 1.

[Table 1 about here]

The sample is sufficiently balanced across different countries and differences in the number of NTBFs mainly reflect the presence of industrial activities and /or the different intensities of the high-tech segment over national production systems. VC-backed NTBFs representation appears larger in the three strongest economies, with UK being the leader (176 VC-backed firms, 23.13% of the total VC-backed firms), followed by Germany (134 VC-backed NTBFs, 17.61%) and France (14.72%). Most of sample firms were borne around year 2000: 2951 (339 VC-backed) were established between 1995-1999 and 3171 (306 VC-backed) from 2000 and 2004. Software with 256 VC-backed NTBFs (33.64% of the total VC-backed firms) out of 3765 sampled companies (44.87% of the total sample), ICT manufacturing with 126 VC-backed firms (16.56%) out of 1508 companies (17.97%), and Internet & TLC services with 178 VC-backed NTBFs (23.39%) out of 1367 companies (16.29%) are among the most represented sectors as in terms of VC-backing activity and total presence. This reflects the considerable importance of IT-related activities during the observation period.

Table 2 reports the distribution of NTBFs backed by different types of VC investors again segmented by country, foundation period and sector.[5]

[5] The sum of the total number of PRVC-backed firms and PUVC-backed firms is greater than the total number of VC-backed firms shown in Table 1 (761). This is due to the fact that in Table 1 we do not take into account syndicated deals and co-financed deals, i.e. the focal NTBF may receive VC from different types of VC investors in different stages of its life. This also explains why the sum of GVC-backed firms and UVC-backed firms is not equal to the total number of PUVC-backed firms.

[Table 2 about here]

With regard to country distribution, PRVC-backed NTBFs representation appears similar to that shown in Table 1: UK leads (162 PRVC-backed firms, 25.23% of the total PRVC-backed firms), followed by Germany and France (117 and 104 PRVC-backed NTBFs respectively, 18.22% and 16.20% respectively). The situation is very different by looking at the PUVC-backed NTBFs representation, where Belgium has the greatest share of public investors (52 PUVC-backed firms, 18.44% of the total PUVC-backed firms) followed by Spain (47 PUVC-backed firms, 16.67%) and still France (46 PUVC-backed firms, 16.31%). Again great heterogeneity emerges once the PUVC category is decomposed into GVC-backed and UVC-backed firms, with France that shows the highest percentage among GVC-backed NTBFs (46 GVC-backed firms, 19.33% of the total GVC-backed firms), followed by Spain (44 GVC-backed firms, 18.49%) and Germany (36 GVC-backed firms, 15.13%). Conversely, UVC seems more developed in Belgium and UK (24 and 20 UVC-backed firms respectively, 38.71% and 32.26% of the total UVC-backed firms respectively). It is worth noting that there are strong differences between shares of private and public investors in some countries. In Belgium (52 PUVC-backed firms out of a total number of 282 PUVC-backed firms, 18.44%), Finland (34 PUVC-backed firms, 12.06% of the total PUVC-backed firms) and Spain (47 PUVC-backed firms, 16.67%) there is a relatively stronger presence of public investors (shares of PRVC-backed firms out of the total of PRVC-backed firms are 11.37%, 7.94%, and 7.63% respectively). While in Italy and UK, the presence of private investors is higher (86 and 162 PRVC-backed firms, 13.40% and 25.23% of the total number of PRVC-backed firms respectively) than that of PUVCs (23 and 43 PUVC-backed firms, 8.16% and 15.25% of the total number of PUVC-backed firms respectively). Most of both PRVC-backed firms and PUVC-backed firms were born between 1995 and 2004: 552 PRVC-backed (85.99% of the total number of PRVC-backed firms) and 234 PUVC-backed firms (82.98% of the total number of PUVC-backed firms). UVC investments represent a relatively new phenomenon: there are no UVC-backed firms before 1995.

Software represents the main target sector both for PRVC investors (219 PRVC-backed firms out of a total of 642 PRVC-backed firms, 34.11%) and for PUVC investors (96 PUVC-backed firms, 34.04% of the total number of PUVC-backed firms). Conversely, Biotech and Pharmaceuticals represent the highest share of UVC investments (23 UVC-backed firms, 37.10% of the total number of UVC-backed firms), the second target markets for GVC investments (26.89% of the total number of GVC-backed firms) and the second industry for the PRVC market (127 PRVC-backed firms out of a total of 642 PRVC-backed firms, 19.78%). The third share of GVC investments is in ICT manufacturing (18.49% of the total number of GVC-backed firms) while the third target market for PRVC investments is represented by Internet (121 PRVC-backed firms, 18.85% of the total number of PRVC-backed firms).

Table 3 illustrates the distribution of NTBFs backed by different types of VC investors by the age of the investee firm at the time of the first round of financing. It is worth noting that 208 out of 282 PUVC investments (73.76%) were made when NTBFs were less than 2 years old. The same pattern (and even more sharp) also applies to UVC financing: only 1 out of 62 (1.61%) investments was made in a mature firm (i.e. older than 5 years). Quite unsurprisingly, the PRVC category is the one less oriented in investing in very young NTBFs, but still the great majority of private investments flows towards NTBFs when these latter are very young: 68.22% of PRVC investments were made on NTBFs that were less than 2 years old.

[Table 3 about here]

4. Econometric methodology

4.1. Specification of the econometric models

The impact of PRVC and PUVC investments on firm growth is investigated through the estimation of an augmented Gibrat law panel data model a là Evans (1987):

$$LnGrowth_{i,t} = \alpha_0 + \alpha_1 LnAge_{i,t} + \alpha_2 LnSize_{t-1} + \psi_1 PRVC_{i,t} + \varphi_1 PUVC_{i,t} + W_i + \varepsilon_{i,t}. \qquad (I)$$

The basic specification is a sort of gold standard in the industrial organization literature examining firm growth dynamics (see e.g. Sutton, 1997; Caves, 1998). $LnGrowth_{i,t}$ is the annual logarithmic growth and the model includes the following covariates as independent variables: $LnAge_{i,t}$ is the (logarithmic) age of NTBFs at time *t*; $LnSize_{i,t-1}$ which measures (alternatively) the logarithm of sales and number of employees (and total assets, see the Appendix) at time *t-1*. We depart from the standard Gibrat testing specification in that we include the dummy variables $PRVC_{i,t}$, and $PUVC_{i,t}$ which indicate the VC status of firms (PRVC-backed, $PRVC_{i,t}$=1; PUVC-backed, $PUVC_{i,t}$=1). $PRVC_{i,t}$ and $PUVC_{i,t}$ switch from 0 to 1 in the year in which firms obtain the first round of PRVC or PUVC finance, alternatively. If PRVC (PUVC) investments positively affect firm growth, we obtain $\psi_1>0$ ($\varphi_1>0$). Consequently, if $\psi_1>\varphi_1$ ($\psi_1<\varphi_1$), PRVC investments have a relatively more (less) positive effect on firm growth than PUVC investments. W_i are random effects uncorrelated with regressors and $\varepsilon_{i,t}$ are i.i.d. error terms. In estimating eq. (1), we implicitly assume that after receiving VC (either from a private financial investor or from a public institution) the growth rate of the focal firm changes with respect to a situation with no VC financing, and this change is independent from the age of the firm at the time of the first investment round.

But the intensity of the effect of VC investment on firm growth might be different according to the different age of the NTBF at time of reception of the investment. In this respect, we expect both PUVCs and PRVCs to exert a greater positive impact on firm growth especially when the firm is very young because: a) NTBFs are more likely to suffer from capital and other market imperfections in the very early stages of their lives; b) the signaling function of the VC investment is likely to decrease its importance once the firm has already gained a track record. The question is of particular relevance in our context. In fact, for their specific economic rationale, PUVC investments should flow intensively towards riskier and pre-paradigmatic business projects. So the evidence of a positive impact of this typology of venture capital on the growth of a young NTBF might confirm its important function in this respect.

To differentiate the effect of VC on firm growth for a young NTBF from that of a mature one, we estimated another augmented Gibrat law panel-data model of the following form:

$$LnGrowth_{i,t} = \alpha_0 + \alpha_1 LnAge_{i,t} + \alpha_2 LnSize_{t-1} + \psi_1 PRVC_{i,t} + \psi_2 PRVC * Young_{i,t} + \\ + \varphi_1 PUVC_{i,t} + \varphi_2 PUVC * Young_{i,t} + W_i + \varepsilon_{i,t}. \qquad \text{(II)}$$

In this specification, *Young* is a dummy variable that equals unity for firms that are 5 years old or younger. Therefore, whereas ψ_1 and φ_1 reflect the effects of PRVC and PUVC investments on firm growth for relatively more mature firms, the positive effects of PRVC and PUVC investments for relatively younger ones, if any, are captured by ψ_1+ψ_2 and φ_1+φ_2, respectively. So the difference between the two treatment effects (i.e. ψ_2 and φ_2 for PRVC and PUVC, respectively) represents the test on the hypothesis that treatment effects are greater for young NTBFs.

Then, the estimation of Models (I) and (II) is repeated by splitting the variable PUVC into its two different components: GVC and UVC. This originates our Models (III) and (IV). Finally, note that in all four specifications we also add a set of control variables, including country dummies, industry dummies and year dummies, which allow us to control for cross-sectional differences between countries and industries and across time, respectively.

4.2. Estimation methodology

We estimate all models by the means of random effects (RE) and two-stages least square random effects (2SLS-RE) estimators.[6] In fact, the possible endogenous nature of the relationship between VC investment and firm growth requires the use of appropriate instrumental variables techniques. This latter aspect is crucial for the purpose of the present study. A positive association between VC investment and firm growth may simply be the result of selection or unobserved heterogeneity. This problem is likely to be especially significant for NTBFs, because their performance (including growth performance) is closely related to unobservable characteristics such as innovative business

[6] The use of a fixed effects estimator was not recommended in our context given the loss of information that it would have implied because of the extremely high number of VC-backed NTBFs financed at the founding time (247 out of 761). Note also that ad-hoc classical Hausman tests and the use of alternative estimation methods that also exploit the cross-section dimension of data (GMM-SYS, Hausman-Taylor, see Section 5.2 on robustness checks) reassured us on the reliability of results obtained with RE and 2SLS-RE estimators.

ideas, development of a unique technology, or a team of smart owner-managers.[7] As long as VC regressors are correlated with the error terms $\varepsilon_{i,t}$, their coefficients in a simple OLS regression are likely to be biased and the same may apply to RE estimates. Hence, to take the endogeneity problem into account, we adopted a 2SLS-RE estimator. In this latter case, we used as exogenous instruments the annual amount of total funds raised in a given EU country from PRVC, GVC and UVC investors, and the annual amount of total funds raised in US from the abovementioned three types of investors.

5. Empirical findings

5.1. Results of the estimates

Results from the 2SLS-RE estimates considering growth in sales and employees are illustrated in tables 4a, 4b, 4c and 4d. For comparison purposes, we also report estimates obtained from the RE estimator. Estimation of Model I in Table 4a reveals that both typologies of venture capital (PUVC and PRVC) are found to exert a positive impact on the growth rate of European NTBFs, albeit only the private one is always statistically significant. The public operator is found to exert a positive and significant impact on firm growth at 5% only when the growth indicator is measured by the number of employees. Looking at the magnitude of the coefficients, the one for the PRVC variable is always larger than that of the PUVC one, and their difference is always statistically significant at conventional confidence levels as testified by a series of Wald tests on parameters (Prob > $|Z| \leq$ 0.01 in all estimates).

[Table 4a about here]

[7] If unobservables also influence the ability of firms to attract VC investors, a spurious correlation between VC investment and growth follows because of unobserved heterogeneity. An opposite bias is also possible if high-quality NTBFs with superior growth prospects self-select out of the VC market. In a thin VC market, finding a suitable offer from a VC investor might be difficult; with owner-managers time being the scarcest NTBF resource, the opportunity costs of search for a VC investor are clearly higher the better the prospects of the firm.

Results from the estimation of Model II in Table 4b suggest that PRVC has always a positive effect on the NTBF growth, but the treatment effect is greater if the NTBF receives it for the first time when it is young (the coefficient of *PRVC*Young* is always statistically significant at 1% in 2SLS-RE estimates). With regard to the impact of PUVC, if we look at firm's sales growth, the impact of PUVC financing is positive and significant for young NTBFs both on firm's sales growth (i.e. the test of $\varphi_1+\varphi_2 = 0$ is rejected at conventional confidence level: Prob > $|Z|$=0.023 in 2SLS-RE estimates) and on firm's employees growth (i.e. the test of $\varphi_1+\varphi_2 = 0$ is rejected at 1% confidence level: Prob > $|Z|$=0.003 in 2SLS-RE estimates). Furthermore, the difference between the PUVC treatment effect on young and mature NTBFs, captured by the φ_2 coefficient, is always positive and statistically significant in both the sales and employees equations, pointing to a beneficial effect of PUVC to the extent that this entry occurs in the early stages of the NTBF's life.

[Table 4b about here]

In Model III and Model IV (in Table 4c and Table 4d, respectively) we dwell upon the impact of PUVC, estimating the same models' specifications shown above with the inclusion of the two different components of the PUVC category: GVC and UVC. Results of the estimates show that the positive impact of the PUVC in firm's employment growth (in Model I) is more attributable to the governmental rather than the university category. In Model III, GVC is found to exert always a positive impact on firm growth, albeit statistically significant only in the employees equation (Prob > $|Z|$=0.012 in 2SLS-RE estimates), while the UVC variable has a negative impact in the sales equation and a very small and statistically negligible impact on the employees growth.

[Table 4c about here]

The differentiation of VC-backed firms according to their age at the moment of the first round of investment in Model IV adds new interesting insights. GVC has a positive treatment effect on the growth of young NTBFs, and this holds as in the employment equation (Prob > $|Z|$=0.000 in 2SLS-RE estimates) as in the sales one (Prob > $|Z|$=0.054 in 2SLS-RE estimates). In both cases, the difference in treatment effects for young NTBFs of the PRVC and the GVC variables is positively significant, obviously in favor of PRVC investors (Prob > $|Z|$=0.003 in the sales equation and Prob > $|Z|$=0.001 in the employees equation, 2SLS-RE estimates). UVC exerts a negligible impact on both the sales growth and the employees growth of NTBFs independently of the age of the recipient firm (Prob > $|Z|$=0.664 and Prob > $|Z|$=0.949 in 2SLS-RE estimates for sales and employees growth, respectively). Remarkably, and in line with the results exposed in Table 4b, all PUVC investments effectuated in relatively mature NTBFs regardless of the governmental or university source do not positively impact in any significant way the investee growth path afterwards.

[Table 4d about here]

Finally, as far as the impact of control variables is concerned, the coefficient for firm size is always negative and significant. This is consistent with the stylized fact highlighted by the empirical literature on the Gibrat law (e.g. Sutton, 1997; Caves, 1998) that smaller firms tend to grow faster than larger firms. Again coherently with the extant empirical literature, the estimated coefficient for firm age is negative in all the estimates, pointing to a greater growth dynamics for young firms, everything else being equal.

5.2. Robustness checks

We run four different checks in order to test the robustness of our findings. First, we report in the Appendix (Table A1) estimates of all models estimated through 2SLS-RE method considering as dependent variable the annual logarithmic growth in total assets. Results are in the same direction as those exposed in the main text and particularly similar to those that refer to employees as growth indicator.

Secondly, we have ignored the possibility that syndication between different types of VC investors might exert a distinctive treatment effect on firm growth upon the mere summation of the investor parties. If a thoughtful and detailed investigation on this issue is beyond the scope of the present paper and left to future research advances, nonetheless we have verified if the main results of the empirical analysis are undermined by the non consideration of syndication. At this scope, we re-run all models excluding those VC-backed NTBFs that received the first round of VC financing as a syndicated deal by different types of investor. Estimates (reported in the Appendix, Table A2, for the most informative models, Models III and IV) are rather similar to those reported in the main text and confirm all the findings of our analysis. The only notably difference is that the impact of GVC on the sales growth of young NTBFs albeit always positive turns now only to be very close to significance (Prob > $|Z|$=0.102), while it was significant at the 10% confidence level in Model IV of Table 4d. Furthermore, as a more detailed robustness check, we re-define our VC variables by considering the lead investor only. In other words, with regard to each first round of VC financing, we consider the lead investor in case of syndicated deals. This is due to the fact that: i) the lead investor reasonably provides more financial resources and more value added to the portfolio firm than other VC investors participating to the syndicate; ii) this way, we do not lose observations as when we exclude syndicated deals. In turn, the allegedly positive impact on firm growth should be mainly imputable to the contribution of the lead investor. Conversely, in case of non-syndicated deals, the variables remain the same as in tables 4a, 4b, 4c and 4d. Also in this case, estimates (reported in the Appendix, Table A3, for the most informative models, Models III and IV) are rather similar to those reported in the main text and confirm all the findings of our analysis. The only notably differences are that: i) the impact of GVC on the sales growth in Model III is now positively significant at 10% confidence level; ii) the test on the hypothesis that the treatment effect of GVC on the total assets growth is greater for young NTBFs is significant at 5%.

Third, we tested if our results might be driven by the presence of a survivorship bias. As long as low growth performers are more likely to exit from the market and VC-backing is (positively or negatively) associated to this eventuality, our results on the treatment effect of VC-backing could be (downwardly or upwardly) biased. The VICO dataset including information on both surviving and exited firms enables us to test the potential influence of survivorship bias by applying the recent test proposed by Semykina and Wooldridge (2010). This variable-addition test is based on the estimation of the same models' specification presented in tables 4a, 4b, 4c, and 4d, augmented by the inclusion of a time-varying inverse Mill's ratio (IMR). This additional regressor is computed from the coefficients of the independent variables (e.g. size, age, venture-capital backing, sectorial dummies and other control variables) of a series of probit models that are run each year on the firms' probability of exiting the sample because of failure or loss of independence (e.g. acquisition). If a statistically significant coefficient for the IMR variable signals the possible influence of a sample selection bias, the null hypothesis of the absence of a significant survivorship bias in our data is always accepted in all models at conventional confidence levels.

Finally, we re-estimate all models by resorting to: i) the two-step GMM-system estimator (Blundell and Bond, 1998) with finite sample correction for standard errors in accordance with Windmeijer (2005); ii) the Hausman-Taylor estimator. The former is often superior to 2SLS-RE estimator but the use of GMM-system estimator was not recommended in our context given the loss of information that we explained in the footnote 6 (see also subsequent footnote 8). The latter, originally proposed by Hausman and Taylor (1981), fits panel data RE models in which some of the covariates are correlated with the unobserved firm-level random effect (in our case variables related to VC investments and $LnSize_{i,t-1}$). The difference with our 'main' estimator is that while 2SLS-RE estimator assumes that a subset of the explanatory variables in the model are correlated with the idiosyncratic error $\varepsilon_{i,t}$, the Hausman-Taylor estimator assumes that some of the explanatory variables are correlated with the firm-level random effect, W_i, but that none of the explanatory variables are correlated with the idiosyncratic error $\varepsilon_{i,t}$. The results obtained through both GMM-system and Hausman-Taylor estimators are very similar to those reported in the main text and they are available upon request from the authors. [8]

[8] As a partial exception, note that estimation of Model IV by the GMM-SYS method proved to be too highly demanding from a computational point of view given the high number of moment conditions employed and the small number of observations for UVC-backed firms available. In this respect, it registered serious difficulties in reaching full convergence in the maximization of the log-likelihood function bringing to unreliable results. Conversely, Model I, II and III fully confirm the findings reported in the main text.

6. Concluding remarks

The aim of this paper was to empirically analyze the impact of venture capital investments on the growth of European NTBFs, by distinguishing between different types of VC investors, i.e. public (governmental and university-affiliated) and private funds. We considered a long longitudinal dataset (VICO dataset) for a large sample of European VC-backed and non VC-backed NTBFs recently built up under the sponsorship of the European Union. An augmented Gibrat-law-panel data model was estimated using techniques that duly take into account the endogenous nature of venture capital investments. Results highlight that private venture capital appears to positively and significantly affect the growth rate of NTBFs independently of both the growth measures analyzed (e.g. employment, sales and total assets) and the firm's age at the time of the first round of financing. Albeit always beneficial, the treatment effect of private funds is larger for very young firms (aged less than or equal to five years old). Public venture capital is on average always found not to exert a statistically significant impact on the growth of NTBFs (except for the employment measure). But, when we distinguish between NTBFs backed in the early stages of their life and relatively mature NTBFs, the treatment effect of public venture capital for the former appears to be statically greater than the latter. Moreover, when we distinguish governmental from university-affiliated venture capital funds, the impact of university funds is always lower than governmental ones, even when the investee receives this type of financing in the early stages of its life.

Overall, this study highlights two important findings that directly may lead us to derive two important policy recommendations. The first finding is the unequivocal positive role that PRVC exerts on the growth of high-tech start-ups. Certainly, if this was largely expected, we documented the beneficial role of venture capital at European level at an unparallel level in comparison with extant studies in this field. This implies that the EU policy goal of creating a higher number of sustainable high-tech gazelles in Europe has necessarily to go through the strengthening of a still underdeveloped venture capital industry in the old continent. In turn the encouragement and sustainment of venture capital deserves the maximum attention by European policy makers. Having said that, the second important finding relates to the nature of the policy intervention in this field. In fact, we documented that on average venture capital provided by private sources outperforms the one provided by public entities but that, at the same time, this latter does still play a significant role when the investment is directed towards very young entities, especially when it is provided from governmental sources. Given that the propensity to invest in this typology of NTBFs is always high but slightly lower for private rather than public venture capitalists, and more relevantly, governmental entities have social objectives and different firm targets than private operators, our findings suggest that an "hands-on" approach towards (very young) high-tech start-ups may still be a valuable instrument in the European policy toolkit.

With regard to future research we suggest two important directions. First, it would be relevant to answer to the following research questions: i) are there specific drivers affecting the design and the implementation of public VC programs across Europe? Most notably, which are the main features of public VC programs across Europe that are most beneficial to investee firms? If at the moment there is not even an unified and accepted definition of what is "public venture capital" (Lerner, 2002; Cumming, 2007; Jaskelainen et al. 2007). Different definitions of the object of study limit the comparison of results and make it difficult to create a common knowledge framework on the role of public venture capital. Furthermore, most of the studies examined only single programs or, at best, evidence from single countries. Great differences may arise among public VC programs located in different places. The heterogeneity of public VC interventions is a critical issue in Europe, where a global view on the European way to make PUVC is totally missing. Therefore, future research should aim at filling this gap by identifying the main features of Public VC programs in Europe, in terms of: i) sources of financing (e.g. percentage of public money on total fundraising); ii) internal organization (vertical and horizontal independence of the fund); iii) objectives (financial, industrial, strategic, social, product development); iv) selection of portfolio firms (industries, stages, size, age); v) investment style (financial instruments used, syndication, lengths of the investment and investment exit); vi) complementary assets and value added provided to portfolio firms (competences, network, subsidies). Moreover, no empirical evidence is available on which firm-specific (e.g. age of portfolio firms), industry-specific (e.g. degree of protection of IPR) and country-specific factors (e.g. capital gain taxes) moderate the differential impact of private and public sector-related VC investors on firm growth.

The second direction for future research we hint is related to syndicated deals. In the extant literature the main motives to justify them are: i) risk diversification; ii) improved screening through a 'second opinion' in the due diligence process (Casamatta and Haritchabalet, 2003); iii) certification and reputation gains when syndicating with more experienced venture capitalists (Barry et al., 1990). There are no studies that exploit the abovementioned three dimensions in explaining the potentially differential impact of 'private' syndicated deals and 'public-private' syndicated ones on portfolio firm growth. For instance, the presence of a public sector-related VC investor in the syndicated deal may avoid hold-up problems for the focal portfolio firm. Furthermore, in the case of syndicated deals involving universities, there might be a "certification effect" played by universities. As suggested by Lerner (2005, p. 54):

> "[...] venture capitalists and other financiers are inundated with proposals from young firms, many of which may have difficult-to-assess claims. As a result, they may be reluctant to fund ventures that solicit funds without a formal introduction without a trusted intermediary. The best technology transfer offices have been able to play such an ''honest broker'' role. These offices have cultivated relationships with key venture capital organizations and corporations over time [...]".

In this case, the university endowment identifies high quality local investment opportunities and connects these firms to the co-investor. Obviously, the quality of the investment and thus the impact on portfolio firms' performance might be a function of the quality of the co-investor.

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Tables

Table 1. Composition of the VICO dataset by country, foundation period and industry

	Total of VC-backed NTBFs	Control NTBFs	Total of NTBFs
Country			
Belgium	90	832	922
Finland	69	694	763
France	112	1,623	1,735
Germany	134	1,206	1,340
Italy	98	960	1,058
Spain	82	795	877
United Kingdom	176	1,520	1,696
Total	**761**	**7,630**	**8,391**
Foundation period			
1984-1989	22	1,002	1,024
1990-1994	94	1,151	1,245
1995-1999	339	2,612	2,951
2000-2004	306	2,865	3,171
Total	**761**	**7,630**	**8,391**
Industry			
Internet	134	843	977
Software	256	3,509	3,765
Telecommunications	44	346	390
ICT manufacturing	126	1,382	1,508
Biotech & Pharma	159	712	871
Other high-tech manufacturing	23	437	460
Other R&D services	19	401	420
Total	**761**	**7,630**	**8,391**

Table 2. Distribution of NTBFs backed by different types of VC investors by country, foundation period and industry

	PUVC investments	*GVC investments*	*UVC investments*	**PRVC investments**
Country				
Belgium	52	33	24	73
Finland	34	34	0	51
France	46	46	1	104
Germany	37	36	1	117
Italy	23	18	7	86
Spain	47	44	9	49
United Kingdom	43	27	20	162
Total	**282**	**238**	**62**	**642**
Foundation period				
1984-1989	8	8	0	17
1990-1994	40	40	0	73
1995-1999	105	89	20	294
2000-2004	129	101	42	258
Total	**282**	**238**	**62**	**642**
Industry				
Internet	19	17	2	121
Software	96	86	16	219
Telecommunications	10	9	1	39
ICT manufacturing	53	44	12	112
Biotech & Pharma	80	64	23	127
Other high-tech manufacturing	13	12	3	15
Other R&D services	11	6	5	9
Total	**282**	**238**	**62**	**642**

Table 3. Distribution of NTBFs backed by different types of VC investors by the age of the investee firm at the time of the first round of financing.

Age of the NTBF at the time of the first round of financing	0-1		2-5		>5		Total	
Typology of VC investment	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
PUVC	208	73.76	36	12.77	38	13.48	282	100
GVC	168	70.59	33	13.87	37	15.55	238	100
UVC	57	91.94	4	6.45	1	1.61	62	100
PRVC	438	68.22	116	18.07	88	13.71	642	100

Table 4a. Model I estimates for sales and employees growth.

	Sales				Employees			
Variables	**RE**		**2SLS-RE**		**RE**		**2SLS-RE**	
PUVC	0.009 (0.053)		0.038 (0.031)		0.026 (0.015)	*	0.027 (0.012)	**
PRVC	0.221 (0.035)	***	0.196 (0.021)	***	0.094 (0.012)	***	0.087 (0.008)	***
LnSize	-0.187 (0.005)	***	-0.122 (0.002)	***	-0.048 (0.002)	***	-0.033 (0.002)	***
LnAge	-0.161 (0.011)	***	-0.195 (0.009)	***	-0.076 (0.004)	***	-0.080 (0.004)	***
Constant	1.871 (0.224)	***	1.302 (0.353)	***	0.321 (0.093)	***	0.428 (0.207)	**
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	41451		41192		42407		42243	
Groups	7406		7401		7272		7272	
R^2	0.07		0.08		0.05		0.06	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table 4b. Model II estimates for sales and employees growth.

	Sales				Employees			
Variables	**RE**		**2SLS-RE**		**RE**		**2SLS-RE**	
PUVC	-0.033 (0.049)		-0.015 (0.040)		0.007 (0.016)		0.006 (0.016)	
PRVC	0.184 (0.035)	***	0.153 (0.026)	***	0.046 (0.011)	***	0.041 (0.011)	***
PUVC*Young	0.087 (0.068)		0.104 (0.050)	**	0.036 (0.026)		0.043 (0.022)	**
PRVC*Young	0.078 (0.048)		0.091 (0.034)	***	0.104 (0.021)	***	0.101 (0.015)	***
LnSize	-0.186 (0.005)	***	-0.122 (0.002)	***	-0.047 (0.002)	***	-0.033 (0.002)	***
LnAge	-0.157 (0.011)	***	-0.190 (0.009)	***	-0.072 (0.004)	***	-0.076 (0.004)	***
Constant	1.862 (0.224)	***	1.295 (0.353)	***	0.313 (0.093)	**	0.419 (0.207)	**
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	41451		41192		42407		42243	
Groups	7406		7401		7272		7272	
R^2	0.07		0.08		0.05		0.06	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table 4c. Model III estimates for sales and employees growth.

	Sales				Employees			
Variables	**RE**		**2SLS-RE**		**RE**		**2SLS-RE**	
GVC	0.018 (0.054)		0.044 (0.032)		0.031 (0.015)	**	0.031 (0.012)	**
UVC	-0.132 (0.165)		-0.046 (0.080)		0.013 (0.041)		0.019 (0.028)	
PRVC	0.224 (0.035)	***	0.197 (0.021)	***	0.094 (0.012)	***	0.086 (0.008)	***
LnSize	-0.187 (0.005)	***	-0.122 (0.002)	***	-0.048 (0.002)	***	-0.033 (0.002)	***
LnAge	-0.162 (0.011)	***	-0.195 (0.009)	***	-0.076 (0.004)	***	-0.080 (0.004)	***
Constant	1.871 (0.224)	***	1.303 (0.353)	***	0.321 (0.093)	***	0.428 (0.207)	**
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	41451		41192		42407		42243	
Groups	7406		7401		7272		7272	
R^2	0.07		0.08		0.05		0.06	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table 4d. Model IV estimates for sales and employees growth.

	Sales				Employees			
Variables	RE		2SLS-RE		RE		2SLS-RE	
GVC	-0.004 (0.050)		0.012 (0.041)		0.011 (0.016)		0.008 (0.016)	
UVC	-0.322 (0.139)	**	-0.262 (0.127)	**	0.017 (0.043)		0.014 (0.048)	
PRVC	0.187 (0.035)	***	0.154 (0.026)	***	0.045 (0.011)	***	0.040 (0.011)	***
GVC*Young	0.052 (0.071)		0.068 (0.052)		0.047 (0.027)	*	0.054 (0.023)	**
UVC*Young	0.269 (0.179)		0.302 (0.143)	**	-0.027 (0.062)		-0.017 (0.056)	
PRVC*Young	0.078 (0.048)		0.091 (0.034)	***	0.104 (0.021)	***	0.102 (0.015)	***
LnSize	-0.186 (0.005)	***	-0.122 (0.002)	***	-0.047 (0.002)	***	-0.033 (0.002)	***
LnAge	-0.158 (0.011)	***	-0.191 (0.009)	***	-0.072 (0.004)	***	-0.076 (0.004)	***
Constant	1.862 (0.224)	***	1.296 (0.353)	***	0.314 (0.093)	***	0.418 (0.207)	**
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	41451		41192		42407		42243	
Groups	7406		7401		7272		7272	
R^2	0.07		0.08		0.05		0.06	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table A1. 2SLS-RE estimates of augmented Gibrat law equations for total assets growth.

Variables	Model I		Model II		Model III		Model IV	
PUVC	0.020 (0.022)		-0.012 (0.028)		-		-	
GVC	-		-		0.049 (0.024)	**	0.033 (0.030)	
UVC	-		-		-0.032 (0.044)		-0.216 (0.069)	***
PRVC	0.113 (0.016)	***	0.068 (0.020)	***	0.111 (0.016)	***	0.068 (0.020)	***
PUVC*Young	-		0.066 (0.037)	*	-		-	
GVC*Young	-		-		-		0.044 (0.041)	
UVC*Young	-		-		-		0.254 (0.078)	***
PRVC*Young	-		0.097 (0.026)	***	-		0.092 (0.026)	***
LnSize	-0.069 (0.002)	***	-0.069 (0.002)	***	-0.069 (0.002)	***	-0.069 (0.002)	***
LnAge	-0.120 (0.006)	***	-0.115 (0.006)	***	-0.121 (0.006)	***	-0.116 (0.006)	***
Constant	0.744 (0.110)	***	0.738 (0.110)	***	0.744 (0.110)	***	0.738 (0.110)	***
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	44263		44263		44263		44263	
Groups	6866		6866		6866		6866	
R^2	0.05		0.05		0.05		0.05	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table A2. 2SLS-RE estimates of augmented Gibrat law equations for Models III and IV excluding syndicated deals.

	Sales				Employees			
Variables	**Model III**		**Model IV**		**Model III**		**Model IV**	
GVC	0.060 (0.037)	*	0.050 (0.046)		0.025 (0.014)	*	-0.003 (0.018)	
UVC	-0.033 (0.090)		-0.308 (0.138)	**	0.010 (0.033)		-0.000 (0.054)	
PRVC	0.201 (0.021)	***	0.162 (0.027)	***	0.084 (0.009)	***	0.036 (0.011)	***
GVC*Young	-		0.029 (0.059)		-		0.070 (0.026)	***
UVC*Young	-		0.404 (0.157)	***	-		-0.002 (0.065)	
PRVC*Young	-		0.085 (0.034)	**	-		0.107 (0.015)	***
LnSize	-0.121 (0.002)	***	-0.121 (0.002)	***	-0.033 (0.002)	***	-0.033 (0.002)	***
LnAge	-0.195 (0.009)	***	-0.192 (0.009)	***	-0.079 (0.004)	***	-0.075 (0.004)	***
Constant	1.447 (0.351)	***	1.439 (0.351)	***	0.390 (0.207)	*	0.382 (0.206)	*
Year dummies	Yes		Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes	
N. Obs.	40911		40911		41872		41872	
Groups	7345		7345		7209		7209	
R^2	0.08		0.08		0.05		0.06	

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.

Table A3. 2SLS-RE estimates of augmented Gibrat law equations for Models III and IV considering lead investors.

	Sales		Employees		Total assets	
Variables	**Model III**	**Model IV**	**Model III**	**Model IV**	**Model III**	**Model IV**
GVCLead	0.068 * (0.037)	0.042 (0.046)	0.030 ** (0.014)	0.004 (0.018)	0.045 * (0.027)	0.005 (0.033)
UVCLead	-0.013 (0.088)	-0.243 * (0.141)	0.012 (0.030)	0.036 (0.051)	0.048 (0.048)	-0.102 (0.077)
PRVCLead	0.186 *** (0.020)	0.146 *** (0.026)	0.086 *** (0.008)	0.040 *** (0.011)	0.100 *** (0.016)	0.059 *** (0.020)
GVCLead*Young	-	0.061 (0.059)	-	0.062 ** (0.026)	-	0.100 ** (0.046)
UVCLead*Young	-	0.319 ** (0.157)	-	-0.046 (0.060)	-	0.208 ** (0.087)
PRVCLead*Young	-	0.089 *** (0.033)	-	0.104 *** (0.015)	-	0.090 *** (0.026)
LnSize	-0.122 *** (0.002)	-0.122 *** (0.002)	-0.033 *** (0.002)	-0.033 *** (0.002)	-0.069 *** (0.002)	-0.069 *** (0.002)
LnAge	-0.196 *** (0.009)	-0.192 *** (0.009)	-0.081 *** (0.004)	-0.077 *** (0.004)	-0.121 *** (0.006)	-0.117 *** (0.006)
Constant	1.302 *** (0.353)	1.296 *** (0.353)	0.427 ** (0.207)	0.418 ** (0.207)	0.744 *** (0.110)	0.737 *** (0.110)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
N. Obs.	41192	41192	42243	42243	44263	44263
Groups	7401	7401	7272	7272	6866	6866
R^2	0.08	0.08	0.05	0.06	0.05	0.05

Legend. * p value < 0.1; ** p value < 0.05; *** p value < 0.01. Robust standard errors in parentheses.