

Venture capital financing and the growth of new technology-based firms: A longitudinal analysis on the role of the type of investor

Fabio Bertoni, Massimo G. Colombo and Luca Grilli*

Department of Management, Economics and Industrial Engineering,

Politecnico di Milano

Abstract

The financial literature claims that venture capital (VC) financing spurs the growth of new technology-based firms (NTBFs). First, VC investors allegedly have superior scouting capabilities, so they provide great hidden value firms with the financing they would otherwise be unable to obtain. Second they also provide monitoring and coaching services to portfolio companies. Third, VC financing has a “certification” effect, making easier for portfolio firms obtaining support from third parties. Nevertheless, the extent to which these functions are performed, and so the benefits of VC financing, are likely to depend on the type of investor. In this paper we distinguish financial intermediaries (FVC) and non-financial companies (*i.e.* corporate venture capital, CVC) as a source of VC. The aim of the paper is to test whether i) VC financing has a positive effect on the subsequent growth of sales and employment of portfolio companies, and ii) the magnitude of this effect differs according to the type of investor (*i.e.* FVC vs. CVC). We consider a 10 year long longitudinal dataset composed of 550 Italian NTBFs, most of which are privately held. The sample includes both VC-backed and non VC-backed firms. In order to capture the effects of VC financing on the subsequent growth of firms, we estimate an augmented Gibrat-law type dynamic panel data model with distributed lags. We resort to GMM-system estimation to control for the potentially endogenous nature of VC financing. The results strongly support the view that VC financing spurs firm growth. Moreover, even though both FVC and CVC positively affect firm growth, the benefits of the former source of financing considerably exceed those of the latter.

JEL codes: D92, G24, L21

We acknowledge support from the Venture Fun project promoted by the EU PRIME Network of Excellence. We are grateful to participants in Venture Fun and Bocconi University workshops, the 32th EARIE Conference, the 19th RENT Conference, the PRIME Annual Conference 2006, the 11th ISS Conference, the 21st EEA Conference, the 35th EISB Conference, the 16th AiIG Annual Conference, the 47th Scientific Meeting of Italian Economists for helpful comments on this and related works. The usual disclaimer applies.

* Corresponding author: Politecnico di Milano, Department of Management, Economics and Industrial Engineering, Piazza Leonardo da Vinci, 32, 20133, Milan, Italy. ph: +39-02-2399-2748; fax: +39-02-2399-2710. E-mail address: massimo.colombo@polimi.it.

1. Introduction

Since the seminal work by Jaffee and Russell (1976) and Stiglitz and Weiss (1981), the argument that there are frictions in capital markets that make it difficult for firms to obtain external financing and constrain their investment decisions has increasingly been gaining ground in the economic and financial literature (see Fazzari *et al.* 1988 and the studies mentioned by Hubbard 1998). New technology-based firms (NTBFs) are those most likely to suffer from these capital market imperfections. In turn, the fact that poor access to external financing may limit the growth and even threaten the survival of NTBFs is worrisome because of the key role these firms play in assuring dynamic efficiency and employment growth in the economic system (Audretsch 1995, Acs 2004).

The above arguments especially apply to bank loans (Carpenter and Petersen 2002). In fact, banks generally do not possess the competencies required to evaluate *ex ante* and monitor *ex post* the investment projects proposed by young high-tech firms that lack a track record. In principle, the above mentioned adverse selection and moral hazard problems can be alleviated through the recourse to collateralized loans (Berger and Udell 1998). Nonetheless most of high-tech investments is in intangible and/or firm-specific assets that provide little collateral value.

Venture capital (VC) financing is generally considered by both academics and practitioners as a more suitable financing mode for NTBFs than bank loans. In fact, it is contended in the financial literature that this financing mode offers a fundamental contribution to the success of high-tech entrepreneurial ventures (see for instance Sahlman 1990, Gompers and Lerner 2001, Kaplan and Strömberg 2001, Denis 2004).

Nonetheless, whether access to VC financing spurs the growth of portfolio companies is a matter of empirical test. As will be documented in Section 2, the results of previous studies on this issue are not unanimous. The reason may be that these studies suffer from several methodological weaknesses. First, most of them analyze samples of firms that eventually went public. These samples are not representative of the NTBF population, since privately held firms are not considered. Moreover, they capture the moderating effect of VC financing on the relationship between the IPO and firm growth rather than the direct effect of VC financing on growth. Second, most studies resort to cross-sectional estimates and, consequently, their results are likely to be biased as they do not manage to properly control for unobserved heterogeneity across firms and reverse causality. Quite surprisingly, studies based on longitudinal datasets are rare (see Davila *et*

al. 2003, Alemany and Marti 2005).¹ Lastly, it has recently been argued in the VC literature that there is great heterogeneity across VC investors, especially in Europe (Tykvova 2007, Bottazzi *et al.* 2004). Therefore the effect of VC financing on the growth of portfolio firms may well be contingent on the characteristics of the investor (Tykvova and Walz 2007, Engel and Heger 2006).²

In this work we resort to a hand collected 10 year long longitudinal dataset composed of 550 Italian NTBFs that operate in high-tech sectors in manufacturing and services, to analyze the effect of VC financing on firm growth measured both by employees and sales in the years that follow the first round of financing. From a methodological point of view, the sample analyzed in this work has several strengths in comparison with previous studies. As far as we know this is the first study that relies on a large longitudinal dataset relating to privately held NTBFs to distinguish the effects on firm growth of financial intermediaries (*i.e. financial venture capital, FVC*) and non-financial firms (*i.e. corporate venture capital, CVC*). The rather long observation period permits use of estimation GMM-based techniques for panel data models that control quite effectively for the endogenous nature of VC financing (see Section 4.1). Information on firm-specific characteristics is also very detailed and fine-grained; hence, in testing the causality relation between VC financing and growth we are able to insert in the set of explanatory variables several controls including an inverse Mill's ratio factor for ruling out any possible survivorship bias in data. Finally, Italian NTBFs provide a very interesting testbed of the beneficial effects of VC financing on portfolio companies as in Italy the VC industry is quite undeveloped and VC investors operate in a quite unfavourable environment.

The results of the estimates support the view that VC financing has a dramatic positive effect on firm growth. Moreover, even though both FVC and CVC financing positively affect firm growth, the benefits of the former type of investor considerably exceed those of the latter.

The paper is structured as follows. In the next section we survey the literature on the effects of VC financing on growth; we also consider differences between FVC and CVC. In Section 3 we describe the sample of firms that are considered in the empirical analysis and we provide some descriptive statistics on VC

¹ For an attempt to control for this bias in cross-sectional estimates of the relation between VC financing and firm growth, see Engel (2002), Colombo and Grilli (2005).

² In accordance with this argument Hsu (2004) shows that financing offers by VC firms with high reputation are more than three times more likely to be accepted from recipient firms than other offers; in addition, these investors obtain a discount on the purchase price of the participation ranging between 10% and 14%.

financing in Italy. In Section 4 we illustrate the models and results of the econometric analysis on the effect of VC financing on the growth of portfolio companies. Section 5 concludes.

2. *Literature review*

2.1. The added value of VC financing

The financial literature highlights several motives explaining why access to VC financing propels the growth of NTBFs.

First of all, VC investors generally focus on specific industries (see among others Gompers 1995, Amit *et al.* 1998, Bottazzi and Da Rin 2002). Due to their sectoral 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. For an opposed view see Amit *et al.* 1990). Therefore, they are able to deal effectively with the adverse selection problems that would otherwise prevent great hidden value firms from obtaining the financing they need. In turn, relaxation of financial constraints leads to higher firm growth.

Second, VC firms are no silent partners (Gorman and Sahlman 1989, Barry *et al.* 1990). On the one hand, they actively monitor portfolio companies. For instance, Kaplan and Strömberg (2003) show that VC firms control 41.4% of the seats of the board of directors of the US VC-backed companies that are considered in their study; in 25% of the companies they control the majority of the board seats. Bottazzi *et al.* (2004) document that in 66% of the deals of European VC firms the VC investor obtained one or more seats of the board of the participated company. Moreover Lerner (1995) highlights that the number of VC investors who sit in the board of directors is more likely to increase between two financing rounds if during the same period the top manager of the participated firm is replaced, that is in situations where monitoring is most important. On the other hand, VC investors make use of specific financial instruments and contractual clauses (e.g. stage financing) that protect their investments from opportunistic behavior on the part of entrepreneurs and create high powered incentives for them (Sahlman 1990, Gompers 1995, Hellmann 1998, Kaplan and Strömberg 2003, 2004).

Third, VC 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, Kaplan and Strömberg 2004).³ 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 VC 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”. Bottazzi *et al.* (2004) show that European VC firms helped portfolio companies in recruiting outside directors and senior managers in 40.8% and 48.4% of the deals they analyze, respectively. Moreover, portfolio companies take advantage of the network of social contacts of VC investors with potential customers, suppliers, alliance partners, and providers of specialized services like legal, accounting, head hunting, and public relation services (Lindsey 2002, Colombo *et al.* 2006, Hsu 2006).

Lastly, VC 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 VC (Stuart *et al.* 1999). In accordance with the existence of a “certification effect”, Megginson and Weiss (1991) find that US VC-backed IPOs exhibit smaller underpricing than non VC-backed ones that are matched by sector and IPO size.⁴

Nonetheless, it is important to acknowledge that the agency relation between the VC investor and the entrepreneurs of portfolio companies may engender conflicts, leading to a deterioration of the performance of these latter companies. 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 VC 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 VC investors are competent investors, they might be able to expropriate entrepreneurs of their innovative business ideas and exploit them also in their absence

³ Recent theoretical models on this issue are those by Casamatta (2003), Inderst and Müller (2004), Repullo and Suarez (2004).

⁴ Wang *et al.* (2003) use the same methodology to study Singapore IPOs and find similar results. Nonetheless, the literature is not unanimous on this issue. For instance, Lee and Wahal (2004) analyze a large sample of IPOs, more than a third of which are VC-backed. They depart from previous work in that they control for the endogenous nature of VC financing (on this issue see Section 2.2); they find that underpricing is larger for VC-backed firms.

(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.

2.2. The effect of VC financing on the growth of portfolio companies: survey of the empirical literature

A growing stream of empirical literature has analyzed the effects of VC financing on the performances of portfolio companies. Here we focus attention on the effects on growth.

Most early studies relied on matched pair techniques to compare VC-backed firms with non VC-backed ones. Jain and Kini (1995) compare a sample composed of 136 US listed firms that obtained VC financing prior to the IPO with a control sample of non VC-backed IPO firms that were in the same sector and went through an IPO of similar size. They consider sales growth from the year before the IPO up to the year of listing and the three following years, respectively. Over this period, VC-backed firms substantially outperform their non VC-backed counterparts. Manigart and Van Hyfte (1999) find that the rate of growth of total assets of a sample composed of 187 Belgian VC-backed firms is significantly greater than that of the control sample in each year starting in the year in which the firm obtained VC financing and over the following five years. Similar results are obtained as to the growth rate of sales of firms that at the time of the first round of VC financing were at least three years old, while there are no significant differences for younger firms. Lastly, the growth rate of employment is greater in the VC-backed sample only when one considers star performers, that is the firms that belong to the percentiles with the greatest growth, and a sufficiently long period of time (at least three years after the investment). Alemany and Marti (2005) compare the population of the 323 Spanish firms that obtained VC financing in the period 1993-1998 with a control sample of similar but non VC-backed companies; matching is based on the province in which firms are located, sector of activity, age and size in the year in which VC financing was obtained. They consider both early and mature stage financing, including restructuring and MBOs/LBOs. They compute average growth of firms' sales, employment and total assets from the "event" year up to the third year after the event, distinguishing according to the stage of firms' life (*i.e.* start-up, growth, mature) in which VC financing was obtained. VC-backed companies are found to outperform their non VC-backed counterparts if VC investment takes place in the start-up or growth stage. Engel and Keilbach (2007) analyze employment growth of a sample composed of 142 German VC-backed firms that were established between 1995 and

1998. They resort to the propensity score method to build their control sample; more precisely, they apply the nearest neighbour criterion with the additional constraint that twin firms operate in the same sector and have been established in the same year as the corresponding VC-backed firms. In the selection equation they consider a large number of covariates, thus reducing the likelihood of bias in the empirical results. They show that VC-backed firms grow faster than non VC-backed ones. Similar results are obtained by Audretsch and Lehmann (2004) through regression techniques for a sample composed of 341 firms that went public in the German *Neuer Markt* in the 1997-2002 period.

Nevertheless, previous cross-sectional studies are not unanimous as to the positive effect of VC financing on firms' growth. For instance, Bürghel *et al.* (2000) analyze growth of sales and employees of 500 start-ups localized in Germany and the United Kingdom; they fail to detect any effect of VC financing. Bottazzi and Da Rin (2002) similarly consider growth of sales and employees in the three years that follow an IPO in a sample composed of 511 firms that have been listed in the Euro.NM from its establishment up to December 2000. All else being equal, VC financing has no effect on employment growth, while it has a moderate negative effect on sales growth.

The studies that were mentioned above exhibit serious methodological weaknesses. First of all, studies that focus on IPO firms clearly suffer from a selection bias, as privately held firms are not considered. Moreover, the analysis of firm growth in the period following the IPO does not allow to disentangle the effect of VC financing from that of the IPO. What one actually captures is the moderating role played by VC financing on the effect of listing on firm growth. Even more importantly, the above studies do not properly take into account the potentially endogenous nature of VC financing. In fact, access to this financing mode may be determined by both observable factors (e.g. the human capital characteristics of firms' founding team) and unobservable ones. To the extent that these unobservable factors also influence firm growth, lack of control for the endogeneity of VC financing may lead to distorted estimates of its effect on growth.

In order to deal with this problem, some cross-sectional studies adopt a two step approach inspired by the "endogenous treatment" literature (Heckman 1990, Vella and Verbeek 1999). They first consider the likelihood of obtaining VC financing through an involvement equation. Then in analyzing firm growth, they insert in the set of covariates an inverse Mill's ratio type factor calculated from the estimates of the involvement equation. Alternatively, VC financing is instrumented through the predicted probability of obtaining it. While using this methodology Engel (2002) and Colombo and Grilli (2005) document a positive

effect of VC financing on firm growth in samples composed of 95,571 German firms and 506 Italian NTBFs, respectively.

Quite surprisingly, studies that rely on longitudinal datasets are rare. Alemany and Marti (2005) estimate fixed effects panel data models relating to the Spanish firms that obtained VC. Their results indicate that other things being equal, both the presence of a VC investor in the equity capital of firms and the cumulated amount of VC financing they obtained up to a given year, result in greater firm size in the same year. Davila *et al.* (2003) consider monthly data on employment growth for a sample composed of 494 start-ups that chose to outsource their human resource needs to a leading professional employer organization; out of them 193 are VC-backed. They resort to event study analysis. First they identify the month in which 275 VC financing events occurred; then they compare the evolution of the number of employees of these firms in a seven month time window centered in the month in which VC financing was obtained with the evolution in the same period of the number of employees of non VC-backed firms. They find that VC-backed firms enjoy more rapid growth before but above all after obtaining VC financing.⁵

2.3. The role of the type of investor

Recently, it has been argued in the VC literature that, especially in Europe, there is great heterogeneity across VC investors. Different types of VC have different characteristics and investment behaviors (Tykvova 2007, Bottazzi *et al.* 2004); hence they differently affect the performance of portfolio firms (Tykvova and Walz 2007, Engel and Heger 2006). In this paper we focus attention on the distinction between VC provided by *financial intermediaries* (financial venture capital, FVC) and VC provided by *non-financial firms* (corporate venture capital, CVC). As will be explained below, these two categories of investors differ along several dimensions. So we expect the effects on growth of their presence in the equity capital of portfolio companies to differ as well.

First of all, FVC and CVC investors are likely to pursue different objectives. The former investors generally aim at realizing the greatest possible capital gain in the shortest possible time. For this purpose, they are interested in boosting the growth of portfolio companies. Conversely, previous studies highlight that CVC

⁵ Davila *et al.* (2003) also estimate a logit model to investigate whether the growth of the firms in the first month in which they are present in the dataset influences the likelihood of obtaining VC financing in a subsequent period. Their results suggest that firm growth does not attract VC financing.

investors often pursue strategic objectives in addition to or even in substitution of financial objectives (Chesbrough 2002). In a pioneering work on CVC, Siegel *et al.* (1988) show that according to the surveyed parent corporations, “*exposure to new technologies and markets*” is the most important motive to engage in CVC. Similarly, Ernst *et al.* (2005) document that CVC is used by large German firms for technology window purposes; in fact, it allows parent companies to closely monitor the development on the part of young firms of promising technological innovations related to their core business and then possibly to acquire them. In accordance with the view that CVC is mainly used by incumbent firms as a technology learning device and it is not merely driven by financial objectives, Dushnitsky and Lenox (2005a) while analyzing a large sample of US public firms show that CVC investments are mostly attracted by industries which exhibit great technological ferment, weak protection of intellectual property rights, and an intermediate level of technology proximity with the knowledge base of the corporate investor (on this issue see also Gompers 2002). In a related work (Dushnitsky and Lenox, 2005b) they document that these investments substantially boost the citation-weighted patent output of the corporate investor in the five years that follow the investment and that this effect is more pronounced when the CVC investor has both great absorptive capacity (Cohen and Levinthal 1990) and an intermediate technology proximity with portfolio firms (see also Sykes 1986, 1990, Winters and Murfin 1988, Block and MacMillan 1993, Ernst & Young 2002, Dushnitsky and Lenox 2006).

Second, as was explained earlier, the alleged superior growth performance of VC-backed firms relative to their non VC-backed counterparts is a consequence of the scouting, monitoring and coaching activities carried out by VC investors, and the certification effect engendered by reception of VC financing. We also mentioned that the agency relation between VC investors and the entrepreneurs of portfolio companies may lead to inefficiencies. The extent of these positive and negative effects on the growth of portfolio firms is likely to depend on the type of investor and the different objectives it pursues.

In accordance with this argument, Siegel *et al.* (1988) find that the strategic objectives of CVC investors often diverge from those of portfolio firms. This possibly leads to conflicts that absorb entrepreneurs’ time and energy to the detriment of firm growth (Chesbrough 2000). Appropriability hazards also are likely to be greater with CVC than with FVC, especially if the parent company of the CVC investor operates in the same sector as the portfolio firm or in a closely related one (Block and MacMillan 1993). Fear of expropriation may induce entrepreneurial firms with the most promising novel technologies to look elsewhere for external

financing. For the same reason, CVC investors may be disadvantaged relative to FVC investors in reducing both *ex ante* and *ex post* information asymmetries, as high-tech start-ups may be less inclined to reveal to them proprietary information (Dushnitsky 2004). In addition, CVC investors may suffer from organizational deficiencies. Early stage financing of high-tech firms generally is the core business of FVC firms, while it is an ancillary activity for the parent companies of CVC investors. As a corollary, these latter are likely to benefit from learning by doing to a more limited extent than FVC investors. It may also be rather difficult for CVC parent companies to design managerial incentives apt to attract highly qualified individuals (Block and Ornati 1987). Hence the scouting, monitoring and coaching capabilities of CVC investors are likely to be inferior to those of FVC firms. Again, a less positive effect on the growth of portfolio firms follows.

Nevertheless, the presence of a CVC investor in the equity capital of a high-tech start-up may engender benefits that cannot be provided by FVC firms, with this leading to superior firm growth. In fact, CVC-backed firms may obtain access to the specialized assets and distinctive competencies of the parent company of the CVC investor (e.g. distribution channels, brand, qualified sales force, production capacity, complementary technological competencies). The network of industry-specific contacts with potential customers and suppliers of this latter firm also is likely to be more extensive than the one of FVC firms (Block and MacMillan 1993, Dushnitsky 2004).

To sum up, whether FVC financing has greater beneficial effects on portfolio firms than CVC financing is controversial. The empirical evidence on this issue is fairly limited. Gompers and Lerner (1998) analyze more than 30.000 VC investments in US privately-held firms between 1983 and 1994. They find that CVC-backed ventures have better performances measured by the likelihood of going through an IPO by 1998, than FVC-backed ones, but only if the corporate investor and the portfolio firms operate either in the same line of business or in a closely related one. If they do not, CVC-backed firms perform slightly worse. In this vein, Gompers (2002) finds that CVC-backed firms that establish a strategic alliance with the parent company of the CVC investor are more likely to go through an IPO than both FVC-backed firms and other CVC-backed firms; they also exhibit a lower likelihood of going bankrupt. CVC-backed firms are also shown to have greater IPO valuation than firms that exclusively receive external financing from FVC firms (Maula and Murray 2001).

Quite surprisingly, very few studies focus attention on firm growth. Audretsch and Lehmann (2004) show that the percentages of equity capital held by both FVC and CVC investors are positively associated with the

growth of portfolio firms in the year in which they were listed in the *Neuer Markt*. In addition, the results of the estimates of quantile regressions indicate that the former mode of financing has the greatest marginal effect on low growth firms, while the opposite holds true for the latter mode. Engel (2002) estimates that the average treatment effect of FVC financing on firm growth is equal to +177% and +165% in low-tech and high-tech industries, respectively. When equity financing is provided by CVC investors the effect is positive though smaller (+51% and +48%). As far as we know, no previous study has resorted to a longitudinal dataset to analyze differences between the effects of FVC and CVC financing on firm growth.

3. The data

3.1. The sample

In this paper we use a unique hand collected longitudinal dataset relating to a sample composed of 550 Italian NTBFs that are observed over a ten year period (1994-2003). Most sample firms are privately held. They were established in 1980 or later, were independent at founding time and have remained so up to the end of 2003 (*i.e.* they are not controlled by another business organization even though other organizations may hold minority shareholdings). They operate in the following high-tech sectors in manufacturing and services: computers, electronic components, telecommunication equipment, optical, medical and electronic instruments, biotechnology, pharmaceuticals and advanced materials, robotics and process automation equipment, multimedia content, software, Internet services (*i.e.* e-commerce, ISP, and web-related services), and telecommunication services.

We classify external equity investors in two groups: FVC and CVC. The FVC category includes financial intermediaries that specialize in equity investments. Most of the investors falling into this category are independent VC funds, some of which are foreign owned.⁶ VC firms controlled or participated by public institutions are also included in this category. The extent to which these public VC investors pursue financial objectives rather than broader social objectives, is questionable. Nonetheless, among social objectives the

⁶ In Italy, independent VC funds that exclusively focus on early stage financing of high-tech start-ups are rare. Consequently most VC funds included in the FVC category operate in both early- and later-stage equity financing.

growth of portfolio companies is likely to figure quite prominently.⁷ The CVC category is composed of non-financial companies investing in the equity capital of NTBFs. We include in this category both investments made directly by these firms and those made indirectly through affiliated financial subsidiaries or investments funds.

The sample of NTBFs was drawn from the 2004 release of the RITA (Research on Entrepreneurship in Advanced Technologies) database. Developed at Politecnico di Milano, RITA presently is the most complete source of information on Italian NTBFs. It was created in 2000 and it was updated in 2002 and 2004. The development of the database went through a series of steps. First, Italian firms that complied with the above mentioned criteria relating to age and sector of operations were identified. For the construction of the target population a number of sources were used. These included lists provided by national industry associations and regional Chambers of Commerce, on-line and off-line commercial firm directories, lists of participants in industry trades and expositions, and information provided by the national financial press, specialized magazines, and other sectoral studies. Altogether, 1,974 firms were selected for inclusion in the database. For each firm, a contact person (*i.e.* one of the owner-managers) was also identified. Unfortunately, data provided by official national statistics do not allow to obtain a reliable description of the universe of Italian NTBFs.⁸ Second, a questionnaire was sent to the contact person of the target firms either by fax or by e-mail. The first section of the questionnaire provides detailed information on the human capital characteristics of firms' founders. The second section comprises further questions concerning the characteristics of the firms including access to external equity financing, the identity of external investors, and the evolution over time of firms' employees.

Lastly, answers to the questionnaire were checked for internal coherence by educated personnel and were compared with information obtained from firms' annual reports and other public sources. In several cases, phone or face-to-face follow-up interviews were made with firms' owner-managers. This final step was

⁷ Due to the small number of NTBFs financed by public VC investors in our sample (*i.e.* only three firms) we could not create a separate category for this type of investors. Excluding them from the FVC category does not affect the results of econometric analysis that will be illustrated in Section 4. The results of the estimates with the omission of NTBFs backed by public VC firms are available from the authors upon request.

⁸ The main problem is that in Italy most individuals who are defined as "self-employed" by official statistics actually are salaried workers with atypical employment contracts. Unfortunately, on the basis of official data such individuals cannot be distinguished from entrepreneurs who created a new firm.

crucial in order to obtain missing data and ensure that data were reliable.⁹ In addition, financial and economic data including the evolution over time of firms' sales from 1994 onwards, and data on patent activity during firms' entire life were obtained from public sources (i.e. the AIDA and CERVED databases and the databases of patent offices, respectively).

The sample used in the present work consists of the 550 RITA firms that participated in the 2004 survey. χ^2 tests show that there are no statistically significant differences between the distributions of the sample firms across industries and geographic areas and the corresponding distributions of the population of 1,974 RITA firms from which the sample was drawn ($\chi^2(4)=3.39$ and $\chi^2(3)=4.87$, respectively).

The sample is large and quite heterogeneous. Note however that there is no presumption here to have a random sample. First, in this domain representativeness is a slippery notion as new ventures may be defined in different ways (see for instance Birley 1984, Aldrich *et al.* 1989, Gimeno *et al.* 1997). Second, as was mentioned above, absent reliable official statistics, it is very difficult to identify unambiguously the universe of Italian NTBFs. Therefore, one cannot check *ex post* whether the sample used in this work is representative of the universe or not. Third, as is common in survey-based studies (for exceptions see e.g. Delmar and Shane 2006, Eckhardt *et al.* 2006), the sample suffers from a survivorship bias: only firms having survived up to the first survey date (2000) could be included in the sample. In principle, attrition may generate a sample selection bias in our estimates. On one hand, failure rates of NTBFs are likely to decrease with access to VC financing because these firms allegedly benefit from greater endowment of financial resources and capabilities. Hence, the impact of the VC-related variables on firm growth might actually be greater than the one highlighted by our empirical analysis. On the other hand, an opposite bias may also exist. For example, VC-backed firms may be more risk-prone than non-VC-backed firms and so have lower likelihood of survival (Manigart and Hyfte 1999). As a matter of fact, it is fair to admit that we were not able to rigorously control for this selection bias; nonetheless, we are able to provide both indirect and direct partial proofs that its influence on results should be fairly limited.

⁹ Note that only for 3 firms the set of owner-managers at survey date did not include at least one of the founders of the firm.

3.2. Controls for survivorship bias

To check whether a survivorship bias in data might undermine the empirical analysis on firm growth, we focused attention on the RITA 2000 sample. This sample, composed of 401 firms, was selected according to the same criteria and strategy that were used for the RITA 2004 sample (see Colombo *et al.* 2004). Out of these firms 31 were VC-backed at the beginning of year 2000 (18 were FVC-backed and 17 were CVC-backed; 4 firms received both types of VC financing). We examined the exit rate of these firms in the 2000-2003 period due to bankruptcy or closure. 4 VC-backed firms (2 FVC-backed and 2 CVC-backed) ceased activity in this period representing 12.9% (11.1% for FVC and 11.8% for CVC). The corresponding percentage for non VC-backed firms is fairly close (12.2%). χ^2 tests show that the difference between the two values is not statistically significant at conventional confidence levels ($\chi^2(1) = 0.011$ for VC, $\chi^2(1) = 0.014$ for FVC, $\chi^2(1) = 0.001$ for CVC).

More importantly, as a direct way to control for a possible survivorship bias, we adapt a typical Heckman two-step procedure commonly used in empirical studies on firm growth dynamics (e.g. Evans 1987, Dunne and Hughes 1994, Lotti *et al.* 2007) to our specific framework. In particular, we first estimated a probit model on firm exit in the 2000-2003 period conditional on survival up to the end of 1999, again based on the RITA 2000 sample. The independent variables of this sample selection model include founders' human capital variables, receipt of a VC investment before 2000,¹⁰ firm-specific characteristics (e.g. firm size and age in 1999), and other controls. Based on these estimates, we computed the inverse Mill's ratio of firm exit for the 479 firms included in the sample (*i.e.* all 2004 RITA firms with the exception of firms that came into existence after 2000).¹¹ This ratio was then inserted as a control for survivorship bias in the growth equations which will be illustrated in Section 4.1. This additional variable controls for the unobserved heterogeneity that affects both a firm's probability of being sampled in 2004 and its growth, allowing more consistent

¹⁰ Incidentally note that none of the founders' human capital and VC variables turned out to impact significantly the probability of firm exit. This is a further indication (albeit a weak one) that the sample selection bias engendered in our estimates because of lack of control for exit is likely to be negligible.

¹¹ Formally (see Winship and Morgan 1999, Greene 2003): $\lambda_{iEXIT} = \frac{-\phi(\psi' w_i)}{\Phi(\psi' w_i)}$; where w_i is the vector of independent variables of the probit

model on firm exit, $\phi(\cdot)$ and $\Phi(\cdot)$ are respectively, the density and distribution functions of the standard normal.

estimates of the parameters of the growth equation (see Winship and Morgan 1999, Greene 2003). Results (shown in the next sections) highlight that the survivorship bias does not greatly influence the results of the estimates and, more importantly, does not alter in any significant way the relationship between venture capital financing and firm growth.

3.3. Venture capital industry and Italian NTBFs

Italian NTBFs offer an interesting testbed of the alleged positive effects of VC financing on firm growth even in a rather adverse environment. In fact the characteristics of the Italian financial system are quite unfavorable to VC financing in comparison with those of Anglo-Saxon countries. For instance, in Italy the ratio of the market value of listed firms to GDP in 2001 was 48.2% (41.7% in 2004. Source: Consob), while it was 138.0% in the USA and 151.4% in the UK (source: OECD, Financial Market Trends, October 2004).¹² Accordingly, the Italian VC industry is quite undeveloped. Early stage equity financing was almost inexistent up to the mid 1990s. It increased considerably in the 1995-2000 period, reaching a peak of 540 million € in 2000, equal to 0.046% of GDP (source: AIFI, Italian Association of Private Equity Investors). Nevertheless, not all this amount was invested in NTBFs. Since 2001 early stage equity financing experienced a dramatic decline and it almost vanished in 2004, when there were only 50 investments in 36 companies and the total invested amount was only 23 million €, that is 0.002% of GDP.¹³

Out of the 550 sample firms considered in this work, 34 (*i.e.* 6.4%) received financing from FVC, and 38 (*i.e.* 6.9%) have been financed by CVC (5 companies have been financed by both types of investors). Note that the share of CVC-backed firms is slightly larger than that of FVC-backed companies. This contrasts with the evidence provided by previous studies. For instance, in the sample of 750 VC firms considered by Bottazzi *et al.* (2004) CVC accounts for only 8% of the number of firms and CVC investors were found to be involved in only 8.8% of the 1,643 deals under scrutiny. The reason lies in the fact that Bottazzi *et al.* (2004) exclusively focused attention on CVC investments that are made through separate subsidiaries that are

¹² The difference was even larger at the beginning of the 1990s. For instance, Rajan and Zingales (2003) show that in 1990, the ratio of the market value of listed firms to GDP was 13% in Italy, while it was 54% in the USA and 84% in the UK. Conversely, the ratio of bank deposits to GDP was 40% in Italy, 33% in the UK and only 19% in the USA.

¹³ These figures exclusively refer to AIFI members; so they are likely to underestimate the actual amount of VC financing. In particular, they do not include most investments made by non-financial firms. For further details on the Italian VC industry see Bertoni *et al.* (2006).

member of national Venture Capital associations. They neglected direct corporate investments which, according to our data, represent the majority of CVC investments. Our data are provided by high-tech start-ups. This allowed us to circumvent selection problems from which previous studies are subject and obtain a more comprehensive coverage of CVC investments.

Table 1 reports the distribution of portfolio firms by age at the time of the first round of VC financing; we also distinguish between FVC-backed and CVC-backed firms. More than half of the VC-backed NTBFs included in the RITA sample received early stage VC financing; in fact, 55.2% of firms obtained VC financing prior to foundation or in the first year of their life. The situation is similar for FVC-backed and CVC-backed firms (50.0% and 57.9%, respectively).

[insert Table 1]

4. The econometric analysis

4.1 Specification of the econometric models

The impact of VC financing on firm growth is investigated through the estimation of a first type of augmented Gibrat law dynamic growth model:

$$LSize_{i,t} = \alpha_1 LSize_{i,t-1} + \alpha_2 LAge_{i,t-1} + \beta_1 VC_{i,t} + W_i + \varepsilon_{i,t}. \quad (1)$$

$LSize_{i,t}$ is the logarithm of the size of firms measured alternatively by the number of employees (including owners-managers) and sales; $LAge_{i,t-1}$ is the logarithm of the age of firms. $VC_{i,t}$ is a status dummy variable that equals unity from time t when NTBF i got access to VC financing for the first time onwards. W_i are unobservable firm-specific time-invariant characteristics of the firms and $\varepsilon_{i,t}$ are i.i.d. disturbance terms.

In order to take into account differences in the effects of VC financing on firm growth according to the type of investor, we estimate a different version of the model in which the dummy variables $FVC_{i,t}$ and $CVC_{i,t}$, capturing equity financing provided by financial venture capitalists and non-financial firms respectively, replace $VC_{i,t}$.

$$LSize_{i,t} = \alpha_1 LSize_{i,t-1} + \alpha_2 LAge_{i,t-1} + \phi_1 FVC_{i,t} + \phi_2 CVC_{i,t} + W_i + \varepsilon_{i,t}. \quad (2)$$

Then, a second type of augmented Gibrat law dynamic growth model is estimated in order to differentiate the effect of venture capital on firm growth in the first two years of reception of the investment (*i.e.* transitory state) from the long-run (*i.e.* steady state):

$$LSize_{i,t} = \alpha_1 LSize_{i,t-1} + \alpha_2 LAge_{i,t-1} + \beta_1 VCtransitory_{i,t} + \beta_2 VCsteady_{i,t} + W_i + \varepsilon_{i,t}. \quad (3)$$

In this case, $VCtransitory_{i,t}$ is a dummy variable that equals unity from time t when NTBF i got access to VC financing and the year immediately after, while $VCsteady_{i,t}$ starts to equal unity from then onwards. Again, we estimate the model also differentiating per type of investor:

$$LSize_{i,t} = \alpha_1 LSize_{i,t-1} + \alpha_2 LAge_{i,t-1} + \phi_1 FVCtransitory_{i,t} + \phi_2 FVCsteady_{i,t} + \varphi_1 CVCtransitory_{i,t} + \varphi_2 CVCsteady_{i,t} + W_i + \varepsilon_{i,t}. \quad (4)$$

4.2 Estimation methodologies

The inclusion in all models of the lagged dependent variable as one of the covariates and the possible endogenous nature of the relationship between VC financing and firm size require the use of appropriate estimation techniques. In fact, as long as regressors are correlated with disturbance terms $\varepsilon_{i,t}$, both pooled ordinary least squares (OLS) and fixed effects within groups (WG) estimators are likely to produce biased estimates.¹⁴ Following the recent literature on dynamic panel data models (see Arellano and Bond 1991, Arellano and Bover 1995, Blundell and Bond 1998) we resort to the generalized method of moments (GMM) procedure and estimate growth models by a series of GMM estimators. In fact, GMM framework is the frontier methodology usually applied in empirical industrial organization studies to deal with endogeneity concerns in longitudinal datasets. In applying GMM techniques we follow a build-up approach similar to that proposed by Bond (2002). As suggested by Winship and Morgan (1999) there is no “econometric panacea” for endogeneity, in the sense that there is no single econometric method that may solve the problem. Allegedly several GMM estimation approaches are employed. They rely on various (in most cases testable) assumptions and present different pros and cons, but clearly when alternative estimation methods lead to similar results, this brings support to the robustness of the findings.

First, a GMM-DIF estimator (first differenced) is used (Arellano and Bond 1991). To take the endogeneity problem into account, growth equations are differenced, so to eliminate any possible correlation between regressors and individual time invaring effects W_i . Then, the model is estimated in first differences using the appropriate lag structure of the variables in levels as instruments for the differenced regressors in

¹⁴ In particular, OLS is likely to be biased upwards and the WG is likely to be biased downwards. Note also that the bias produced by this latter estimator decreases along with the time span of the panel data set. Allegedly, given the 10-year time span here considered, the bias of the WG estimator should be fairly limited in this context.

order to deal with potential endogeneity concerns caused by time varying unobserved heterogeneity. In particular the Arellano-Bond method overcomes the endogeneity problem by employing an appropriate set of linear orthogonality conditions which depends crucially on the assumptions one is willing to make on the endogeneity, predetermination, exogeneity of the explanatory variables. In this context, other than the lagged dependent variable, we make the weakest assumption possible and consider venture capital financing variables as potentially endogenous. This means that instruments used starts from t-2 both for the lagged dependent and the venture capital variables. In terms of orthogonality conditions and taking equation (1) as reference:

$$E(LSiz_{i,t-s} \Delta \varepsilon_{i,t}) = 0 \text{ for } t = 3, \dots, T \text{ and } s \geq 2 \quad (5)$$

$$E(VC_{i,t-s} \Delta \varepsilon_{i,t}) = 0 \text{ for } t = 3, \dots, T \text{ and } s \geq 2$$

As shown by Blundell and Bond (1998), this first GMM estimator proves to be subject to serious finite samples biases when series are highly persistent¹⁵ (*i.e.* have near unit-root properties) and consequently, instruments in levels for equations in first differences are weak. The problem is usually tackled by enlarging the set of moment conditions used in the estimation. A first type of these augmented estimators is the GMM-SYS (system) one. In particular, other than using lagged levels of the series as instruments for first differences equations, additional moment conditions are employed using first differences as instruments for variables in levels. These additional orthogonality conditions are:

$$E[(W_i + \varepsilon_{i,t} \Delta LSiz_{i,t-1})] = 0 \text{ for } t = 3, \dots, T \quad (6)$$

$$E[(W_i + \varepsilon_{i,t} \Delta VC_{i,t})] = 0 \text{ for } t = 2, \dots, T$$

These additional moment conditions are only valid if differenced instruments are uncorrelated with error terms or, in other words, if deviations from the long-run mean of dependent and independent endogenous variables are uncorrelated with any unobservable and observable individual fixed effect. Whether the appropriateness of this stationary mean assumption may be questionable on a priori ground since it requires for example that size shocks do not depend on unobserved firm-specific effects, the validity of these SYS additional moment conditions may be simply tested (and it is usually accepted in our case) by (Difference) Sargan tests. Moreover, pseudo-first stage regressions speak in favour of the goodness of

¹⁵ On this issue, see Bond (2002). If we can exclude the presence of unit roots for the size variable (results available upon request from the authors), persistency is nonetheless present (e.g. OLS estimate of the autoregressive parameter is equal to 0.940).

GMM-SYS estimators. In fact, they highlight that lagged instruments in first differences are strongly correlated with the venture capital variables, whereas oppositely, lagged instruments in levels are poorly correlated with the change in the VC-backing status, pointing to the goodness other than the validity of the additional instruments (see the technical appendix for details). We employ five different GMM-SYS estimators. First, as moment conditions in (6) indicate, differenced instruments for the equations in levels starts from $t-3$ for size and $t-2$ for the VC variable, again under the mild assumption of endogeneity of this latter covariate. Second, in order to avoid both possible finite sample biases due to the use of a large number of instruments and potential distortions caused by the occurrence of measurement errors (see for both points, Bond 2002) moment conditions (as for the equations in levels as for the differenced one) are comprised between $t-3$ and $t-6$. Then, in order to further deal with the potential endogeneity of the VC variable, we use other three different versions of GMM-SYS estimators. In fact, a third GMM-SYS estimator adds to the set of instruments an additional variable capturing the intensity of VC investments in the geographic area on which the NTBF is located.¹⁶ In the fourth and fifth GMM-SYS estimators we adapt a typical Heckman two-step approach (Heckman 1978, 1979) to our longitudinal setting.¹⁷ Following Vella and Verbeek (1999) we estimated a selection equation on the probability of NTBFs to access VC through a probit model. In particular, a dummy variable that denotes VC-backed firms in every given year is regressed on a set of covariates including founders' human capital (measured at foundation) size, age and other controls. Then, the results of these probit estimates are used to estimate the growth equation via both instrumental variables (IV) and the (restricted) control function (CF) approach. In the first case, the predicted probability of being VC-backed is used as additional instrument. In the second case, an inverse Mill's ratio type of control factor (*i.e.* the estimated value of the generalized residual - see Gourieroux *et al.* 1987) is included in the set of covariates in addition to the dummy VC which is now considered as exogenous.¹⁸

¹⁶ *VCarea* is calculated as follows. First, we considered the total number of high-tech firms that obtained VC financing over the period 1997-2003 (source: AIFI). Let VCA_k indicate the share accounted for by geographical area k out of this number. Let A_k be the estimated shares accounted for geographical area k out of the total number of Italian NTBFs in 2003 (source: RITA Directory). Then: $VCarea_k = VCA_k / A_k$.

¹⁷ For an analogous method applied to a panel data set see also Benfratello and Sembenelli (2006).

¹⁸ The functional form of this added regressor is $\lambda_i(\gamma' z_i) = VC_i \frac{\varphi(-\gamma' z_i)}{1 - \Phi(-\gamma' z_i)} + (1 - VC_i) \frac{-\varphi(\gamma' z_i)}{\Phi(-\gamma' z_i)}$; where z is the vector of independent

variables of the probit model on venture capital financing. Exogeneity of VC implies that instruments for this variable starts now from t .

The specific assumptions on which the SYS-GMM rely, on which we can only partially get control through the results of the (Difference) Sargan tests (see Bond 2002, p. 156), lead us to implement a second type of GMM augmented estimator which does not require any assumption implied by the SYS-GMM on the validity of differenced instruments. This estimator originally proposed by Ahn and Schmidt (1995) adds to the moment conditions carried by the DIF-GMM an additional set of non-linear moment conditions that follow from the standard assumptions in dynamic panel data model and in particular requires the milder assumption that individual effects W_i and the disturbances $\varepsilon_{i,t}$ are uncorrelated (see Bond 2002, Baltagi 2003).¹⁹ These $T-2$ additional quadratic moment conditions are given by:

$$E(\varepsilon_{i,T} \Delta \varepsilon_{i,t}) = 0 \text{ for } t = 2, \dots, T-1 \quad (7)$$

Finally, as stated in Section 3.2, to control for a possible survivorship bias in data that may intervene in the investigated relationship, we also estimated the growth equations via SYS-GMM inserting as a further control variable an inverse Mill's ratio factor computed from a probit model on the firm's probability of exit. Note that we apply different tests to evaluate the relevance of all our econometric models. First, we implement the Arellano and Bond test for first- and second- (AR(1), AR(2)) order serial autocorrelation of residuals. If ε_{it} is not serially correlated, the difference of residuals should be characterized by a negative first-order serial correlation and the absence of a second-order serial correlation. The Hansen test for the validity of overidentifying restrictions is implemented for each regression. This statistics presents the null hypothesis that specified orthogonality conditions are equal to zero (Hansen, 1982). Failure to reject the null hypothesis indicates the instruments to be valid.

Lastly, note that model (1) is estimated through all the different estimators described above, while for the sake of synthesis, we present estimates for the remaining models obtained only by a selection of the exposed estimators.

¹⁹ Note that Ahn and Schmidt (1995) methodology albeit technically elegant is computationally rather complex and, as a matter of fact, full convergence in the estimation algorithm may not be reached even after many iterations. Moreover its empirical implementation is not immediately applicable by standard econometric software-packages. In this respect, we are indebted to Prof. Ahn who has provided us with useful suggestions on how to put into practice the augmented GMM estimator she proposed.

4.2 Econometric results

Table 2 shows the results of the estimation of equation (1) by GMM-system. The fixed effects within groups (WG) estimator is added for comparison purposes. In the remaining of this section we focus attention on the estimates with three lagged VC variables, as the coefficient of the four periods lagged VC variable turned out not to be statistically significant at conventional confidence levels both in the employment and sales equations.²⁰

[insert Table 2]

Let us first consider the effects on firm growth of the size and age variables. The coefficient of firm size is significantly smaller than unity in both the employment and sales equations. This is consistent with the stylized fact highlighted by the empirical literature on Gibrat's law (see Evans 1987, Hart and Oulton 1996, Sutton 1997, Caves 1998) that smaller firms tend to grow faster than larger ones. Conversely, the coefficient of age is negative and significant as expected in the sales equation, but it is positive, though insignificant in the employment equation. In other words, the contention of Jovanovich (1982) that older firms grow more slowly than younger ones is only weakly supported by our estimates (for similar results see Shanmugam and Bhaduri 2002).²¹

More interestingly for the purpose of this paper, the estimates of model (1) reveal that VC financing has a dramatic positive impact on the growth of NTBFs. This especially applies to the growth of the number of employees. The coefficients of the three lagged VC variables are positive and significant at 99% in the employment equation. Moreover, the marginal increase in the number of employees generated by VC financing decreases over time, indicating that a VC investment has the highest effect on firm growth in the first year after obtaining the first round of financing. In the sales equation all VC variables exhibit positive coefficients, but only the one and three periods lagged variables are significant at conventional confidence levels. This may partly be due to the greater volatility of sales over time.

²⁰ We estimated all models also through the GMM-DIF technique. Since results are very similar and Difference Sargan tests generally accept the null hypothesis of the validity of the additional moment conditions implied by the GMM-system estimator, we only present these latter estimates. Results of the GMM-DIF estimates are available from the authors upon request.

²¹ In our sample firms are never older than 24 years, with most of them being less than 10 year old. So results cannot be generalized to older firms.

To measure the long-run effect of VC financing on firm growth (\hat{E}) we use a non-linear combination of the regression coefficients. In particular the long-run effect is computed by the following expression:

$$\hat{E}_{VC(long-run)} = \frac{\sum_{k=1}^3 \hat{\beta}_k}{1 - \alpha_1}.$$

This approach is equivalent to measuring the cumulative distance between the size of a VC-backed firm and that of its twin non-VC-backed counterpart over time (for a similar approach in a different context see Maliranta 2005). A χ^2 test (performed by the Delta method) shows that the long-run total effect of VC financing on firm size is positive and significant, regardless of whether size is measured by the number of employees or by sales ($\chi^2(1)=21.67$ and $\chi^2(1)=6.39$, respectively).

It is also interesting to calculate the magnitude of the positive effect of VC financing on the growth of firms' employment and sales. For this purpose, we considered a benchmark firm with age and size (*i.e.* number of employees and sales, respectively) being set at their mean values (*i.e.* 6.23 years, 8.02 employees, and 428.7 thousands €). Then we analyzed the evolution of firm's employment and sales after obtaining VC financing. More precisely, we calculated the estimated number of employees and amount of sales of the firm in the three years after the one in which it obtained the first round of VC financing. Lastly, we repeated the same calculation for a firm with the same age and initial size which did not obtain VC financing. At the end of the period under examination, the estimated number of employees and sales of the VC-backed firm were 98.5% and 93.2% greater than those of its non VC-backed twin.

In this paper we are especially interested in distinguishing the effect of VC financing on firm growth according to the type of investor (namely, FVC and CVC). For this purpose let us turn attention to Table 3 that illustrates the estimates of model (2) estimated by the GMM-system method (WG estimates are reported for comparison purpose). Again the coefficients of the four periods lagged FVC and CVC variables proved to be insignificant in both the employment and sales equation. So we concentrate on the model with three lagged variables. The results relating to firms' age and size are similar to those discussed above and do not deserve any further comments.

[insert Table 3]

The estimates show that the effect of VC financing on firm growth indeed depends on the type of investor. In particular, they suggest that VC financing obtained from financial intermediaries spurs growth of

portfolio firms to a larger extent than financing obtained from CVC investors. This especially applies to firms' sales. In the employment equation the GMM-system estimates of the coefficients of all the three lagged dummies for both FVC and CVC are positive and significant at conventional confidence levels. As it was the case for the VC variables, the estimated values of the coefficients indicate decreasing marginal effects over time on firm growth of both FVC and CVC financing. Moreover, the values of the FVC coefficients are systematically greater than those of the CVC coefficients. In the sales equation the three lagged FVC variables again exhibit positive, statistically significant coefficients. Conversely, none of the coefficients of the CVC variables is significant at conventional confidence levels, and the two period lagged variable has an unexpected negative coefficient.

We also run χ^2 tests relating to the total long run effects of FVC and CVC financing. The methodology we used to calculate long-run effects is the same as the one that was described above. The null hypotheses that FVC and CVC financing have no long run effect on the growth of the number of employees of sample NTBFs can be rejected at conventional confidence levels ($\chi^2(1)=24.15$ and $\chi^2(1)=11.37$, respectively). As to firms' sales, only the null hypothesis relating to FVC financing was rejected (at 90%, $\chi^2(1)=3.16$), while the long run effect of CVC financing though positive, was found not to be statistically different from null. In addition, we run χ^2 tests of the difference between the long run effects of FVC and CVC financing on firms' employees and sales, respectively. The former type of VC financing turned out to have significantly greater long run effects on firm growth than the latter type ($\chi^2(1)=25.06$ and $\chi^2(1)=4.48$, respectively).

The magnitude of the positive effects of FVC and CVC financing on firm size, measured either by the number of employees or by sales, is illustrated in Figures 1a and 1b. The procedure we followed to calculate the values that are displayed in the figures is the same as the one that was illustrated above. Three years after obtaining the first round of FVC financing, a portfolio firm exhibits a number of employees and sales that according to our estimates, are 91.0% and 143.2% greater than those of an otherwise similar (*i.e.* same age and initial size) non VC-backed firm. As to CVC-backed firms, the difference though positive, is much smaller, especially as regards firms' sales. The estimated number of employees three years after the first round of CVC financing is 70.2% greater than the one that the same firm would exhibit absent any VC financing. The estimated amount of sales is only 9.6% higher.

We are quite confident that the econometric results that have been illustrated above are robust. In particular, the rather long longitudinal dimension of our dataset allowed us to use GMM-system techniques that

effectively control for the allegedly endogenous nature of VC financing and the serial correlation engendered by the presence of the lagged endogenous variable in the right hand side term of models (1) and (2). Nonetheless, we carried out additional checks for robustness. The results are reported in the Appendix (see Tables A1, A2 and A3).

In particular, we were concerned that in spite of use of GMM-system estimation, the positive relation between VC financing and firm growth be driven by time-varying unobserved factors that (positively or negatively) affect both variables. For instance, financial euphoria during the so-called Internet bubble period at the end of the 1990s may have led to an increase of VC investments and it may have contextually induced VC-backed firms to adopt a strategy based on aggressive growth. To control for this effect, we added year dummies to the set of explanatory variables introduced in models (1) and (2). Results relating to the effect of VC financing on firm growth were almost unchanged (see Table A1). When we distinguish FVC and CVC financing (see Table A2), the former mode of financing again turns out to have a more positive effect on firm growth than the latter one, with the difference being larger for sales than for employment.

We then introduced into models (1) and (2) several time-varying variables capturing firm-specific characteristics that might both attract VC financing and lead to superior firm growth. More precisely, we inserted dummy variables indicating whether: i) a firm's management team included a salaried manager (in addition to owner-managers), ii) a firm was granted one or more patents, with granted patents being assigned to the year in which the corresponding application was made, iii) a firm obtained public subsidies, and iv) a firm had gone through an IPO. In order to control for the fact that the effects on growth of these variables may be delayed, we again resorted to distributed lags. As is apparent from the estimates illustrated in the second column of Tables A1 and A2, these variables were not statistically significant at conventional confidence levels with very few exceptions. The estimated value of the coefficients of the lagged VC variables were reasonably close to those reported in Table 2. The same holds true for the FVC and CVC variables in the employment growth model. Conversely, the estimates of the effects of FVC and CVC financing on sales growth are less precise, even though they again highlight a more positive effect of FVC financing.

Lastly, we also checked for the potential endogeneity of VC financing using a "placebo leads" method (see Bartel and Harrison 2005). We added three leads for each of the VC financing variables (*i.e.* VC, FVC and CVC) to WG regressions for both employees (Table A3, columns 1 and 2) and sales (Table A3, columns 3

and 4) in order to test if the causality relationships between VC financing and growth highlighted in Tables 2 and 3 were actually reversed. In every regression, Wald tests were found to accept the null hypothesis that these leads were jointly insignificant at conventional confidence levels.²²

To sum up, the results of our estimates clearly support the view that VC financing has a beneficial effect on the growth of both employment and sales of NTBFs. They also indicate that the source of VC matters: in fact VC financing obtained from financial intermediaries generates higher growth of portfolio firms than that obtained from non-financial corporations.

5. Discussion and conclusions

The aim of this paper was to analyze empirically whether VC financing spurs the growth of NTBFs. The extant literature emphasizes the beneficial effects that VC financing allegedly has on portfolio firms, due to the scouting, monitoring and coaching role performed by these investors, and the certification effect of their endorsement to uninformed third parties. Nevertheless, the empirical evidence on this issue is fairly limited and not unanimous. Actually, most previous econometric studies suffer from serious methodological drawbacks. The selection bias possibly engendered by exclusive consideration of firms that went through an IPO and failure to effectively control for the endogenous nature of VC financing may have led to non generalizable or distorted estimates. In addition, a small but growing literature suggests that VC investors are an heterogeneous category. Accordingly, the effect of VC financing on the growth of portfolio firms may depend on the identity of the investor.

In order to detect the positive impact on growth that could unambiguously be attributed to VC financing and differences relating to the type of investor, we have considered here a unique hand collected longitudinal dataset that includes 550 Italian NTBFs that operate in high-tech manufacturing and service sectors and are

²² As a further check for the endogeneity of VC financing, we also implemented a Heckman correction method (for an application with panel data see Boning *et al.* 2001). We introduced into the regressions the inverse of the Mill's ratio computed from a selection equation of the probability of a firm being VC-backed. The vector of explanatory variables of the selection equation includes measures of firm size and innovativeness, founder's human capital and other control variables. The inverse of the Mill's ratio controls for the non-zero portion of the expected value of residuals under the hypothesis that the errors in the selection and growth equations are jointly normally distributed. These selection corrected results are comparable to those presented in Tables 2 and 3 and reveal the presence of a negative selection bias (for a similar result see Colombo and Grilli 2005). Unfortunately, the robustness of these results is somehow undermined by the low predictive power shown by the selection equations. Results are available from the authors upon request.

observed over a 10 year period (*i.e.* 1994-2003). The rather long longitudinal dimension of the dataset has allowed us to estimate an augmented Gibrat law type dynamic panel data model with distributed lags using a GMM-system estimation technique that takes duly into account the endogenous nature of VC financing. As most sample firms are privately held, this dataset does not suffer from the selection bias that affects samples exclusively composed of IPO firms. Furthermore we have been able to assess the different effects of VC financing obtained from financial intermediaries (FVC) and non-financial firms (CVC). Lastly, in Italy the VC sector is fairly undeveloped in comparison to the USA and the UK; hence, this study offers fresh new insights on the positive role that VC could play for the development of the NTBF sector of the economy even in an adverse environment.

Our results clearly support the view that VC financing fuels firm growth. According to our estimates, after receiving the first round of VC financing portfolio firms exhibit a considerably greater growth rate measured in terms of both the number of employees and the amount of sales, during the three subsequent years. The difference of the growth rate with respect to that of otherwise similar non VC-backed firms is both statistically significant and of an economically considerable magnitude. At the end of the third year the estimated number of employees and amount of sales are 98.5% and 93.2% greater than those in absence of VC financing.

A remarkable difference also emerges between FVC and CVC financing. Our analysis shows that the causality relationship between FVC financing and growth is quite robust. After receiving the first round of VC financing FVC-backed firms grow much faster than their non-VC-backed peers. Conversely, the evidence relating to CVC financing is more ambiguous (for a similar result relating to German IPO firms, see Tykvova and Walz 2007). The estimated increase of firm size measured by the number of employees three years after receiving the first round of CVC financing is positive but smaller than the one exhibited by FVC-backed firms (+70.2% and +91.0%, respectively). As to growth of sales, we have been unable to detect any statistically significant positive effect of CVC financing, while the positive effect of FVC financing is large: the estimated increase of the sales of a FVC-backed firm attributable to VC financing at the end of the third year after receiving the first round of financing is equal to +143.2%. Our results provide quite robust empirical evidence supporting the argument raised by previous studies that the identity of the VC investor matters (see Gompers and Lerner 1998, Gompers 2002, Da Rin *et al.* 2006, Engel and Heger 2006, Tykvova 2007, Tykvova and Walz 2007).

We think that these results offer new interesting insights into the role of VC financing in fostering the growth of high-tech start-ups. Quite interestingly, they clearly document that even in an unfavorable environment as the one provided by the Italian financial system, VC financing has a dramatic positive influence on NTBF growth, especially when the investor is a financial venture capitalist. This evidence has important policy implications. In fact, in Europe the VC sector is far less developed than in the USA or in Israel. While an analysis of the determinants of this situation lies beyond the scope of the present work,²³ the findings illustrated here support the view that the development of the demand for and supply of VC financing should figure prominently in the innovation policy agenda of European governments.

In spite of the interest of this study, it is fair to acknowledge that much remains to be done in this field. There are three directions for future research that seem very promising. First, one may wonder whether the results relating to Italy can be generalized to other countries. This remark especially applies to the difference between FVC and CVC financing. Therefore, the creation of long longitudinal datasets relating to privately held firms located in different countries is an essential step forward in order to extend our knowledge of the relation between VC financing and firm growth.

Second, our findings indicate that FVC-backed firms perform better than CVC-backed ones. However, they are not helpful in telling why. On the one hand, CVC investors may lack the specialized scouting, coaching and monitoring competencies that are necessary to pick winners and/or build them. The relationships of portfolio companies with CVC investors may also be more adversarial than those with FVC investors, with this diverting the time and energy of ventures' entrepreneurs from the pursuit of firm growth. On the other hand, for FVC investors growth of portfolio firms is clearly instrumental to an exit strategy aimed at rapidly obtaining a sizable capital gain. Conversely, several previous studies have documented that most CVC investors do not exclusively have financial objectives, being primarily interested in opening a window on the novel technologies that portfolio firms are developing (see among others Siegel *et al.* 1988, Chesbrough 2002, Ernst *et al.* 2005, Dushnitsky and Lenox 2005a,b).

Our estimates indicate that CVC financing leads to greater growth of the number of employees of portfolio firms, while it has negligible effects on firms' sales. These results may be interpreted as a signal that contrary

²³ See Da Rin *et al.* (2006) for an econometric study of country-specific and industry-specific factors that stimulate VC investments. For an analysis of the development of the Israel VC industry and the role of public policy see Avnimelech and Teubal (2004).

to their FVC peers, CVC investors are not interested in boosting the sales of portfolio firms, as they indeed pursue non financial objectives. Alternatively, they may reveal a worrisome decline of the productivity proxied by the ratio of sales to employees of CVC-backed firms after receiving external financing. As a matter of facts, additional empirical work and the collection of data on aspects such as the evolution of the activity of portfolio companies after obtaining VC financing, and changes in their structure and strategy are needed in order to understand the reasons why CVC-backed firms perform differently from their FVC-backed counterparts.

Lastly, in accordance with the insights provided by previous studies (see for instance Da Rin *et al.* 2006), there may be substantial heterogeneity within the two categories of investors we have considered here, according to such characteristics as their investing experience and the human capital of managing partners. These differences are likely to influence the effect of VC financing on firm growth. Furthermore, the portfolio firms of these two types of investors may also differ as to such characteristics as their size and sectoral specialization. In turn these characteristics could influence the effect of FVC and CVC financing on the growth of portfolio firms. More generally, several factors may differently moderate the impact of FVC and CVC financing on firm growth. They include the stage of firm's life in which the first round of VC financing is obtained, the technological knowledge and other specialized assets possessed by portfolio companies, the competitive and technological environment in which they operate, and the extent of the adverse selection, moral hazard and appropriability problems that make it difficult for them to obtain external financing. Getting a better understanding of the moderating role of these factors represents a key priority for the literature interested in assessing the economic effects of VC.

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Tables and figures

Table 1. Distribution of VC-backed firms by age at the time of the first round of VC financing

<i>Firms' age at time of first round of financing</i>	<i>VC-backed firms</i>		<i>FVC-backed firms</i>		<i>CVC-backed firms</i>	
	<i>N.</i>	<i>%</i>	<i>N.</i>	<i>%</i>	<i>N.</i>	<i>%</i>
0-1 year	37	55.2	17	50.0	22	57.9
2-5 years	16	23.9	9	26.5	7	18.4
> 5 years	14	20.9	8	23.5	9	23.7
<i>Total</i>	67	100.0	34	100.0	38	100.0

Table 2. Effect of venture capital financing on NTBF growth

	<i>Employees</i>				<i>Sales</i>			
	<i>Within Groups</i>		<i>SYS-GMM</i>		<i>Within Groups</i>		<i>SYS-GMM</i>	
<i>LSize (-1)</i>	0.5318 (0.0151) ***	0.53 (0.0152) ***	0.8873 (0.0383) ***	0.8879 (0.0411) ***	0.4215 (0.0169) ***	0.4217 (0.0169) ***	0.8969 (0.0524) ***	0.876 (0.0495) ***
<i>LAge (-1)</i>	0.2462 (0.0228) ***	0.2471 (0.0228) ***	0.0217 (0.0325)	0.0218 (0.0342)	0.3284 (0.0403) ***	0.3284 (0.0403) ***	-0.1799 (0.0786)**	-0.1472 (0.0748) **
<i>VC (-1)</i>	0.391 (0.0572) ***	0.4019 (0.058) ***	0.5708 (0.0838) ***	0.5638 (0.0875) ***	0.247 (0.0885) ***	0.243 (0.0898) ***	0.7339 (0.3791) *	0.7546 (0.3679) **
<i>VC (-2)</i>	0.3487 (0.0579) ***	0.3596 (0.0587) ***	0.3387 (0.074) ***	0.331 (0.0781) ***	-0.3593 (0.089) ***	-0.363 (0.0901) ***	0.0219 (0.1678)	0.0462 (0.1673)
<i>VC (-3)</i>	0.3085 (0.0641) ***	0.3199 (0.0648) ***	0.2352 (0.0736) ***	0.2312 (0.0786) ***	0.2313 (0.0988) **	0.2274 (0.1) **	0.3221 (0.1547) **	0.3516 (0.1508) **
<i>VC (-4)</i>		0.1024 (0.0894)		0.009 (0.0784)		-0.0348 (0.1352)		0.0957 (0.0911)
<i>AR (1)</i>			-8.35 ***	-8.28***			-5.45 ***	-5.42 ***
<i>AR (2)</i>			-0.47	-0.46			1.24	1.29
<i>Sargan-Hansen</i>			92.68 [86]	92.60 [86]			66.82 [67]	65.55 [67]
<i>Difference Sargan</i>			17.87 [16]	19.37 [16]			0.89 [14]	0.97 [14]
<i>Long-run effect of VC</i>	66.49 ***	47.03***	21.67 ***	18.77***	0.36	0.07	6.39 **	6.85***

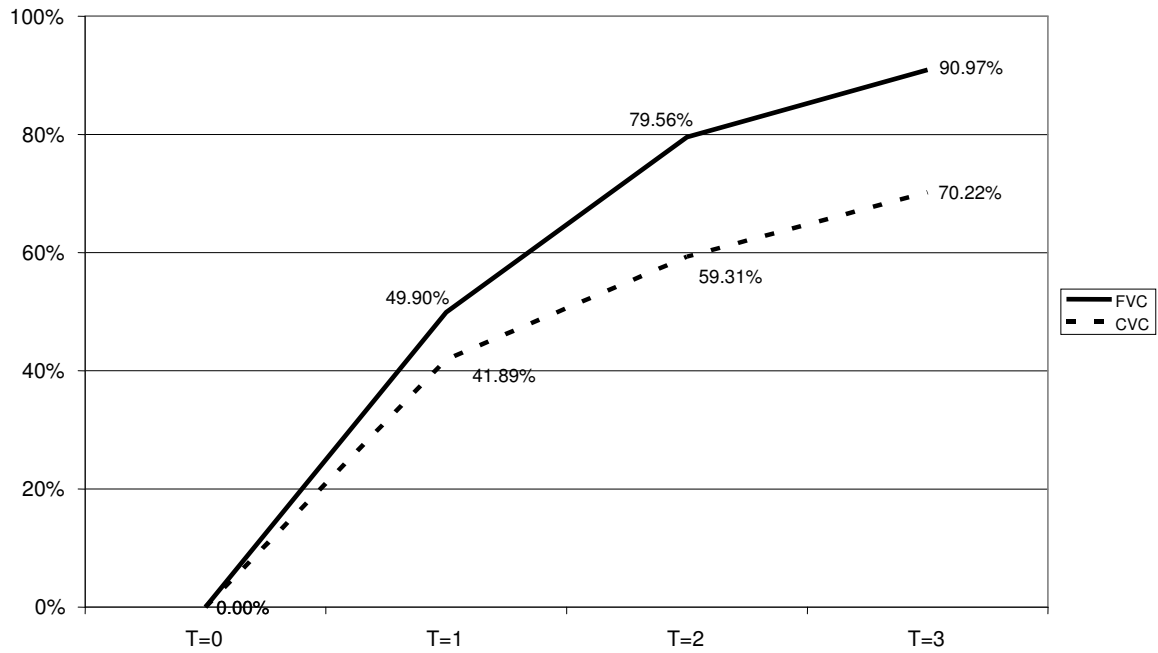
Legend : * p < .10; ** p < .05; *** p < .01. The p value relating to the coefficient of LSize refers to the null hypothesis $\square=1$. SYS-GMM estimates are obtained through the estimation of a two-step GMM-System model with finite sample correction (Windmeijer 2005). AR(1) and AR(2) are tests of the null hypothesis of respectively no first- or second-order serial correlation. Sargan-Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. Difference Sargan is a test of the validity of the additional instruments in differences for the equations in levels. SYS-GMM estimates are based on the hypothesis of VC financing being endogenous, which implies use of instruments dated at least t-2 for the equations in first differences and instruments dated t-1 for the equations in levels. Since the Sargan-Hansen test rejects the null hypothesis on instrument validity in the SYS-GMM sales equation, in this case instruments begin from time t-3 in the difference and t-2 in the level equations. The estimates of long-run effects are computed by the Delta method. Standard deviations in round brackets, degrees of freedom in square brackets. Number of observation is 3,082.

Table 3. Effect of financial and corporate venture capital financing on NTBF growth

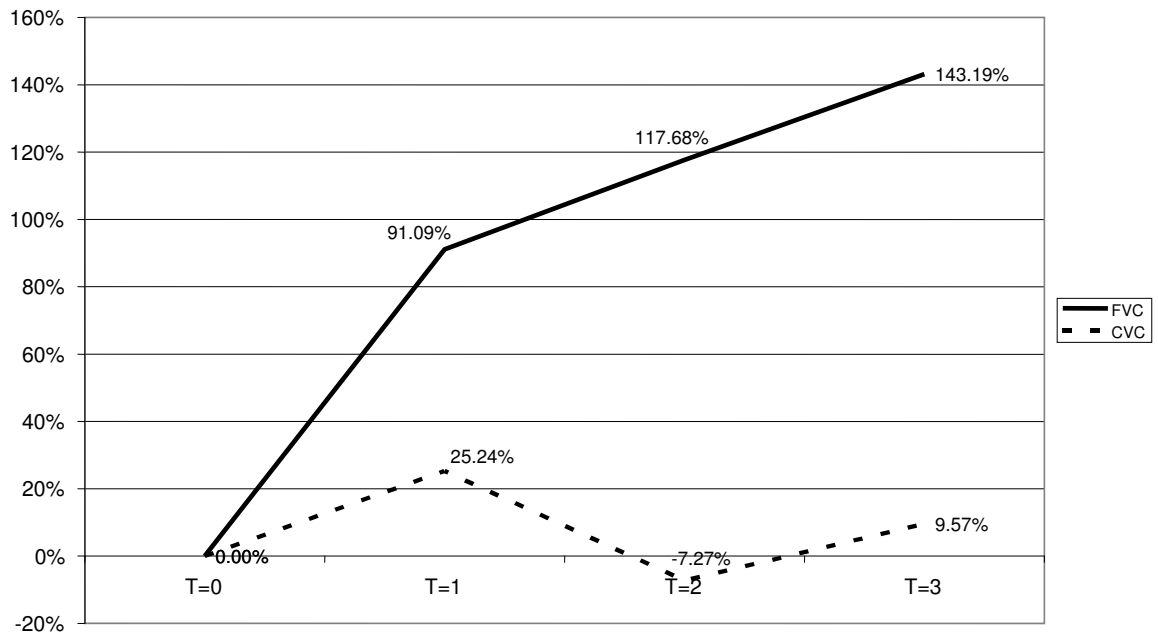
	<i>Employees</i>				<i>Sales</i>			
	<i>Within Groups</i>		<i>SYS-GMM</i>		<i>Within Groups</i>		<i>SYS-GMM</i>	
<i>LSize (-1)</i>	0.5288 (0.0152) ***	0.2475 (0.0228) ***	0.8816 (0.0316) ***	0.8806 (0.0332) ***	0.4244 (0.017) ***	0.4243 (0.017) ***	0.8927 (0.0524) ***	0.8832 (0.0519) ***
<i>LAge (-1)</i>	0.2461 (0.0228) ***	0.5488 (0.0826) ***	0.03 (0.0248)	0.0302 (0.0261)	0.319 (0.0403) ***	0.3191 (0.0403) ***	-0.1687 (0.783)**	-0.1496 (0.0743) **
<i>FVC (-1)</i>	0.5293 (0.0816) ***	0.5891 (0.085) ***	0.4990 (0.1000) ***	0.5087 (0.1042) ***	0.3362 (0.1278) ***	0.3489 (0.1293) ***	0.9109 (0.5120) *	0.8798 (0.5094) *
<i>FVC (-2)</i>	0.5652 (0.0837) ***	0.4808 (0.0962) ***	0.3557 (0.0633) ***	0.358 (0.0668) ***	0.1663 (0.1302)	0.1818 (0.1324) ***	0.3636 (0.1806)**	0.2072 (0.1953)
<i>FVC (-3)</i>	0.4532 (0.0946) ***	0.2688 (0.1713)	0.2083 (0.0824) **	0.2068 (0.0861) **	0.43 (0.1479) ***	0.4482 (0.1505) ***	0.3814 (0.1775) **	0.3867 (0.1489) ***
<i>FVC (-4)</i>		0.2106 (0.0824) **		-0.2529 (0.1691)		0.1654 (0.2589) ***		0.2213 (0.2652)
<i>CVC (-1)</i>	0.2092 (0.0811) **	0.0981 (0.0851)	0.4189 (0.1264) ***	0.4371 (0.1346) ***	0.2579 (0.1258) **	0.2497 (0.1281) ***	0.2524 (0.8384)	0.2554 (0.8563)
<i>CVC (-2)</i>	0.0971 (0.0836)	0.1655 (0.0953) *	0.2238 (0.0850) ***	0.2395 (0.0928) **	-0.7077 (0.1277) ***	-0.717 (0.1302) ***	-0.2988 (0.2700)	-0.2502 (0.2752)
<i>CVC (-3)</i>	0.164 (0.0933) *	0.025 (0.1212)	0.1793 (0.0933) *	0.1954 (0.099) **	0.0863 (0.1415)	0.0751 (0.1448) ***	0.1606 (0.1948)	0.1935 (0.1929)
<i>CVC (-4)</i>		0.2475 (0.0228) ***		0.0472 (0.0996)		-0.0556 (0.1836) ***		0.1118 (0.1406)
<i>AR (1)</i>			-8.61 ***	-7.46***			-5.64 ***	-5.66 ***
<i>AR (2)</i>			-0.49	-0.59			1.07	1.15
<i>Sargan-Hansen</i>			96.92 [101]	96.51 [101]			58.92 [77]	56.18 [77]
<i>Difference Sargan</i>			21.35 [24]	21.48 [25]			8.38 [20]	9.46 [21]
<i>Long-run effect of FVC</i>	64.24 ***		24.15 ***		9.78 ***		3.16 *	
<i>Long-run effect of CVC</i>	6.51 **		11.37 ***		1.62		0.01	
<i>ΔLong-run effect (FVC-CVC)</i>	14.62 ***		25.06 ***		5.28 ***		4.48 *	

Legend : * p < .10; ** p < .05; *** p < .01. The p value relating to the coefficient of LSize refers to the null hypothesis $\square_1=1$. SYS-GMM estimates are obtained through the estimation of a two-step GMM-System model with finite sample correction (Windmeijer 2005).AR(1) and AR(2) are tests of the null hypothesis of respectively no first- or second-order serial correlation. Sargan-Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. Difference Sargan is a test of the validity of the additional instruments in differences for the equations in levels. SYS-GMM estimates are based on the hypothesis of venture capital financing being endogenous, which implies use of instruments dated at least t-2 for the equations in first differences and instruments dated t-1 for the equations in levels. Since the Sargan-Hansen test rejects the null hypothesis on instrument validity in the GMM-SYS sales equation, in this case, instruments begin from time t-3 in the difference and t-2 in the level equations. The estimates of long-run effects are computed by the Delta method. Standard deviations in round brackets, degrees of freedom in square brackets. Number of observation is 3,062.

Figure 1. Estimated effect of financial and corporate venture capital financing on NTBF growth
 Panel A: Number of employees



Panel B: Sales



Legend: The vertical axis reports the percentage difference in firm size (measured by the number of employees and the amount of sales respectively) between a FVC- or CVC-backed firm and a twin firm having the same characteristics at time T=0 (mean values of size and age) but receiving no FVC or CVC financing. Calculations are based on the SYS-GMM estimates of Table 3.

Appendix

Table A.1. Effects of venture capital financing on NTBF growth: alternative specifications (SYS-GMM estimates)

	<i>Employees</i>		<i>Sales</i>	
<i>LSize (-1)</i>	0.9563 (0.0444) ***	0.8882 (0.0672) ***	0.9718 (0.0464) ***	0.8443 (0.0511) ***
<i>LAge (-1)</i>	-0.0141 (0.0382)	0.0121 (0.0493)	-0.2342 (0.072) ***	-0.1248 (0.069) *
<i>VC (-1)</i>	0.4595 (0.0946) ***	0.5654 (0.1772) ***	0.5993 (0.3416) *	0.728 (0.3968) *
<i>VC (-2)</i>	0.2667 (0.0862) ***	0.3286 (0.1339) **	-0.0304 (0.1358)	-0.0919 (0.1603)
<i>VC (-3)</i>	0.1854 (0.0867) **	0.2005 (0.1281)	0.2557 (0.1322) *	0.2946 (0.1099) ***
<i>DManager (-1)</i>		0.1478 (0.1449)		0.1344 (0.2697)
<i>DManager (-2)</i>		-0.0239 (0.1448)		0.0852 (0.1726)
<i>DManager (-3)</i>		0.0112 (0.1366)		0.1307 (0.1073)
<i>DPublicSubsidy(-1)</i>		0.0152 (0.0818)		0.1213 (0.1582)
<i>DPublicSubsidy(-2)</i>		-0.0336 (0.0627)		-0.2159 (0.1433)
<i>DPublicSubsidy(-3)</i>		0.0204 (0.0975)		0.0741 (0.0626)
<i>DPatent(-1)</i>		0.1101 (0.2196)		-0.204 (0.4273)
<i>DPatent(-2)</i>		-0.1532 (0.1667)		-0.0154 (0.3291)
<i>DPatent(-3)</i>		0.0012 (0.0822)		0.2032 (0.1414)
<i>DIPO(-1)</i>		0.0834 (0.3118)		-0.6218 (0.4569)
<i>DIPO(-2)</i>		0.3005 (1.1698)		0.0443 (0.1933)
<i>DIPO(-3)</i>		0.4113 (0.8301)		0.3635 (0.2254)
<i>Year dummies</i>	Yes	No	Yes	No
<i>AR (1)</i>	-8.84***	-7.46***	-5.68***	-5.59 ***
<i>AR (2)</i>	-0.45	-0.59	1.15	1.27
<i>Sargan-Hansen</i>	84.45 [86]	167.01 [215]	65.19 [67]	138.80 [169]

Legend : * p < .10; ** p < .05; *** p < .01. DManager=1 if the management team includes a salaried manager. DPublicSubsidy=1 if a firm obtained public subsidies. DPatent=1 if a firm has been granted one or more patents (granted patents are assigned to the date of application). DIPO=1 if a firm went through an IPO. The p value relating to the coefficient of LSize refers to the null hypothesis $\alpha_1=1$. SYS-GMM estimates are obtained by the estimation of a two-step GMM-System model with finite sample correction (Windmeijer 2005). AR(1) and AR(2) are tests of the null hypothesis of respectively no first- or second-order serial correlation. Sargan-Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. SYS-GMM estimates are based on the hypothesis of venture capital financing and additional control variables as being endogenous, which implies use of instruments dated at least t-2 for the equations in first differences and instruments dated t-1 for the equations in levels. Since the Sargan-Hansen test rejects the null hypothesis on instrument validity in the SYS-GMM sales equations, in this case instruments begin from time t-3 in the difference and t-2 in the level equations. Standard deviations in round brackets, degrees of freedom in square brackets. Number of observation is 3,082.

Table A.2. Effect of financial and corporate venture capital financing on NTBF growth: alternative specifications (SYS-GMM estimates)

	<i>Employees</i>		<i>Sales</i>	
<i>LSize (-1)</i>	0.9255 (0.042) ***	0.8958 (0.0387) ***	0.9673 (0.0521) ***	0.8596 (0.0495) ***
<i>LAge (-1)</i>	0.0103 (0.0354)	0.011 (0.028)	-0.228 (0.0801) ***	-0.1335 (0.0676) **
<i>FVC (-1)</i>	0.4848 (0.1118) ***	0.4995 (0.1029) ***	0.7475 (0.4534) *	0.3729 (0.4346)
<i>FVC (-2)</i>	0.3388 (0.0916) ***	0.3637 (0.0698) ***	0.2829 (0.1609) *	0.1173 (0.2629)
<i>FVC (-3)</i>	0.196 (0.093) **	0.171 (0.0859) **	0.3468 (0.1833) *	0.502 (0.1984) **
<i>CVC (-1)</i>	0.4025 (0.1256) ***	0.4103 (0.1203) ***	0.5109 (0.7286)	0.8458 (0.7186)
<i>CVC (-2)</i>	0.2128 (0.085) **	0.2059 (0.0822) **	-0.273 (0.21)	-0.3762 (0.2733)
<i>CVC (-3)</i>	0.185 (0.0974) *	0.1216 (0.0829)	0.2102 (0.1173) *	0.1099 (0.1618)
<i>DManager (-1)</i>		0.1541 (0.0798) *		0.1721 (0.2814)
<i>DManager (-2)</i>		-0.0492 (0.0845)		0.0072 (0.2103)
<i>DManager (-3)</i>		0.0343 (0.0703)		0.1604 (0.1414)
<i>DPublicSubsidy(-1)</i>		0.02 (0.045)		0.0564 (0.1693)
<i>DPublicSubsidy(-2)</i>		-0.0329 (0.0425)		-0.1857 (0.1537)
<i>DPublicSubsidy(-3)</i>		0.0134 (0.0348)		0.0882 (0.0899)
<i>DPatent(-1)</i>		0.1216 (0.1109)		-0.1353 (0.311)
<i>DPatent(-2)</i>		-0.1525 (0.1042)		-0.0589 (0.316)
<i>DPatent(-3)</i>		-0.0183 (0.0561)		0.1933 (0.1281)
<i>DIPO(-1)</i>		0.3255 (0.2343)		-0.8828 (0.512) *
<i>DIPO(-2)</i>		0.2877 (0.4022)		0.0588 (0.1895)
<i>DIPO(-3)</i>		0.3637 (0.2161) *		0.3171 (0.21)
<i>Year Dummies</i>	Yes	No	Yes	No
<i>AR (1)</i>	-8.60***	-8.59 ***	-5.67***	-4.90 ***
<i>AR (2)</i>	-0.48	-0.63	1.12	1.39
<i>Sargan-Hansen</i>	94.17 [101]	161.50 [229]	64.07 [77]	205.11 [227]

Legend : * p < .10; ** p < .05; *** p < .01. DManager=1 if the management team includes a salaried manager. DPublicSubsidy=1 if a firm obtained public subsidies. DPatent=1 if a firm has been granted one or more patents (granted patents are assigned to the date of application). DIPO=1 if a firm went through an IPO. The p value relating to the coefficient of LSize refers to the null hypothesis $\alpha_1=1$. SYS-GMM estimates are obtained by the estimation of a two-step GMM-System model with finite sample correction (Windmeijer 2005). AR(1) and AR(2) are tests of the null hypothesis of respectively no first- or second-order serial correlation. Sargan-Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. SYS-GMM estimates are based on the hypothesis of venture capital financing and additional control variables as being endogenous, which implies use of instruments dated at least t-2 for the equations in first differences and instruments dated t-1 for the equations in levels. Since the Sargan-Hansen test rejects the null hypothesis on instrument validity in the SYS-GMM sales equations, in this case instruments begin from time t-3 in the difference and t-2 in the level equations. Standard deviations in round brackets, degrees of freedom in square brackets. Number of observation is 3,062.

Table A.3. “Placebo leads” effects of venture capital, financial and corporate venture capital financing on NTBF growth (Within-Group estimates)

	<i>Employees</i>		<i>Sales</i>	
<i>LSize (-1)</i>	0.5244 (0.0153) ***	0.521 (0.0154) ***	0.4180 (0.0169) ***	0.4209 (0.0169) ***
<i>LAge (-1)</i>	0.2535 (0.0396) ***	0.2556 (0.0396) ***	0.0778 (0.0662)	0.0708 (0.0662)
<i>VC (-1)</i>	0.4051 (0.0615) ***		0.1907 (0.0947) **	
<i>VC (-2)</i>	0.3886 (0.0619) ***		-0.3769 (0.0944) ***	
<i>VC (-3)</i>	0.3647 (0.0666) ***		0.2574 (0.1021) **	
<i>VC (+1)</i>	0.0729 (0.0764)		0.0867 (0.117)	
<i>VC (+2)</i>	0.1166 (0.0838)		-0.1702 (0.1266)	
<i>VC (+3)</i>	-0.0621 (0.1019)		-0.1028 (0.1540)	
<i>FVC (-1)</i>		0.5332 (0.0872) ***		0.3943 (0.1350) ***
<i>FVC (-2)</i>		0.5963 (0.0881) ***		0.2460 (0.1364) *
<i>FVC (-3)</i>		0.5063 (0.0972) ***		0.5386 (0.1505) ***
<i>FVC (+1)</i>		0.0233 (0.1081)		0.2937 (0.1630) *
<i>FVC (+2)</i>		0.0494 (0.1253)		0.0792 (0.1890)
<i>FVC (+3)</i>		-0.137 (0.1558)		0.0364 (0.2349)
<i>CVC (-1)</i>		0.2229 (0.0891) **		0.1312 (0.1373)
<i>CVC (-2)</i>		0.1312 (0.0898)		-0.7919 (0.1370) ***
<i>CVC (-3)</i>		0.2092 (0.0969) **		0.0535 (0.1467)
<i>CVC (+1)</i>		0.0576 (0.1145)		-0.0973 (0.1779)
<i>CVC (+2)</i>		0.0245 (0.1201)		-0.3713 (0.1811) **
<i>CVC (+3)</i>		0.0209 (0.1387)		-0.1303 (0.2093)
<i>Year Dummies</i>	Yes	Yes	Yes	Yes
<i>VC(+1)=VC(+2)=VC(+3)=0</i>	3.33 [3]		3.42 [3],	
<i>FVC(+1)=FVC(+2)=FVC(+3)=0</i>		1.17 [3]		3.27 [3]
<i>CVC(+1)=CVC(+2)=CVC(+3)=0</i>		0.27 [3]		4.32 [3]

Legend : * p < .10; ** p < .05; *** p < .01. The p value relating to the coefficient of LSize refers to the null hypothesis $\beta_1=1$. F-Statistics on the null hypothesis that placebo effects are null are reported. Standard deviations in round brackets, degrees of freedom in square brackets. Number of observation is 3,062.