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VENTURE CAPITALISTS AT WORK: WHAT ARE THE EFFECTS ON THE FIRMS THEY FINANCE?

by Raffaello Bronzini°, Gianpaolo Caramellino^ and Silvia Magri*

Abstract

Italian startups financed by venture capitalists (VCs) experience a faster growth in size and become more innovative compared with other startups. VC-backed firms also show a much larger increase in equity and a reduction in their leverage. This evidence is obtained by comparing a representative sample of firms financed by private VCs in the period 2004-2014 with a sample of firms rejected by VC at the very last stage of the screening process or in the due diligence phase. These firms narrowly lost the contest and before VC financing have very similar observable and unobservable characteristics to the VC-backed firms; self-selection is specifically taken into account. The effects on firms' size and innovation are not exclusively explained by equity financing. The results hold when we restrict the comparison to firms in the control group that also increase their equity from investors other than VCs: this suggests that VC effects can also be linked to their managerial expertise and network connections. Finally, the results are exclusively driven by independent VC investors compared with captive VCs.

JEL Classification: G21, G24, G32, O30.
Keywords: venture capital, innovation, firm financial structure, differences-in-differences.

Contents

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1 Introduction [1]

Venture capital (VC) investors provide equity capital to early-stage, high growth potential startup companies that develop a new technology or a new business model in high-tech industries. Equity is an important source of finance for startup innovative companies that could find it difficult to obtain debt as banks normally require collateral they might lack of; additionally, debt financing involves the ability to service debt, while startup firms might not generate any cash flow for the initial years of activity. Venture capitalists aim at getting a return by selling their shares in the companies through a trade-sale or an Initial Public Offering (IPO). They usually expect important returns on some of their investments to offset the fact that a good amount of their projects will fail.[2] In order to increase the return of the investments, VC investors adopt an active form of financing: almost all of them sit on the board of directors and they provide entrepreneurs with advice and contacts.

VC investors might therefore have important effects on the firms they finance, whose performances are hence expected to be better than those of other similar firms that did not receive VC finance (Gompers and Lerner, 2001). This is not just because the equity capital they provide helps reducing the funding gap of high-tech startup firms, but also due to the fact that VC managerial and financial experience could be very useful in enhancing firms' grow perspectives. Finally they can also improve firms' performances through their network connections and a signaling effect on other financiers, specifically banks. On the other hand, following the VC intervention, important conflicts can arise in the governance of the firms, which could be harmful for their performances. First, the aims and strategies of VC investors could be very different from those of the entrepreneurs; specifically, most VC investors could have too a short-term investment perspective compared with that of the entrepreneurs, who can consider this feature detrimental for long-term firm performances. Although VC investors are committed to a company for a long haul, their primary aim is to find a

[1]The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank of Italy. Cristiana Rampazzi and Stefania De Mitri provided excellant research assistance. We would like to thank for their useful comments participants at the BOI and LSE-PhD seminars, at the 14 International Conference on Credit Risk Evaluation (Venice, October 2015) and at the 65 Midwest Finance Association (Atlanta, March 2016), specifically Matteo Benetton, Andreas Ek, Giorgio Gobbi, Juanita Gonzalez-Uribe, Andrea Lamorgese, Andrea Linarello, Francesca Lotti, Samuele Murtino, Daniel Paravisini, Enrico Rettore, Paolo Sestito, Enrico Sette, Luigi Federico Signorini, Roger Stein and Konstantinos Tokis. We are also grateful to the Italian Association of Private Equity and Venture Capital (AIFI) for their help in collecting information on rejected businesses by venture capitalists, and to Diana Del Colle who initially helped us with the dataset.

[2]Shikhar Ghosh of Harvard Business School (HBS) found that three-quarters of US startups backed by venture capital failed to return the capital invested in them, let alone generate a positive return; the figure was calculated on a sample of 2,000 companies that received VC funding between 2004 and 2010. Entrepreneurs anonymous, The Economist, Sept 20th 2014.

good form of exit from the company.[3] Secondly, appropriability problems can arise as VC investors might just try to capture the innovative idea of the entrepreneurs and exploit it by themselves. The evaluation of VC effects is therefore an empirical question. As a matter of fact, some studies have found no or weak beneficial effects of VC investors on firms' results.

The aim of this paper is to evaluate the private VC contributions on Italian startups they finance. We focus on Italy where the VC market is still very underdeveloped compared with other European countries and the US (Figure 1). The evaluation of private VC activity is very important in our country where a public support has been suggested in order to provide a kick off to the expansion of the private VC market: with this purpose, some VC funds have been created, partially funded with public money.[4]

The most important challenge in this type of analysis is finding an adequate identification strategy so that a VC treatment effect is detectable, while selection effect is controlled for. Firms that apply for VC funding may be different: the decision to apply may be related to the quality of the new idea and the consequent determination to exploit it. Moreover, VC investors could be smart enough to select the best startup high-tech companies. In other words, there could exist some firm unobservable features (unobservable to the econometrician) that both affect the firm long-term growth prospects and its probability to be financed by a VC. VC treatment could therefore be endogenous. In this case, the effect found when VC companies are compared with other startups, which have not been financed by VC, could be just the selection effect or a mix of selection and treatment effects.

The empirical literature on this topic, reviewed in Section 2, struggles more or less fiercely with this selection problem. Many papers use propensity score matching to obtain a sample of control firms that are similar to those financed but with regard to just some observable features. Few papers rely on IV strategies that also attempt to control for unobservable characteristics. Most of the papers focus on few output indicators. The evidence of important VC effects is stronger in the US experience than in Europe. The most frequent results are that VC investors tend to

[3]The US Small Business Administration website reports that on average the exit happens 4 to 6 years after an initial investment; in Italy, AIFI, the Italian Association of Private Equity and Venture Capital, estimates an average holding period of 5 years.

[4]The Fondo Italiano di Investimento SGR runs 2 VC funds of funds with a target funding of more than 200 million, partly covered by Cassa Depositi e Prestiti, a state-owned company; since 2012 to 2016 they invested more than 100 million in private Italian VC funds, whose size was around 400 million at the end of 2016. Invitalia Venture SGR, a subsidiary of a public agency, runs another fund with a target funding of 100 million, which should be reached also with the contribution of private investors: this is a fund that directly co-invests in innovative start-ups with other private operators. Their effect on the size of the Italian venture capital market is expected to be remarkable when considering that early-stage investments in Italy in the whole period 2012-2016 were a bit more than 400 million.

largely increase the size and the survivorship-rate of the firms they finance. Effects on other firms' characteristics, such as profitability, productivity, innovation, and, namely, financial structure and governance are sometimes documented, though less frequently analyzed, specifically altogether, due to the difficulty in gathering data.

One contribution of this paper is that we control for the selection effect by comparing VC firms with similar firms that have requested a VC financing, but were not able to get it by a *narrow* margin (late-stage discarded firms). First, considering in the control sample only firms that demand a VC intervention excludes self-selection bias and is an important control for firm *unobservable* features, mainly the desire and determination to grow, and therefore of firm growth perspectives. Secondly, since VC investment is not random, we select our control group by considering only firms that have been discarded *at the very last stage* of the screening process or in due diligence. This strategy is very similar to that applied by Greenstone, Hornbeck and Moretti (2010) in a very different framework.[5] The rationale is that by including in the control sample only the late-stage discarded firms we enhance the similarity with the sample of VC financed firms. The reason for which the deal has not been completed is likely not the quality of the project, but more reasonably the inability to find an agreement on the valuation of the idea, the lack of funds or of coordinated interest by different investors as deals are sometimes syndicated. The selection process has been very strict and meticulous: only 6 per cent of the sample of the initial applicants for VC funding are included in the control sample.

The similarity between financed firms and those of the control group supports our identification strategy. We verify that, *before VC financing*, the firms in the control group are very similar to VC backed firms as for almost all the observable characteristics available in our data, included the average credit score, a sort of proxy catching-up the whole risk and quality of the firm measured using balance sheets indicators. On this respect, we use many more variables than previous studies. Finally, the longitudinal nature of our data allows us to estimate a diff-in-diff model where we control for all unobservable firms' characteristics before VC financing. All in all, the differences that we find between treated and control sample firms *after* VC financing can hence be considered as a good measure of the VC treatment effect.

A second contribution of this paper is that we initally consider the population of the firms financed by private VC investors in Italy in the period 2004-2014 (293 startups), as reported in

[5]The authors want to estimate the plant opening's spillover in the US and need to identify a county that is identical, in the determinants of incumbent plants' TFP, to that where the plant decided to locate. To this purpose, they use a ranking reporting the winner county as well as the one or two runner-up counties (i.e., the "losers") that have survived a long selection process, but *narrowly* lost the competition.

the Venture Capital Monitor by AIFI, the Italian Association of private equity and venture capital investors.[6] The AIFI dataset is one of the best representation of private VC investments in Italy; the dataset is not proprietary and can be used by other scholars to replicate the analysys: this is not frequent in VC studies often based on proprietary data (Kaplan and Lerner, 2016). After the merge with the Cerved dataset, from which we get firm balance sheets data, and imposing the essential condition that firms have data the year before VC financing, the number of VC backed firms decreases to 101. This sample is still representative of the initial population of VC backed firms according to industries and geographical areas.

Thirdly, unlike other empirical papers, we consider the VC effects on many different firm outputs: in detail, we evaluate the effects of VC investors on firm size, sales, profitability, credit score, financial structure, survivorship and innovation. We are specifically interested in the effects on firms' financial structure and loan terms in order to test whether VC investment creates a signaling effect for other investors, above all banks (Hellmann, Lindsey and Puri, 2008). Finally, we focus on understanding the main channels through which VC investors have a positive impact on the firms they finance by disentangling the pure financing effect, for equity provision, from the one due to VC management and network connections.

As a brief preview of the results, we find that VC investors have a fast and extended positive effect on the size of the firm: during the 4 years after VC financing, total assets increase on average by almost 800,000 euro more than that of firms that do not receive any VC finance (more than half of the average total assets before financing/rejection). Results on assets are confirmed by labour costs, mainly through an increase in the number of employees. A larger rise in labour costs with a similar trend in sales explains the worse profitability of VC-backed firms and the deterioration of their credit score: both these effects tend to disappear after 4 years from VC financing, when sales increases more for VC-backed firms, though with a large dispersion that makes not significant the difference with the control sample. We also uncover important effects of VC investors on innovation activity that develop 2/3 years after financing: both the probability and the number of patent applications increase more for VC-backed firms. No differences are detected for the survivorship rates.

As expected, equity increases much more for VC-backed firms (452,000 euro more with an average value of equity before financing of almost 400,000 euro); leverage consequently decreases. As for bank loans, we detect a larger shortening in debt maturity and a higher increase in the cost of debt

[6]The analysis excludes corporate VC, i.e. VC investments made by non-financial corporations, and public VC that are not reported in the Venture Capital Monitor by AIFI.

for VC-backed firms, which are likely to be correlated with the worsening in their credit score. The effects on firms' size and innovation persist when the control sample is reduced to consider only rejected applicants that increased their capital. This means that VC positive effects on size and innovation are not only explained by equity financing: their managerial experience and networking connections play also an important role. Finally, the positive effects on size and innovation are exclusively driven by independent VC investors with respect to captive VC; the injection of equity of the former is much larger.

The plan of this paper is as follows. Section 2 reviews the empirical literature on this topic, while Section 3 explains our research desing based on the VC selection process of start-ups. Section 4 describes the data used and presents some descriptive statistics and Section 5 shows the main empirical strategy followed in the analysis. In Section 6 the results obtained when comparing VC treated firms with late-stage discarded firms are presented. In Section 7 some robustness and extensions of the analysis are considered, while Section 8 discusses the results and concludes.

2 Literature review

The empirical literature most related with this paper analyzes US companies. Most of the papers are aware of the selection problem, though only a few tackle it in a very comprehensive way by controlling for unobservable firm characteristics before VC financing. Helmann and Puri use a sample of Silicon Valley startups and do not control for other selection problems; they find that the startups receiving VC financing were faster in reaching the market with their products (Hellmann and Puri, 2000) and that venture capitalists also play an important role in the firm's organization, frequently replacing the founder with an outside CEO (Hellmann and Puri, 2002). Kortum and Lerner (2000) analyze the impact of VC on patents and they control for unobserved factors using a policy shift that freed pension funds to invest in VC in 1979 in the US; they find that increases in VC activity in an industry are associated with significantly higher patenting rates.

More recently, Puri and Zarutskie (2012) use a longitudinal dataset of private companies and match VC backed firms with others non VC backed firms using only size, sector, geographical area and age in the year that the VC financed firm receives the first round of VC; they find that VC financed firms achieve larger scale, but are not more profitable; default rates are also lower among VC backed firms. Chemmanur, Krishnan and Nandy (2011), using a very similar dataset but also different empirical strategies to control for unobservable firms' characteristics, find that VC backed firms have higher survivorship rate and total factor productivity, the main output they focus on.

One of the most appealing studies as for the attempt to control for the selection problem is Kerr, Lerner and Schoar (2014). The authors compare firms financed by early stage investors (business angels in their case) with those that have been discarded with a level of score just below a threshold and that are hence very similar, in some observable and unobservable characteristics, to the firms that have been financed; they find that firms receiving financing by business angels have improved survival, exits, employment, patenting, Web traffic, and further equity financing.[7] Another study (Samila and Sorenson, 2011) points out some macroeconomic effects of an increase in the supply of venture capital, even when instrumented, in terms of firm starts, employment, and aggregate income.

Regarding Europe, the results about VC effects are weaker. Bottazzi and Da Rin (2002) develop a unique hand-collected data set recording the companies that went public on Euro.nm market from its inception in 1996 to December 2000[8]; they argue they consider only startups companies to reduce the bias in the comparison, similarly to what Hellmann and Puri (2000) did in the same period in the US. They find European venture capital to have a limited effect on firms' ability to grow, create jobs and raise equity capital; these results hold after matching firms using few observable characteristics. Weak results of VC on innovation are also found in Popov and Roosenboom (2012) who follow an approach similar to Kortum and Lerner (2000): they work with data on 21 European countries and 10 industries during the period 1991-2005 and use, as an exogenous variation of VC, data on fund-raising and on the structure of private equity funds in each country.[9][10] They find that VC investments seem to have an effect only in the sub-sample of high-VC countries and in countries with lower barriers to entrepreneurship, with a tax and regulatory environment that welcome venture capital investments, and with lower taxes on capital gains.

A couple of recent papers, mainly based on matching procedures and on the VICO dastaset[11], find that independent VC have effects on sales growth and on exit performances of financed firms,

[7] Another interesting paper regards China between 1998 and 2007: Guo and Jiang (2013) use a a propensity score matching and also instrumental variable estimations based on the number of IPO in the stock market. They find that VC backed firms outperform non-VC backed in terms of profitability, labour productivity, sales growth, and R&D investments.

[8] Euro.nm was the result of the alliance of Europe's new stock markets for innovative companies in high-growth industries along the lines of America's Nasdaq.

[9] Their idea is that independent funds have to invest within a relatively short time window compared with captive funds that do not have a limited lifespan and do not raise capital from outside investors other than the single owner of the private equity fund (e.g. a bank or insurance company). Therefore, increased flows in venture capital translate into investments in companies at a faster pace when a country has a higher fraction of independent as opposed to captive VC funds.

[10] They are able to replicate Kortum and Lerner (2000) results for the US in the same period; however, they also show that, even in the US, in a more recent period, VC had a comparably weak impact on innovation.

[11] More than 8,000 European high-tech firms, of which less than 10 per cent are VC backed.

while no effects are detected for government-managed VC (Grilli and Murtinu, 2014; Cumming, Grilli and Murtinu, 2017). On a similar line of research, Bottazzi, Da Rin and Hellmann (2008), analyzing *only* VC firms, using a hand-collected sample of European venture capital deals[12], find that investors' activism is more widespread among independent than captive VC (bank-, corporate- or government owned) and is positively related to the success of portfolio companies which is measured with a successful VC exit, either through an IPO or an acquisition. However, they do not look at specific different outputs of financed companies and they do not compare VC backed firms with others.

As for Italy, some empirical papers use a dataset built by the Politecnico of Milan, based on a sample of high-tech startups followed between 1993 and 2003, of which around 10 per cent were VC backed.[13] One of the most interesting result is obtained in Bertoni, Colombo and Grilli (2011): after controlling for selection of the unobservable variables with a panel fixed effect estimation, this study finds that VC financing spurs firm growth.

3 Selection process among venture capitalists and research design

How do VC investors decide whether or not to finance an innovative startup?

A typical flow chart is reported in Figure 2. VC investors receive thousands of requests of financing each year. Normally the entrepreneurs send a copy of their business plan or an executive summary. Most of them (50 per cent) are rejected after an initial and rapid evaluation of the papers. A share of startups of around 20 per cent reach the phase of a deeper evaluation. At this stage VC investors meet the team and conduct a broad analysis of the data; the startup team is invited to give a short presentation, which is followed by a question-and-answer session. They also analyse the business plan, the way the idea can be protected, the team experience in the market and its commitment in terms of time and funds devoted to the development of the idea, commercial and/or industrial partnerships. For the most promising ideas, VC investors also start to think about the structure of the operation, i.e. the terms of VC entrance and exit and the valuation of the firm. The most promising companies arising the greatest interest (around 10 per cent) enter a costly due diligence process during which the structure of the operation is finalised. Eventually, only 2-3 per cent of the ideas are financed.

There are many reasons why a deal is not reached during the screening or in due diligence. Most

[12] They analyze 1652 companies financed in 17 European countries by 119 venture capitalists between 1998-2001.

[13] The same dataset is included in the VICO dataset at the European level, mentioned in the previous paragraph.

of them arise quickly in the process and are related to the quality of the firm, i.e. an inadequate business plan, an idea that is not developed enough, poor quality and/or low commitment of the management team. Some of the reasons are not related to the quality of the idea, but arise from VC preferences for some industries, in which they are specialized, or for the envisaged size of the business that could often be considered too small or too large.

Some other reasons might arise later in the process and are mostly related to the lacking agreement on the terms of entrance and exit of the VC fund in the firm and its evaluation, or to the difficulties in finding co-investors in the deal, or the absence of an envisaged way out. Trust is also quite important: early-stage investors take on significant risks as there are often many unknown factors. VC must be confident that the management team will be able to adapt to new conditions without losing focus. VC investors can hence change their mind about a startup also in the final stage of screening or even in due diligence. Moreover, trust is a matter of chemistry, not necessarily connected with the quality of the business. It could be that some startups are rejected by a VC for lacking of trust, but the overall idea is good.

Our research design is based on singling out the *late-stage rejected business* in the idea that at this stage the reasons for which the deal has not been concluded might be those mentioned in the previous paragraph and are less likely to be related to the quality of the idea or of the management. All in all, we try to select the best projects among those that have been rejected.

We are able to build this control sample as we have information on a sub-sample of startups rejected at the different steps of the screening or during the due diligence process. We asked all the VC members of the AIFI to share with us confidential information about the companies that applied for venture capital and their subsequent evaluations. Five of them, which account for one fourth of all the investments undertaken in the period 2004-2014, gave us the information we need. We thus know the tax code of more than 4000 companies that applied for this source of financing during the period 2006-2014, the year in which the screening process occurred, and the stage of the process when the applicant has been rejected. Albeit these VC use different ways of ranking firms, we were able to single out for each investor those businesses that were discarded *at the very last stage* of the screening process or in due diligence and with the highest grades.[14]

In conclusion, this research design allows us to identify the best applicants that were not able to get VC financing. We end up with 258 firms in the control group that account for almost 6

[14]Some VC gave a summary grade to the applicant, others comment about the reasons not to undertake the investment. For some VC we choose discarded firms among those with the highest grades, for others the descriptions and comments given by the investors implied they were among the best of rejected firms.

per cent of all VC applicants for which we have information, a percentage that is very similar to the difference between the share of firms reaching the last step of the evaluation and that of firms financed by VC (Figure 2).

4 Source of data and descriptive statistics

Aside from information on rejected startups among a sub-sample of VC applicants, the analysis is based on data coming from three other different sources. The first source of data is the annual survey Venture Capital Monitor by AIFI. We use the surveys between 2004 and 2014 to identify the universe of venture capital deals in the period (293 VC investments). For each deal we observe the name and the origin of the target firm, the name and the type of the investors, and, for most of the investments, some other details, such as the amount invested and the share of the firm acquired by VC. More specifically, about three-fourths of the target companies are private enterprises, 9 per cent are corporate spin offs and 15 per cent university spin offs. There are 82 different investors: many of them are however associated to only one deal, whereas the most active venture capital has invested in 17 different firms. As for deal terms, the amount invested is specified for more than 70 per cent of the investments: the average and the median value of the investments are 2.5 and 1 million of euro, with a range from 0.1 to 66 millions; 30 per cent of the deals are syndicated. Regarding the years of investments, prior the financial crises the trend in total number of deals was increasing, a pattern that has recovered starting from 2011.

Secondly, for every company in our study we gather information for the period 2000-2015 using the Cerved database that contains detailed annual balance sheets for all limited liability companies based in Italy. In the analysis we only focus on active firms with available information at least one year before the VC treatment. This condition reduces the number of ventures in our study to 101, but is crucial to evaluate the level and trends of the variables of interest since the year before the treatment. In order to evaluate the representativeness of this smaller sample of the initial population of VC-backed firms, in Table 1 we compare their industry and geographical distributions that turn out to be very similar, while firms in our sample tend to be slighlty more innovative when considering the probability and the number of patent applications.[15]

As mentioned, we focus on different firm characteristics, such as size, profitability, and financial

[15]Industry and geographical area are available in the the Venture Capital Monitor, while patent applications are found in the Orbis database as explained in the final paragraph of this section. The status of limited liability company, determined by the use of the Cerved database for the balance sheet data, is likely to have low impact on the representativeness of our sample as the innovative start-ups included in the register since the 2012 Law, which has created them and given them important fiscal beneftis, need to have this legal form.

structure. As for size, we present results on total assets, labor costs and sales; we are able to use the number and wages of employees by incrementing the Cerved database with data from INPS (the Italian retirement management agency). Our measures of profitability are EBITDA/Assets and ROE, whereas for financial structure we focus on book value of equity, total financial debts, and leverage, which is defined as the ratio between financial debts and the sum of equity and total financial debts. Moreover, in order to capture the relationship with banks, we also consider the ratio between bank debt and total financial debts, the ratio between short term bank debt and total bank debt, and the cost of loans.

Our group of VC-backed firms is therefore composed by 101 ventures financed over the period 2004-2014 for which we have balance-sheet information in the year before the treatment. Table 2 provides summary statistics on these VC-backed firms: 58 per cent of them are located in the North of Italy, whereas 24 per cent operate in the Center and 19 per cent in the South. About 70 per cent of these companies operate in sectors with high-growth potential, that is ICT, telecommunication, engineering, and pharmaceuticals, 17 per cent of them work either in the energy sector or in manufacturing, whereas 14 per cent in other services. As expected, these firms are young (5 years on average), small, as the size dummy, which reflects different accounting variables such as assets and labour costs and whose range is between 1 and 4, is on average equal to 1.1, and have a large incidence (71 per cent) of intangible assets on total fixed assets (tangible and intangible assets). They are also not profitable and, much less expected, their leverage is high (96.6 per cent), tough three quarters of their bank loans have a maturity shorter than 1 year. According to the score provided by Cerved, they are quite risky firms. The score in Cerved is particularly important as it captures the intrinsic quality of a company: the average rating for the treated firms is 6.5 out of 9, where higher values mean higher risk.[16]

Finally, as a measure of innovation we collect patent applications from the European Patent Register, which is kept by the European Patent Office, such as reported in the Orbis database. We focus on patent applications, rather than grants, to conform with most of the empirical literature about innovation. Using this dataset, we augment the Cerved dataset on balance sheets with information about the total number of patent applications at the European Patent Office by each firm in every year.[17]

[16] Cerved calculates the Z-score on the basis of different balance-sheet indicators and assigns firms in different 9 risk classes, from safe (1-4), to vulnerable (5-6) and risky (7-9).

[17] As in three out of four sources of data, firms' identifiers are names rather than fiscal codes, we double check that merges with the Cerved dataset are correct using the Business Register kept by the Italian Chambers of Commerce ($https://telemaco.infocamere.it$.).

5 Empirical strategy

To assess whether firms that benefitted from VC financing afterward outperform those that did not receive VC funding is a challenging task, as mentioned in the Introduction. In order to identify the impact of VC financing, recipient and non-recipient firms should differ only for the assignment of the funds. This assumption is not easily testable and could be affected by two sources of bias that we need to address in order to correctly identify the impact of VC financing.

The first source of bias comes from firms' self-selection. Enterprises that apply for VC funding can be different from those that do not. The decision to apply may be related to the quality of the new idea and the willingness to economically exploit it, or to other unobservable characteristics of the firms that are correlated with the firm performance. In these circumstances, comparing the results of recipients with those of non-recipient firms that do not apply for VC funds might produce biased estimates of the effects of the VC financing.

The second source of bias is due to the non-random assignment of VC. Recipient firms might be inherently different from those that applied, but were not financed. VC investors could select the best high-tech startups, and unobservable firm features might affect both the firm probability to be financed by a VC and its long-term growth prospects. Again, this type of problem induces a bias in the estimation of the effect of the financing to the extent that firm characteristics for which we are not able to control for are correlated with the firm performance and differ between recipient and non-recipient firms. To deal with these issues, we use an identification strategy based on a careful selection of the control group and diff-in-diffs estimation method.

The availability of the information on rejected applicant firms allows us to fully control for the first source of bias, i.e. self-selection. We use rejected applicants as the set of firms from which we choose the control group for financed firms. Since both groups of firms self-select among the applicants they cannot differ in this respect; hence self-selection bias does not occur.

Our strategy tries to control as much as possible also for the second source of bias. As carefully explained in Section 3, we exploit the multi-step screening process of VC investors and the grades they assign to the applicants to build a control sample of firms that were rejected in the final stages of the screening process or in due diligence.

To evaluate the validity of our identification strategy, we carefully verify whether VC backed firms and those in the control group are very similar before VC financing in terms of a larger set of observable characteristics than that used in previous studies. We consider indicators of size, profitability, financial structure, innovation and some other variables including a synthetic measure

of the risk of corporate failure (Z-score calculated by Cerved), which is very useful as it is an index of the overall quality of the firm, able to catch-up some unobservable firm characteristics such as for example the ability of the firms' management team. The results are very clear-cut. Even without imposing any matching, there are no statistically significant differences between VC-backed and late stage rejected firms (Table 3), but for the initial age of the firm that we hence include in our estimations as control.

Finally, in order to control for any residual differences in unobservable firm characteristics between financed and rejected firms *before* VC financing, we exploit the longitudinal nature of our data and use the diff-in-diffs (DID) estimation method. Using the DID, the effect of the VC financing is estimated by the change in the difference of the output between recipient and non-recipient firms before and after the VC investment.

Formally,

$$DID = [E(Y^1_{it*+x}) - E(Y^0_{it*+x})] - [E(Y^1_{it*-1}) - E(Y^0_{it*-1})] \tag{1}$$

where E is the average value, Y_i is the outcome variable of the firm i, t* is the year of VC financing, x are the number of years after VC financing (1 to 4 years) and the top index 1(0) refers to the VC-backed firms (control firms).

The DID method is strongly dependent on the parallel trend assumption, i.e. is based on the assumption that without the VC financing the outcome variables of the two groups would have followed the same time paths. Therefore, we carefully verify this hypothesis by testing the similarity of outcome variable trends in our samples before the treatment. The results are plotted in Figures 3 and 4: they indicate very similar trends before the VC financing for the main outcome variables analyzed in the paper. These graphs are also very useful because they show graphically the effects of VC financing on selected firms' outputs.

In detail, our baseline model is:

$$y_{it} = \beta_1 * post_t + \beta_2 * VC_i + \beta_3 * post_t * VC_i + \beta_4 * dyears + \beta_5 * f_i + const + \epsilon_{it} \tag{2}$$

where y_{it} are the outcome variables (assets, sales, labor costs, etc.), i is an index for firms, t refers to different years, VC_i is a dummy equal to 1 for firms that are financed by VC investors, $dyears$ are year dummies to control for different economic cycles and f_i stands for the firm fixed effect to control for unobservable firm characteristics that are fixed over time; in this equation $beta_4$ and $beta_5$ are vectors of coefficients. Standard errors are clustered at firm level to take into account

the correlation among the observations of the same firm.

As for the term $post_t$, first we run a DID estimation collapsing the various $post_t$ terms in a single dummy *post* to capture the overall effect of VC financing since the year of financing/rejection over the 4 years afterwords. Then we run 5 different DID estimations with the variable $post_t$ $(t = 0, ..., 4)$ defined as dummies taking values 1 the year of financing/rejection or one of the 4 years afterwords, 0 the year *before* financing/rejection and missing otherwise: in this way we study the effects of VC year by year. In other words the dummy $post_t$ is equal 1 in the year when we want to evaluate the VC effect on the firm, 0 in the year before financing/rejection and missing otherwise.[18] The parameter of interest is $beta_3$, that of the interaction term $post_t * VC_i$, which is reported in the tables.

One potential drawback of DID estimates is that they could be biased if the outcome variable of VC financed and VC non-financed firms have different trends. Apparently, from the figures this does not emerge. In any case, we control also for potential differences in time trends by interacting some pre-financing control variables, such as the initial age of the firm at financing/rejection, geographical area and sector dummies, with the post financing dummies $post_t$, in the idea that firms in different steps of life-cycle, belonging to different sectors or geographic areas could be subject to different time trends. In a less parsimonous specification of the previous estimation we hence include also the following control variables, where all coefficients stand for vectors of coefficients:

$$\beta_6 * init.age_i + \beta_7 * init.age_i * post_t + \beta_8 * sec_i + \beta_9 * sec_i * post_t + \beta_{10} * area_i + \beta_{11} * area_i * post_t \quad (3)$$

6 Results of the effects of VC financing

In this section we present the results concerning VC effects on firm's size, activity, innovation and financial structure. From Figures 3 and 4, in which we include graphs for selected variables that show some changes between VC backed and non-VC backed firms, the evidence is that after the VC intervention we observe a much stronger increase in total assets and labour costs over the entire period of the analysis. There is also a positive effect on firm sales, though only after 4 years from VC financing. We also observe a negative trend in the firm profitability (EBITDA/total assets) for VC backed firms, which also vanishes after 4 years since the VC financing, consistently with the

[18] In order to avoid Betrand, Duflo and Mullainathan (2004) criticism, the estimations by years include the period -1 and separately each single year in the post financing period, thus only two periods are included in each estimation: -1 and 0; -1 and 1; -1 and 2; -1 and 3; -1 and 4. Alternatively we present also the results of the estimations over the whole post financing period taking the average of each variables between 0 and 4 over the post period.

surge in sales. The figures also show that VC backed firms tend to have a much higher equity[19], more innovation activity and lower survival rate.

We then verify the previous graphical evidence in a multivariate econometric setup. In Tables 4 to 6 we report the results for the coefficient $beta_3$ of DID estimations (equation 2). We run the estimations with no controls and with all controls, including initial age, area and sector and their interactions with the term $post_t$. As the results of the two specifications are similar, we report in the tables only those obtained with all controls. Most of the graphical evidence is confirmed. In the tables we show first the effect on the whole period since VC financing and then the one for each single year.

First, we find that VC investors have a rapid and extended effect on firms' size: during the 4 years after the VC financing, total assets increase on average by 780,000 euro more for VC backed firms than for firms not receiving any VC financing (Table 4) a bit more than half of the average total assets of companies before financing. This is the average effect on firm size over the 4 years after the VC financing; from the interaction dummies, which capture the trends year by year, we elicit that the effect on firm size is increasing over time: after 4 years from VC financing the increase in assets is almost 2 million of euro more than for the control group. The gradual increase in firm size is confirmed by the rise in labor costs: on average roughly a rise of 157,000 euro more for VC backed firms with respect to an average amount of labor costs before VC financing equal to 280,000. Furthermore, the last two columns show that the increase in labor costs is due almost exclusively to a rise in the number of employees (increasing by 2 units more for VC backed firms), while the difference in the increase of monthly wage is positive but not significant.

As for sales, the effect of VC is increasingly positive, though never significant due to the large heterogeneity in the results which reflects in high standard errors. This could be a consequence of projects financed by VC that frequently take more time to reach the commercialization phase, i.e. projects that are in an earlier stage of their life-cycle and hence riskier. As a consequence of the gradual upsurge in sales, the operating profitability (EBITDA/assets) of firms that got VC financing, which was initially much worse than that of control group, improved; after 4 years from financing the difference between VC backed firms and control sample is no longer significant (Table 5. Moreover, there are almost no differences in the return on equity (ROE) of the two groups of firms. Nonetheless, the strongest negative trends in operating profitability for VC-backed firms is

[19]Rejected applicants do not get any equity financing from VC operators, but they might get equity from other investors. Indeed, investors in the capital of innovative start-ups, like friends, small entrepreneurs and corporates, have benefitted from fiscal incentives introduced with a Law passed in 2012.

likely to explain their worse rating, measured by an increase in the Z-score index by 0.6 points more than that of non-VC backed firms (the average score before financing is 6.5); consistently with the improvement in operating profitability, this difference vanishes after 4 years.

We then focus on firm financial structure indicators that are seldom analyzed in previous studies (Table 6). We find a remarkable stronger increase in equity for VC-backed firms: 452,000 euro higher than for the control group, more than double the average equity of firms before financing. The increase in equity becomes more and more wider, suggesting a multi-stage process of financing. This considerably reduces more the leverage of VC-backed firms (64 percentage points of additional reduction compared with a leverage before financing of VC-backed firms of 96.6 per cent). Overall VC-backed firms have a much more capitalized and hence stronger financial structure after VC financing. It is worth noticing that the additional increase in total assets for VC-backed company is much larger (almost twice as much) than that in equity: there is therefore a multiplicative effect induced by VC activity; we will deepen more thoroughly this issue in the next section.

Financial debts of VC financed firms also increase more than for the control sample, though the high variance of the results makes the difference not significant. Interestingly, VC-backed firms tend to have a shorter debt maturity than firms in the control sample (an increase of 10.6 percentage points more in the short term debt share compared with an average of 75 per cent before financing) and pay a higher interest rate on their financial debt (an increase of 7 percentage points more than for the control sample, compared with an average cost of funds of 4.5 per cent before the treatment). These worse conditions on bank loans might be explained by the deterioration in operating profitabiliy and credit score; this seems specifically true for the cost of funds for which the differences tend to disappear after 3 years since VC financing when the differences in score also vanish.

We finally deepen the evaluation on innovation activity and survival rates using the DID estimations (Table 5). When considering a dummy equal to 1 for firms that applied for a patent, the estimations show that the effect of VC financing on the whole period is positive, but not statistically significant. However, the increase in the cumulated number of patent applications is much larger for VC backed firms: a rise of 0.25 more patent applications than for the control sample, almost twice as much as the average number of patent applications before financing/rejection. When analysed over time, the effects on firms' innovation develop clearly 3-4 years after financing; this is expected as it takes time to strengthen an idea to the point of asking for a patent: after 4 years of financing, VC-backed firms show a much higher increase in patent applications (1.6 more)

compared with the control sample. We have reported in the table the results obtained with linear estimations that allow us to use the same controls as for the other output indicators, including the firm fixed effect; we also verify the evidence regarding innovation with non-linear estimations such as probability and negative binomial models. Finally, we do not detect any significant difference in the firm survivorship rate after three years of VC financing or rejection.

7 Robustness and extensions of the results

7.1 Comparison with firms in the control sample that increased their equity

In this subsection we show the results of some estimations regarding a control sample of late-rejected firms that also increased equity thanks to investors different from venture capitalists. The main intent of this exercise is to evaluate whether the VC effects on firms' size and innovation are exclusively connected with equity financing or there are some effects linked to their managerial expertise or networking connection. Results are reported in Tables 7 to 9 and refer to a control sample of 163 firms compared with an initial initial control sample made of 258 firms.

The evidence is that even restricting the control sample in this way, the effects of VC financing on firm size and innovation are very similar to those presented in the previous section; this is also true for the results concerning the worsening of profitability and credit score (Tables 7 and 8). It seems therefore that the VC effects on firms' growth and innovation are related to the general activity of venture capitalists, and not only to the fact that they offset a funding gap with equity financing.

It is however important to underline the fact that even restricting the control sample to rejected firms that also got some equity financing from outside investors, the increase in equity for VC-backed firms is much stronger, similarly to what we have shown in the previous section (an increase in equity of 448,000 more for VC-backed firms; table 9). It is therefore possible that some rejected firms get equity from other investors, but the amount they gather is so tiny that the previous conclusion appears not well grounded.

We therefore further restrict the sample to rejected firms that rise equity and for which this increase is higher than a certain threshold (the 1st quartile of the distribution of the increase in equity). In this case the rise in equity for VC-backed firms is not significantly different than the one observed in this much smaller control sample (122 firms), while all previous results on the size, innovation and activity of firms financed by VC investors are confirmed.[20]

[20] To preserve space results are not reported; they are available upon request.

The overall take of this extension of the analysis is hence that VC effects on firms' size and innovation of the firms they finance are not only mechanically linked to their equity financing.

7.2 Captive and independent venture capitalists

Another important issue is whether there are differences in the effects of the firms that have been financed by captive VC (bank-, financial or insurance company-owned in our sample) and independent VC investors. Captive VC do not raise capital from outside investors other than the single owner of the private equity fund and they could have specific indications, from the single owner, about the investment policy to adopt. Independent VC investors gather funds from the market and they are freer to chose the companies in which to invest. In our sample of 101 startups, 42 have been financed by captive VC and the remaining 59 by independent VC.

In order to test the differential effects of the two categories of VC, we split the crucial interaction term - post*VC - in the equation 2 using two dummies for VC: the first referring to captive VC and the second to independent VC. For each period, we report the coefficients of two interaction terms - post*VC-captive and post*VC-independent - measuring the effect of each specific group of VC after their financing.[21]

In Table 10 the evidence is that the growth in total assets for the whole period after VC financing is stronger, compared with the control group, only for independent investors. Similar results hold for labors costs and the number of employees that increase more, compared with the control group, only for VC-backed firms financed by independent operators. All in all, the positive effect of VC on the size of firms arise only when financing is obtained by independent investors. Similarly, for innovation activity in Table 11 the evidence is that the positive effect on the number of patent applications after 3 years is entirely driven by indipendent VC investors, while some effects on the probability of patent applications are detectable also for captive VC investors.

The previous findings are strictly connected to what we observe in the financial structure of the firms. Equity increases much more for VC backed firms than for firms in the control sample, but only when they are financed by independent VC (Table 12). When the firm is financed by a captive VC, its equity has the same path as for the firms in the control group one year after financing, suggesting that the injection of capital is much smaller and limited in time. Conseguently only firms financed by independent VC investors show a much stronger reduction in leverage compared with the one observed in the control group.

[21]The dummy VC has been similarly split in two dummies.

On the contrary, there are no remarkable difference as for operating profitability and credit score that are worse for all VC-backed firms, regardless of the type of VC investors (Table 11). However, the worsening of credit score and operating profitability has different effects on banking loan terms: as for firms financed by independent VC, interest rates increase much more than for the control group (almost 10 percentage points more), while for firms financed by captive VC we observe a much stronger increase in the share of short-term bank loans (16 percentage points more; Table 12).

All in all, independent and captive VC investors appear to be characterized by very different investment attitudes. Italian independent VC show greater activism in line with what has been found in other European countries (Bottazzi et al., 2008; Grilli and Murtinu, 2014; Cumming et al., 2017). They invest important amount of capital in the firms held in their portfolio that consequently grow faster and innovate more. On the contrary, captive VC invest less money in startups that are hence gathering an amount of equity similar to those obtained by firms in the control sample; for these investors we detect no effect in term of faster growh of the firms and much weaker effects as for innovation.

8 Discussion of results and conclusions

In this paper we use a novel strategy to tackle the selection problem influencing all the evaluation exercises of VC activity. On the one hand, we get rid of firms self-selection by considering in the control sample firms that have also looked for VC finance. On the other hand, we deal with the selection made by VC investors considering only late-stage discarded firms in the idea that firms that narrowly lost the contest were more similar to financed firms. This strategy is very similar to the one used by Greenstone et al. (2010) when tackling a very different empirical issue.

Although starting with the whole population of firms financed by private VC investors in Italy in the period 2004-2014, as reported in the Venture Capital Monitor by AIFI, when we impose the essential condition that firms have a balance sheet one year before VC financing, we end up with a sample of firms equal to one third of the universe; though we assess the representativeness of our sample in terms of geographical areas and sectors, it is true that the results can be generalized only with caution.

The evidence is that VC investors are able to accelerate the growth of the firms they finance and help their innovation activity. These firms show a larger increase in size (total assets, labor costs, no. of employees) and they innovate more (in term of the probability and number of patent

applications) compared with very similar firms in the control sample. This is not just a mechanical effect of the injection of equity capital. First, we notice that the larger increase in assets for VC-backed firms is by far greater than the wider rise in their equity. Secondly, we repeat the exercise by considering only firms in the control sample that also increase equity thanks to other investors (family, friends, corporate, etc) and the results still hold. The positive effects of VC investors in terms of firms' growth and innovation are hence likely to be connected also with their managerial expertise or network connections.

In general, an unexpected result is that all the innovative startups analyzed have a high leverage in the year before VC financing or rejection. This is actually in line with was has been discovered in the US by Robb and Robinson (2012), who find that new firms, even the home-based ones, analyzed for the period 2004-2007 rely heavily on external debt sources, such as bank financing: when summing up all forms of debt, it accounts for more than 50 per cent of the total capital of the firm. Similar recent evidence is found for Italy (Bonaccorsi di Patti and Nigro, 2017). Still, we focus in this paper on innovative startups, which are riskier and with a high share of intangible assets, for which bank lending is not the more appropriate source of finance. Consistently, Brown, Fazzari and Petersen (2009) find that for the US high-tech listed firms the share of new net debt issues on total net finance is very low, less than 2 per cent and that of net equity is higher (29 per cent); corresponding figures for Italian high-tech listed firms were reversed for the period 1998-2006 (Magri, 2014). In this paper, the evidence for a more recent period (2004-2014) is indeed that for VC-backed firms the wider increase in equity also mirrors in a stronger financial structure after VC financing: their leverage hence decreases much more than for firms in the control sample.

As for the effects on other sources of finance different from equity, we find that financial debts increase more for VC-backed firms though there is large heterogeneity: the differences are hence not significant. It is likely that the higher banks' selectivity after the 2008 financial crisis had an impact on these results given that VC-backed firms are quite risky firms. Due to the very innovative nature of their ideas, which delays the commercialization of products and services, and the upsurge in labor costs, their operating profitabiliy is much worse than that of non treated firms. This mirrors in a worsening in credit score for VC-backed firms that is likely to be the culprit of the larger increase in interest rates and in the share of short-term bank loans that we observe for them.

Finally, the positive VC effects on faster growth and innovation are exclusively driven by independent VC investors. Firms financed by captive VC investors (bank-, financial or insurance company-owned in our sample) have the same growth in size, equity and patent applications that those in

the control sample. This evidence is line with some recent literature that shows more activism and results for independent VC investors (Grilli and Murtinu, 2014; Cumming et al., 2017; Bottazzi et al., 2008). Specifically, independent VC investors finance their firms in subsequent stages and this is likely to help them as it takes time to reach the point where a patent could be asked for. To support firms' innovative ideas and their profitability and growth, a longer period of time and patience is likely to be required (Mazzuccato, 2013).

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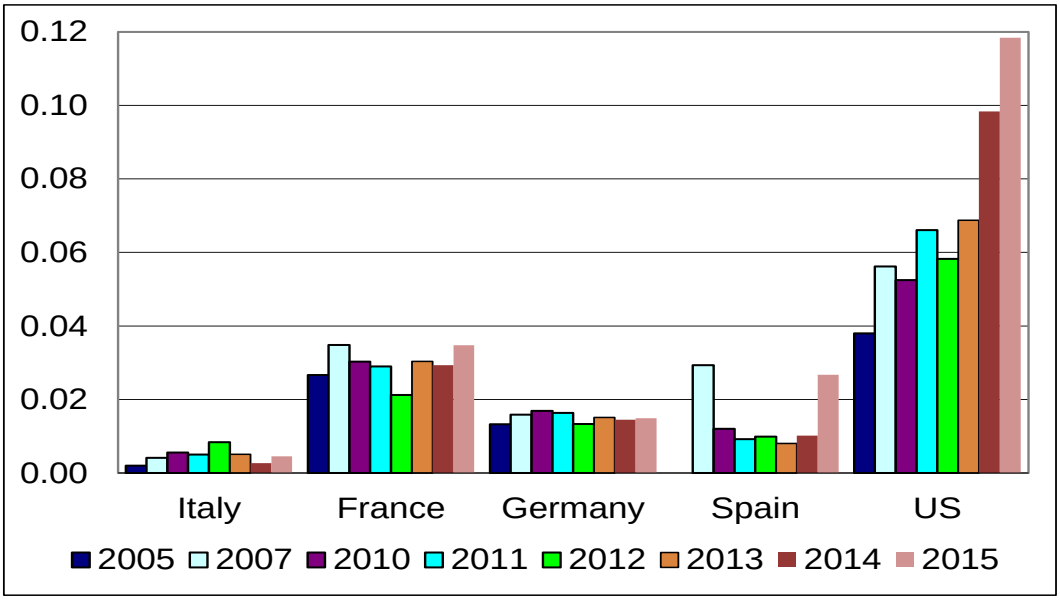
Tables and figures

Figure 1: Venture capital investments as a percentage of GDP



Source: AIFI for Italy, AFIC for France, EVCA-BVKA for Germany, ASCRI for Spain and NVCA for the United States.

Figure 2: Selection process among venture capitalists

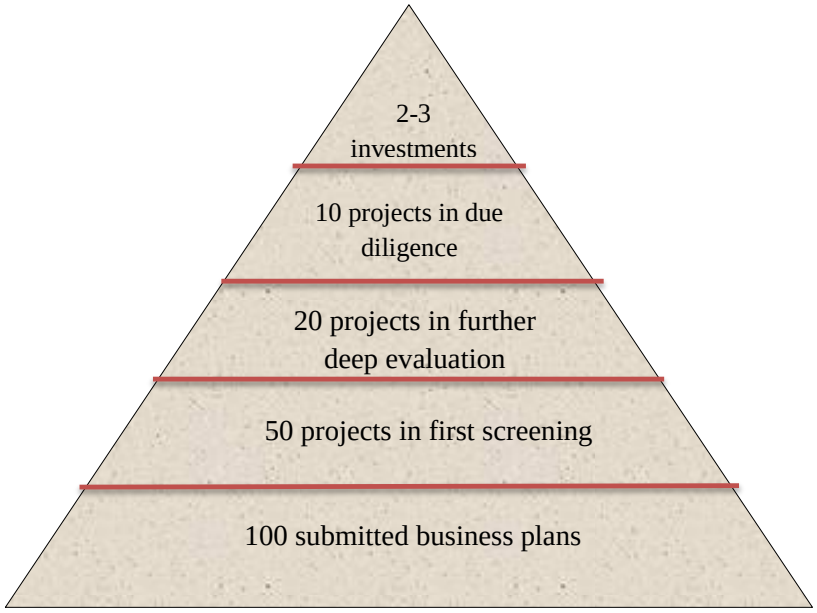
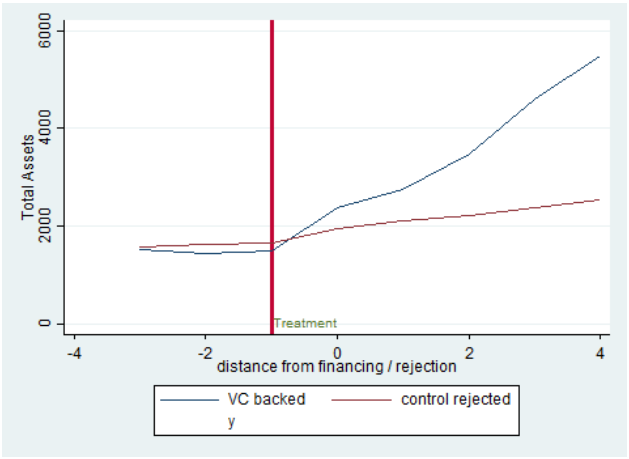


Table 1: Comparision between samples of VC-backed firms

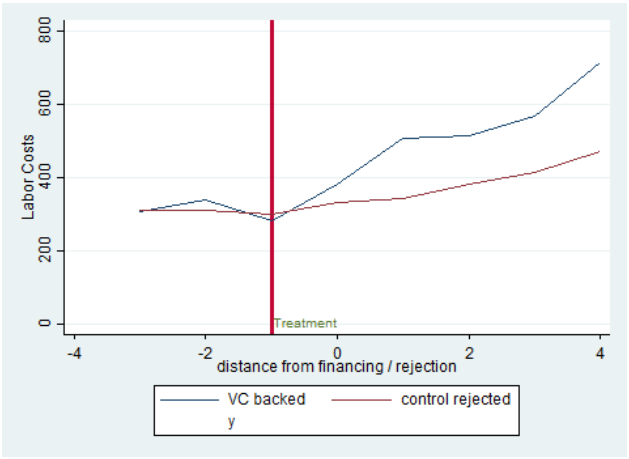
Percentage values, frequency, and numbers

	Our sample	VC population		Our sample	VC population
Sector			**Geographical area**		
Business services	3	1	North-west	40	49
Clean tech	7	6	North-east	18	13
Construction	2	2	Center	24	20
Consumer goods	3	2	South-islands	19	17
Financial services	2	2	**Innovation**		
Food and beverages	1	2	Probability patent application	0.3	0.2
Health care and social services	5	5	No. patent applications	0.12	0.08
ICT	36	37			
Industrial products	9	9			
Leisure	1	1			
Media and communications	7	7			
Nanotech	2	1			
Other professional and social services	6	6			
Pharmaceutical and biopharmaceuticals	11	13			
Transportation	1	1			
Utilities	2	3			
Web and mobile applications	3	2			
Total	100	100	Total	100	100
N	101	293		101	293

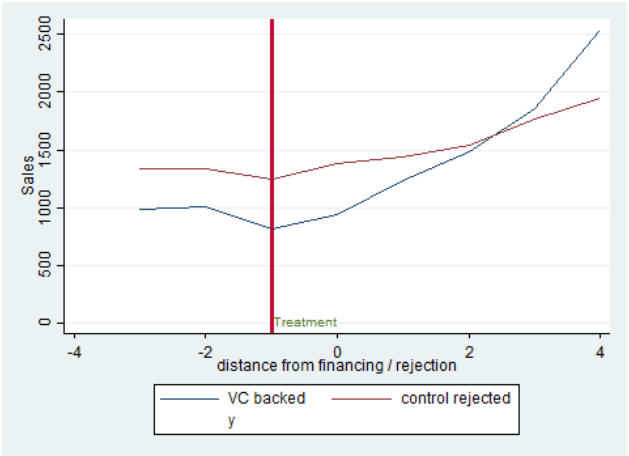
Figure 3: Trends in some output variables: late stage rejected control sample



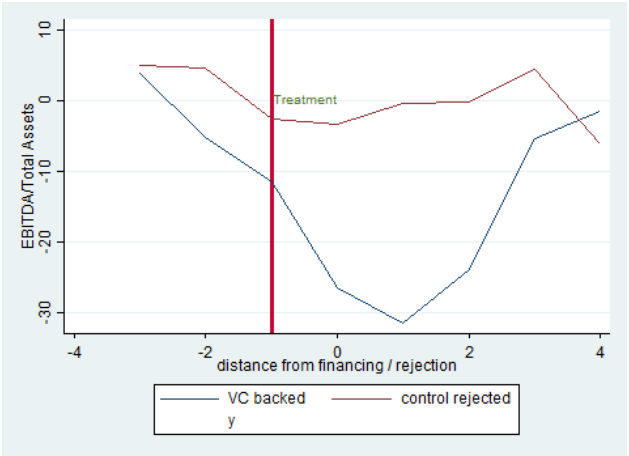
(a) Total Assets



(b) Labor Costs

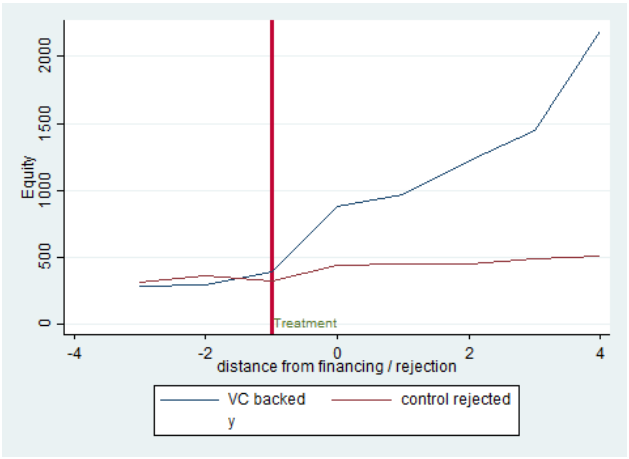


(c) Sales

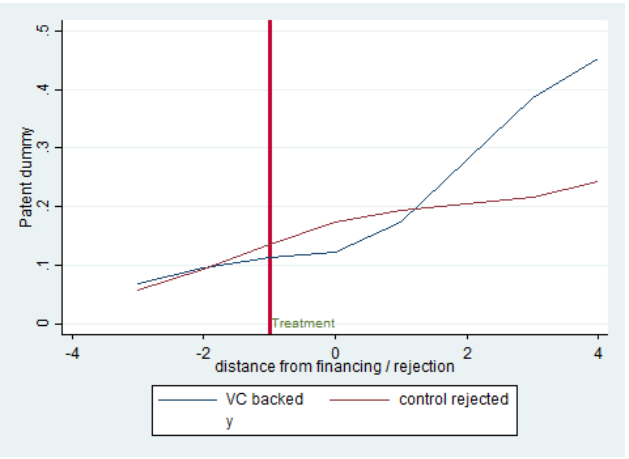


(d) Profitability

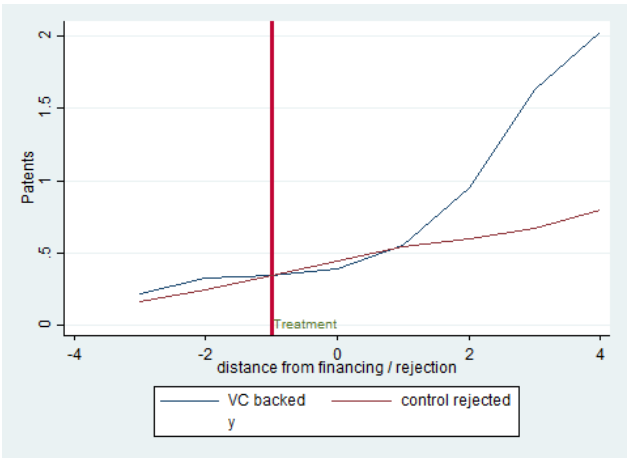
Figure 4: Trends in some output variables: late stage rejected control sample



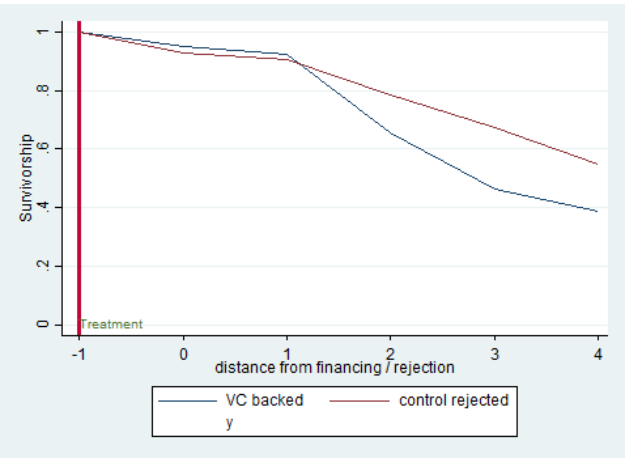
(a) Equity



(b) Patent-dummy



(c) Number of patent applications



(d) Survivorship

Table 2: Summary statistics for venture-backed firms

Summary Statistics VC				
Area			**Size**	
North-west	40	40%	Total Assets (*1000 euro)	1506
North-east	18	18%	Size dummy	1.1
Center	24	24%	Labor costs (*1000 euro)	281
South-islands	19	19%	Sales (*1000 euro)	814
Year of Financing			**Profitability**	
2004	3	3%	EBITDA/Assets %	-11.5
2005	3	3%	ROE %	-59.1
2006	6	6%	**Financial structure**	
2007	8	8%	Leverage %	96.6
2008	6	6%	Short-term bank debt/Bank debt %	75.2
2009	4	4%	Equity/Assets %	20.2
2010	7	7%	Financial costs/Financial debts %	4.5
2011	19	19%	**Innovation**	
2012	6	6%	Probability patent application	0.12
2013	17	17%	No. patent applications	0.35
2014	22	22%	**Other characteristics**	
Sector %			Age (years)	4.9
Manufacturing	8	8%	Intangible assets/Tangible+Intangible assets %	71.3
Energy	9	9%	Rating	6.5
IT	39	39%		
Telecomunication	5	5%		
Engineering	6	6%		
Pharmaceutics	20	20%		
Other services	14	14%		
N	101			

The statistics for area, sector, size, profitability, financial structure and other characteristics are calculated in the year before treatment.

Table 3: Balancing properties between treated and control groups

	VC-backed(1)	Late stage rejected (2)	t test (2)-(1)
Size			
Total Assets(*1000 euro)	1506	1648	0.44
Labor Costs(*1000 euro)	281	298	0.20
Sales(*1000 euro)	814	1242	1.42
Profitability			
EBITDA/Assets %	-11.5	-2.5	1.62
ROE %	-59.1	-63.2	-0.06
Financial Structure			
Leverage %	96.6	58.5	-1.68
Financial debts(*1000 euro)	544	576	0.20
Equity(*1000 euro)	393	324	-0.60
Bank debts/Financial debts %	57.5	60.2	0.48
Short-term bank debts/Bank debts %	75.2	79.4	0.83
Financial Costs/Financial debts %	4.5	6.3	1.06
Innovation			
Probability of patent applications	0.12	0.14	0.42
No. patent applications	0.35	0.34	-0.037
Other characteristiscs			
Age	4.9	7.5	2.5
Rating	6.5	6.2	-1.46
N	101	258	

Table 4: Effects of venture capitalists on firms' size and activity indicators

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods

Post-treatment periods	Assets (*1000 euro)	Labor costs (*1000 euro)	Sales (*1000 euro)	Employees number	Monthly wage euro
average post-treatment	780.4	157.3	126	2.0	189.6
	(378.2)**	(42.5)***	(163.3)	(1.2)*	(191)
t* (year of financing)	607.2	89.9	-29.8	4.2	157.7
	(333.4)*	(26.0)***	(132.1)	(1.6)***	(180.2)
t*+1	727.5	210.1	132.4	1.8	427.9
	(358.6)**	(45.0)***	(145.3)	(1.2)	(208.8)**
t*+2	1330.9	237	336	1.3	639.9
	(517.9)**	(59.4)***	(212.0)	(1.8)	(506.4)
t*+3	1720.2	193.5	343.7	0.0	145.5
	(715.5)**	(77.4)**	(359.6)	(2.0)	(642.1)
t*+4	1981.2	253.9	570.2	3.9	-309.4
	(971.1)**	(106.4)**	(525.7)	(3.0)	(684.2)
N. observation max	694	694	694	446	446
N. observation min	539	539	539	310	310
mean of variables at t*-1	1506	281	814	10.9	2354

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms.

Table 5: Effects of venture capitalists on firms' profitability, innovation and survivorship

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods

Post-treatment periods	EBITDA/Assets %	ROE %	Rating index	Patents dummy	Patents numbers	Survival rate
average post-treatment	-23.8	23.2	0.6	0.04	0.25	-0.008
	(6.4)***	(69.3)	(0.2)***	(0.04)	(0.14)*	(0.75)
t* (year of financing)	-20.5	108.2	0.5	-0.04	-0.06	
	(6.0)***	(90.5)	(0.2)**	(0.02)*	(0.07)	
t*+1	-24.1	56.3	0.6	-0.01	0.07	
	(7.9)***	(89.4)	(0.2)***	(0.04)	(0.12)	
t*+2	-22.9	-201.8	0.6	0.09	0.35	
	(11.6)**	(249.7)	(0.3)**	(0.06)	(0.18)*	
t*+3	-16.3	241.8	0.8	0.19	1.1	
	(6.2)***	(127.6)*	(0.5)	(0.07)**	(0.31)***	
t*+4	3.8	-6.8	0.10	0.21	1.6	
	(8.1)	(39.5)	(0.5)	(0.09)**	(0.43)***	
N. observation max	692	640	649	694	694	293
N. observation min	538	490	492	539	539	
mean of variables at t*-1	-11.5	-59.1	6.5	0.12	0.3	1

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms. Patents number is the cumulative number of patent applications in the period considered. Survival rate is the rate of survival after 3 years since financing/rejection, considering only firm financed until the year 2012; the mean at t*-1 is 1 per cent as all firms are alive at that time.

Table 6: Effects of venture capitalists on firms' financial structure

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods

Post-treatment periods	Leverage %	Fin. Debts (*1000 euro)	Equity (*1000 euro)	Bank/Fin.Debts %	Bank short/Bank %	Interest rate %
average post-treatment	-64.5	165.1	452.1	-5.6	10.6	7.1
	(38.9)*	(167.8)	(200.6)**	(5.1)	(5.4)*	(2.8)**
t* (year of financing)	-41.2	53.7	418.4	0.14	5.7	5.9
	(40.9)	(156)	(115.2)***	(4.5)	(5.4)	(2.8)**
t*+1	-88.1	179.4	439.7	-5.4	7.4	7.0
	(41.9)**	(170.6)	(196.5)**	(6.0)	(7.0)	(3.6)*
t*+2	-113.3	218.6	766.7	-9.7	17.3	7.5
	(53.9)**	(274.8)	(244.0)***	(9.2)*	(9.2)	(4.8)
t*+3	-53.7	572.7	801.4	-8.9	23.5	4.1
	(34.4)	(341.9)*	(350.2)**	(9.0)	(10.2)**	(3.4)
t*+4	-61.3	127.3	1197.4	-15.2	30.7	2.3
	(42.7)	(322.3)	(628.4)*	(11.9)	(11.8)***	(2.6)
N. observation max	618	629	694	527	425	526
N. observation min	468	483	539	413	334	413
mean of variables at t*-1	96.6	544	393	57.5	75.2	4.5

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms. Leverage is financial debts/(financial debts + equity); bank stands for bank loans; bank short are bank loans with maturity shorter than 1 year. Interest rate is financial costs on financial debts.

Table 7: Effects of venture capitalists on firms' size and activity indicators

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications with a control sample of firms that increase their capital

Post-treatment periods	Assets (*1000 euro)	Labor costs (*1000 euro)	Sales (*1000 euro)	Employees number	Monthly wage euro
average post-treatment	965.7	147.2	206.7	1.5	192.3
	(418.3)**	(46.1)***	(184.2)	(1.2)*	(242.1)
t* (year of financing)	755.6	74.2	-31.9	3.3	206.4
	(391.7)*	(23.2)***	(145.8)	(1.5)**	(200.9)
t*+1	931.2	205.8	192.5	2.0	392.6
	(396.8)**	(44.4)***	(164.9)	(1.3)	(221.8)*
t*+2	1617.6	223.8	347.8	-0.7	619.4
	(503.7)***	(63.7)***	(223.5)	(2.7)	(613.6)
t*+3	1930.6	170.2	381.0	-1.4	-136.9
	(771.6)**	(92.2)*	(402.5)	(2.1)	(620.9)
t*+4	2453.5	265.5	895.8	4.2	-470.2
	(1042.4)**	(122.2)**	(574.6)	(3.5)	(661.5)
N. observation max	522	522	522	330	330
N. observation min	395	395	395	227	227
mean of variables at t*-1	1506	281	814	10.9	2354

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms

Table 8: Effects of venture capitalists on firms' profitability, innovation and survivorship

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications with a control sample of firms that increase their capital

Post-treatment periods	EBITDA/Assets %	ROE %	Rating index	Patents dummy	Patents numbers	Survival rate
average post-treatment	-24.4	11.3	0.7	0.05	0.26	-0.08
	(6.5)***	(78.8)	(0.2)***	(0.02)	(0.16)*	(0.079)
t* (year of financing)	-21.0	79.3	0.5	-0.03	-0.05	
	(6.2)***	(111.7)	(0.2)**	(0.03)	(0.07)	
t*+1	-25.2	143.0	0.6	0.00	0.09	
	(8.1)***	(160.8)	(0.3)**	(0.04)	(0.13)	
t*+2	-23.4	-184.9	0.7	0.10	0.3	
	(10.7)**	(305.9)	(0.3)**	(0.06)	(0.18)*	
t*+3	-17.5	279.9	0.8	0.20	1.1	
	(5.9)***	(145.5)*	(0.5)	(0.08)**	(0.3)***	
t*+4	6.0	-8.9	0.0	0.21	1.5	
	(9.4)	(47.2)	(0.5)	(0.09)**	(0.5)***	
N. observation max	520	473	482	522	522	208
N. observation min	394	349	353	395	395	
mean of variables at t*-1	-11.5	-59.1	6.5	0.12	0.3	1

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms. Patents number is the cumulative number of patent applications in the period considered. Survival rate is the rate of survival after 3 years since financing/rejection, considering only firm financed until the year 2012; the mean at t*-1 is 1 per cent as all firms are alive at that time.

Table 9: Effects of venture capitalists on firms' financial structure

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications with a control sample of firms that increase their capital

Post-treatment periods	Leverage %	Fin. Debts (*1000 euro)	Equity (*1000 euro)	Bank/Fin.Debts %	Bank short/Bank %	Interest rate %
average post-treatment	-63.6	223.0	447.9	-7.9	9.6	7.3
	(40.4)	(187.1)	(215.6)**	(5.4)	(5.9)	(2.9)**
t* (year of financing)	-36.5	118.7	415.2	-1.0	7.2	6.6
	(41.6)	(177.9)	(126.8)***	(5.2)	(5.9)	(3.0)**
t*+1	-83.8	219.1	450.6	-9.9	5.5	5.7
	(41.9)**	(194.5)	(212.5)**	(6.0)	(7.7)	(3.4)*
t*+2	-123.5	297.8	786.1	-12.8	14.5	8.1
	(55.8)**	(270.3)	(255.7)***	(9.5)	(11.0)	(5.0)
t*+3	-63.3	584.8	825.1	-8.8	18.6	5.4
	(41.5)	(374.9)	(361.6)**	(9.2)	(12.3)	(3.8)
t*+4	-64.7	9.4	1317.2	-11.7	24.0	3.3
	(51.4)	(377.3)	(641.1)**	(12.2)	(13.4)*	(2.3)
N. observation max	468	478	522	401	321	400
N. observation min	347	361	395	313	248	313
mean of variables at t*-1	96.6	543	393	57.5	75.2	4.5

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level. The means of variables at t*-1 refer to the sample of venture-backed firms. Leverage is financial debts/(financial debts + equity); bank stands for bank loans; bank short are bank loans with maturity shorter than 1 year. Interest rate is financial costs on financial debts.

Table 10: Effects of venture capitalists on firms' size and activity indicators

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications that split between independent and captive venture capitalists

Post-treatment periods	Assets (*1000 euro)	Labor costs (*1000 euro)	Sales (*1000 euro)	Employees number	Monthly wage euro
average post-treatment independent	698.4**	210.5***	151.4	5.4***	182.1
average post-treatment captive	897.1	81.6	89.8	-1.1	196.5
t* (year of financing) independent	378.4*	93.3***	-25.0	5.7***	253.2
t* (year of financing) captive	933.0	85.1**	-36.5	2.8	69.0
t*+1 independent	707.0**	263.1***	115.9	3.5***	634.2**
t*+1 captive	756.2	135.6**	155.6	-0.0	198.7
t*+2 independent	1213.8***	320.1***	304.7	4.2*	219.1
t*+2 captive	1500.8	116.1	381.4	-2.6	1230.2
t*+3 independent	1699.3***	334.5***	512.0	6.2***	646.5
t*+3 captive	1750.2	-9.0	102.0	-7.2***	-430.8
t*+4 independent	1779.9*	381.3***	687.0	9.7***	232.3
t*+4 captive	2300.4	51.9	384.9	-10.6***	-1694.9**
N. observation max	694	694	694	446	446
N. observation min	539	539	539	310	310
mean of variables at t*-1	1506	281	814	10.9	2354

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level and are not reported to preserve space. The means of variables at t*-1 refer to the sample of venture-backed firms

Table 11: Effects of venture capitalists on firms' profitability, innovation and survivorship

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications with a control sample of firms that increase their capital

Post-treatment periods	EBITDA/Assets %	ROE %	Rating index	Patents dummy	Patents numbers	Survival rate
average post-treatment independent	-28.4***	30.3	0.6**	0.02	0.33*	0.03
average post-treatment captive	-17.4**	11.2	0.7***	0.06	0.14	-0.06
t* (year of financing) independent	-21.6***	109.1	0.5*	-0.03	-0.01	
t* (year of financing) captive	-18.9*	106.5	0.5*	-0.05*	-0.12**	
t*+1 independent	-26.9**	135.0	0.6*	-0.03	0.07	
t*+1 captive	-20.2*	-81.6	0.7*	0.02	0.07	
t*+2 independent	-40.6**	-450.5	0.7*	0.05	0.42	
t*+2 captive	3.0	231.9	0.6	0.14	0.26	
t*+3 independent	-22.3**	-217.1	0.5	0.17*	1.5***	
t*+3 captive	-7.3	-277.7*	1.2**	0.21*	0.5	
t*+4 independent	3.7	39.0	-0.4	0.20*	2.0***	
t*+4 captive	4.0	-95.4	0.9	0.22	0.9	
N. observation max	692	640	649	694	694	293
N. observation min	538	490	492	539	539	
mean of variables at t*-1	-11.5	-59.1	6.5	0.12	0.3	1

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level and are not reported to preserve space. The means of variables at t*-1 refer to the sample of venture-backed firms. Patents number is the cumulative number of patent applications in the period considered. Survival rate is the rate of survival after 3 years since financing/rejection, considering only firm financed until the year 2012; the mean at t*-1 is 1 per cent as all firms are alive at that time.

Table 12: Effects of venture capitalists on firms' financial structure

Diff-in-diff estimations (coefficient $beta_3$ is reported) - different post-treatment periods
Specifications that split between independent and captive venture capitalists

Post-treatment periods	Leverage %	Fin. Debts (*1000 euro)	Equity (*1000 euro)	Bank/Fin.Debts %	Bank short/Bank %	Interest rate %
average post-treatment independent	-61.8**	-63.5	582.5**	-9.8	5.6	9.7**
average post-treatment captive	-68.0	462.7	266.3	-0.5	16.1**	3.8
t* (year of financing) independent	-43.8	-162.5	493.3***	-5.0	3.0	7.8**
t* (year of financing) captive	-37.7	335.2	311.7**	6.7	8.6	3.6
t*+1 independent	-73.9**	-22.8	667.4**	0.0	2.6	7.9
t*+1 captive	-110.3	480.2	120.1	-1.0	13.7*	5.7
t*+2 independent	-67.1**	-154.7	977.1***	-12.4	13.3	1.6
t*+2 captive	-182	763.6	460.9*	5.9	24.2*	15.7
t*+3 independent	-76.9*	149.2	1068.7*	-16.6	20.9	4.6
t*+3 captive	-19.1	1189.6*	417.6	1.3	27.2**	3.3
t*+4 independent	-84.9*	-108.2	1413.7**	-17.6	27.5**	3.2
t*+4 captive	-28.2	463.5	854.4	-11.7	37.3**	1.0
N. observation max	618	629	694	527	425	526
N. observation min	468	483	539	413	334	413
mean of variables at t*-1	96.6	543	393	57.5	75.2	4.5

All the specifications include the following controls: firm fixed effects, year dummies, age at t*-1, age at t*-1*post, industry, industry*post, area, area*post. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are clustered at firm level and are not reported to preserve space. The means of variables at t*-1 refer to the sample of venture-backed firms. Leverage is financial debts/(financial debts + equity); bank stands for bank loans; bank short are bank loans with maturity shorter than 1 year. Interest rate is financial costs on financial debts.

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