Unbiased estimation of economic impact of venture capital backed firms

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Abstract

One of the pending issues in venture capital (VC) research is the analysis of the economic impact of the companies that receive venture funds as part of their financing. This paper analyses a sample of VC-backed firms to study their economic impact, in terms of growth in employment, sales, gross margin, total assets, intangible assets and corporate taxes paid. The results are compared to a control group. Additionally, panel data methodology is applied to verify the significant effect observed over time on the variables analysed. The evidence suggests that VC-backed companies have a greater economic impact and that VC funding has a significant and positive effect on this impact.

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1. Introduction

Venture capital (VC) is a source of financing whereby a financial investor takes an equity stake in a private company that, in general, is starting-up or will grow fast in the following years (Gorman & Sahlman, 1989; Berlin, 1998). From the perspective of the entrepreneur, VC funds are often the only available source of financing to start-up a company, especially in those cases where intangible assets are at the core of the business. From the investors' viewpoint, VC is a risky asset and, therefore, a healthy return is expected (Sahlman, 1990).

During the last two decades both academics and politicians have argued that firms financed with VC grow faster, invest more, are more innovative and create above average employment. However, assertions were based more on intuition regarding the results of those companies achieving an enormous success and on the implication of those superior results on the country's economy. The piece still missing is firm empirical evidence of the existence of a significant, positive economic impact. Gompers and Lerner (2001) identify this subject as one of the unresolved issues of venture capital.

The first impact study regarding VC-backed firms, prepared by Venture Economics Inc in 1982 for the US General Accounting Office, showed promising results. Nevertheless, the sample only included public companies, a strong positive bias, thus limiting the applicability of the conclusions. Since then, annual studies have been conducted, first in the US and later in Western Europe.

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The two flaws in most studies are: (1) they rely on biased samples of limited scope, only including successful companies and (2) they do not consider the event of VC financing in the analysis, confining themselves to a company's development since the IPO or the last few years. Two common reasons can explain these deficiencies. First, the lack of data to fully identify the population. Second, the difficulty to access the financial information of privately held, VC-backed firms. This might explain why most research on this issue to date has been conducted by VC market consultants and not by academics.

The aim of this paper is to advance knowledge of the economic impact of venture-backed companies, providing empirical evidence to affirm that: (1) VC-financed companies have a greater economic impact than similar companies financed by other sources of capital; (2) VC funding has a positive and significant effect on this greater economic impact. For the purpose of our study the economic impact is measured through the evolution of some economic variables in VC-backed firms. In particular, employment, sales, gross margin, total assets, intangible assets and corporate taxes are subject to our analysis. This research is unique because the analysis will be based on an unbiased, highly representative sample with historical financial information, and on the entire population of deals in a specific area.

The method proposed is the analysis of the evolution over time of key economic variables for the sample, and a control group, considering the event of the first round of VC financing, and the period before, during and after the stay of the financial investor. Two databases are used. First, to identify the target companies, the database of Prof. J. Martí (U. Complutense) is used. It contains the complete population of VC deals in Spain since 1988 and is the official source of information of the national VC association. Second, to obtain the financial information, the SABI database (Bureau Van Dijk) is accessed. This database includes the annual official accounts of more than 550,000 Spanish companies.

The results obtained show that, on average, VC-backed companies grow faster. Employment, sales, gross margin, profits, total assets, intangible assets and even corporate taxes grow at a faster rate than comparable firms not receiving venture funding. Furthermore, evidence is found of the significant, positive effect that either the presence or the amount invested exert on the evolution of such items over time.

This paper has implications from a theoretical as well as a practical perspective. The theoretical implication is that economic impact of VC-backed firms is measured and tested for the first time. It also opens up a new line of research. The practical implication is that the VC sector has a positive effect, not only on the pocket of investors, but on the economy of the region where it takes place.

The rest of the paper is organized as follows: Section 2 reviews the limited prior literature before formulating the hypotheses regarding the economic impact of VC-backed firms. Section 3 describes the methodology and data used to test the hypotheses. It also briefly reviews key figures of the Spanish VC market. Section 4 presents the empirical results and the final section discusses the results and key implications.

2. Literature Review and Hypotheses

2.1. Literature related to the value added by venture capitalists

One of the key subjects on the academic literature on VC is how to explain the expected superior performance of VC-backed companies. These rationales can be grouped in three lines of research: (1) venture capitalists (VCs) select those firms that have more potential and whose management is interested in fast growth, (2) VCs add value using corporate governance to take an active role in monitoring and, when needed, on the Board of Directors,

and (3) the network of contacts, the portfolio of companies already invested in and other intangible assets that build up the venture capitalist's reputation.

Regarding the first stream, research has focused on how VCs screen and, supposedly, select the best firms in order to understand the process followed by them (Baum and Silverman, 2004; Zacharakis and Meyer, 1998, 2000). The key assumption behind these studies is that the VCs are able to identify the best firms and do not consider the effect that these selection criteria could have in the posterior development of VC-backed companies (Shepherd and Zacharakis, 2002).

However, the number of failures is significant (Gorman and Sahlman, 1989 ; Manigart et al., 2002) which might indicate that their selection process is far from perfect. That is, although VCs try to make sure they pick the best ventures from those available through their dealflow, they do not have access to all the firms that are looking for financing. In other words, VC-backed firms do not perform better just because they have been selected by experienced VCs.

The second approach focuses on how corporate governance is used to ensure monitoring of the portfolio companies. Contracts between the parts specify each party's rights (voting rights, board seats and liquidation rights among others) and how VCs are going to monitor their investments (Sahlman, 1990; Sapienza and Gupta, 1994; Gompers, 1995; Kaplan and Strömberg, 2004). Through active monitoring and participation in the company's board, VCs add value to the firm, sharing their expertise and knowledge with the portfolio companies (MacMillan et al., 1989; Hellmann and Puri, 2000; 2002). Therefore, the presumed superior impact is due to the VCs efforts to ensure that the portfolio company is well- managed, participating in strategy or recruiting when needed.

The final research stream analyses how VCs bring to the table various intangible assets that end-up adding value to the portfolio companies (Hellmann and Puri, 2002; Davila et al, 2003; Gorman and Sahlman, 1989). Among them, the network of contacts, the deep knowledge of key sectors through participation in other companies, and the close relationship with providers of professional services such as lawyers, investment bankers or consultants are cited in the literature. These intangible assets are supposed to build up the VCs reputation. Affiliating with a highly reputed VCs has a price that firms looking for VC funding are willing to pay (Hsu, 2004). Again, the superior economic impact is expected but not proven.

Summarising, all three lines of research focus on how VCs perform their job in order to explain why they obtain better results. However, these better results are expected, based on the superior returns obtained with those companies that succeeded, and made it to an IPO or successful acquisition. All these studies assume the economic impact but without presenting empirical evidence. Gompers and Lerner (2001) identify the economic impact as one of the three open issues in the VC academic literature. In their own words:

"*But at the same time much remains to be learned. In some cases, the unanswered questions have been posed for years, bur lack of access to data has proven to be a major barrier. [] For example, the impact of the dramatic growth in the industry over the past two decades on venture capital organizations and the high-technology companies that they fund remain quite uncertain*" (Gompers and Lerner, 2001, p. 166)

2.2. Literature on economic impact of VC-funded firms

Research on economic impact of VC-funded companies can be grouped in two: (1) specific research in subjects such as innovation and job creation; (2) studies focusing on impact of VC-backed firms in the general economy. It is this second line of research that is the goal of our paper.

Regarding the first group of studies, empirical research shows that there is a strong positive correlation between venture capital and innovation (Hellmann and Puri, 2000; Kortum and Lerner, 2000). The studies consider the number of patents per firm but also the quality of these patents. Kortum and Lerner concluded that a dollar of VC is three times more effective in promoting patent creation than a dollar from a corporation.

In terms of job creation, research has focused on understanding the relationship of employment growth with VC funding in macroeconomic terms. Wasmer and Weil (2000) find evidence of the impact on employment of an increase in the ratio VC investment/GDP in a panel of 20 OECD countries. Belke et al, (2001; 2003) extend this research by considering the stage of development of the investments computed. However, the research is conducted in aggregated terms, at country level, without considering the micro level of the enterprise and its characteristics.

Within the second group, impact on the economy in general, to our knowledge, the first VC impact study dates back to 1982. It was undertaken by Venture Economics Inc (1982) for the US General Accounting Office. Its aim is to prove that VC-backed companies achieve better results with limited resources. The study considers the complete population of 1,332 VC-backed firms receiving funds between 1970 and 1979. However, the analysis was performed on just 72 companies (5.4% of the population), those that were already public companies. The methodology involved applying historical growth rates of the sample to the 10 following years. The growth rates of the companies in the sample, most of which were start-ups, were not representative of the future evolution of a more mature company. Additionally, the timing or size of the VC round was not considered.

The empirical results show the positive effect of VC-backed companies, in terms of aggregated sales, payment of taxes and job creation. The main flaw is the use of a biased sample, considering only firms making it to an IPO. Financial data on public companies are openly available. The methodology also exhibits other important shortcomings. The main merit of the study is that it was the first to measure the economic impact of VC-backed companies. Many later studies used this research as a starting point.

A similar study was developed in the UK in 1987 (Venture Economics Ltd, 1987). The UK VC association, BVCA, requested the specialised VC market consultant to measure the impact in its country. The sample only included those VC-backed firms that went public between 1981 and 1985 (92 companies, 2.3% of population). The shortcomings of the study are basically the same as in the foregoing analysis. As a result, the empirical results cannot be generalised due to the strong positive bias of the sample.

Posterior studies in the US and UK (Coopers and Lybrand and Venture One for the NVCA[1], 1994; 1995; 1996; Venture Economics Ltd for the BVCA, 1988) tried to address the issue of the positive bias in the sample. The methodology was to use postal questionnaires in order to obtain a random sample. However, two issues affected the validity of the sample: (1) survivorship bias, because the postal survey was sent to firms that were still in business and (2) positive bias, because is very likely that only those firms performing well had any interest in reporting their results.

The European VC association, EVCA, starts the analysis of the economic impact in the region in 1996 (EVCA, 1996). Once again, the shortcomings are similar to the US and UK studies. From 2001 on the analysis was split between the economic impact of pure VC and of MBOs/ MBIs (CMBOR and EVCA, 2001; 2002). The research is based on the opinions of respondents, in both quantitative and qualitative terms. The results are biased and supported

[1] NVCA stands for National Venture Capital Association. It is the US VC association.

by these opinions. In this respect, the results are more of an indicator of the "health" of VC in the UK than a measure of its economic impact.

An improvement in recent studies is the comparison of the results of the VC-backed companies with a control group (DRI-WEFA , 2002; Bannock Consulting, 2002; IE Consulting Ltd, 2003; Global Insight Inc, 2004). If VC-backed firms' sales have grown, for example, 10% p.a. over the last 3 years, the results are positive if this result exceeds the growth rate of similar companies not receiving VC funding. However, the control group is not designed to reflect the nature of the VC-backed companies, and the studies benchmark their results to average results of public data (e.g., FTSE-100, FTSE-250, average of private companies).

Summarising, two fundamental flaws can be identified in past research, namely: (1) the use of biased samples of very limited scope (i.e. including only top performers), and (2) the failure to consider the timing of VC financing in the analysis, limiting examination of a company's development since the IPO or only over the last few years. Additionally, the control groups, for comparison purposes, seem inadequate, failing to mirror the characteristics of the VC-backed population.

There are two basic reasons explaining the flaws in previous studies. First, the lack of data to identify the complete population, given that VCs are not obliged to provide detailed information of their investment portfolios. This was not the case in the US, and other countries, where specialised consultants started to keep records of all VC deals a long time ago. Second, the difficulty of accessing financial information on privately held, VC-backed firms. Disclosing key financial data might compromise their strategic position, thus limiting the possibility to access that information in most countries.

Consequently, this paper analyses two related questions, the existence of superior economic impact in VC-backed firms and its relationship with the VC funding. Therefore, the hypotheses to be tested are:

***Hypothesis 1**:*

H1.a Employment, sales, gross margin, total assets, intangible assets and corporate taxes of VC-backed firms grow faster and, thus, these firms have a greater economic impact than similar companies not financed by VCs.

H1.b The differences observed in the growth rate between the VC-backed companies and the control group are significant.

***Hypothesis 2**:*

There is a positive relationship between VC funding and the evolution of different economic variables of investee companies, such as employment, sales, gross margin, total assets, intangible assets and corporate taxes.

3. Methodology and data

3.1. Methodology

In order to test the first hypothesis, several economic variables are analysed in a comprehensive sample of VC-backed companies. Among these variables are items such as: employment, sales, gross margin, total investment, investment in intangible assets and corporate taxes. We include the variable 'investment in intangible assets' as a proxy to

innovation.[2] This variable is identified by a Green Paper of the Commission of the European Communities (1995) as one of the reasons for the higher productivity level found in the US when compared to Europe. Other financial variables regarding earnings are excluded from the analysis because negative values would result in missing values when transformed in logarithm terms,[3] thus introducing a bias in the analysis. A proxy for the impact on after-tax earnings is, however, the amount of corporate taxes paid, since this amount is based on earnings before tax, after deducting past losses.

For each variable selected, we analyse the annual growth in a period that goes from the year of the first VC-funding, namely 'event year' or 'year 0', to three years after that, 'year 3'. This period reflects the average holding period of the sample, the fourth year being the moment when the VCs, on average, divest their equity participation (see Table 2). From the growth figures we cannot conclude that the sample companies perform better than those without VC-backing. Therefore, we select a control group of similar companies that do not receive VC funding. Each company in the sample is matched with a similar one non VC-backed. The method for the selection of the control group is as follows: (1) we pick out all the companies in the same province (2) we select those with the same activity code. (3) we filter the companies that are within the same range of sales in the year of the VC funding event. (4) we select the company that is closer in age to that of the sample. In many cases we find a company founded in the same year. Due to the filtering tools of the SABI database we can only build a control group for companies that received VC from 1993 onwards. Consequently, we use a sub-sample of five years (1993 to 1998) to compare results with the control group.

Provided that growth patterns differ in companies at various stages of development, we classify the VC-backed firms and their respective comparables into three groups: start-up, growth and late stage investments. Firms that receive the first round of VC funding from the start-up point to the moment they reach break-even are included in the start-up group. Those firms with a track record of earnings, that receive their first round in order to finance the expansion of the business through a capital increase are grouped into the growth stage. Finally, buyouts, turnaround and replacement capital deals, which generally do not involve an entry of fresh money into the firm, are classed as late stage investments.

To test Hypothesis 1.a, we compute the average growth from the event year '0' to ' 3' for each economic variable, in each of the three stage groups in the VC-backed sample. Similarly, we replicate the same calculation for the three groups of comparable companies. To test Hypothesis 1.b, we perform a test of equality of means between pairs of groups representing VC-backed companies, at a given stage, and their comparables from the control group. Significant differences in the means related to employment, sales, gross margin, total assets, intangible assets and corporate taxes are expected.

To test Hypothesis 2, which provides further evidence on the positive, significant impact of the presence of a VC investor on the economic variables analysed, we rely on econometric techniques applicable to panel data (Hsiao, 2003; Arellano and Bover, 1990), with the VC-backed firms being the unit of analysis. Using panel data techniques has several advantages, allowing us: 1) to control for unobservable individual heterogeneity, which is high among the VC-backed companies; 2) to use a large amount of information, including many companies and several years for each company, thus increasing the degrees of freedom and reducing colinearity between the explanatory variables; 3) to analyse the evolution over time of the variables in a group of companies.

[2] Spanish official financial accounts of the companies do not include information regarding patents, which is the variable generally used as proxy to innovation.

[3] The growth patterns are encouraging. Descriptive statistics are available upon request.

We follow two approaches, which are formalised through two empirical models to be tested. The first empirical model aims to find a positive impact of the presence of a VCs as a shareholder through dummy variables. It is presented in the following equation (1), with the endogenous variables of the multiple specifications being the different items used to measure the economic impact. The latter are a function of two dummy variables plus a control variable representing the gross domestic product. The first dummy variable (Dwhile) equals 1 in the years the VC remains as a shareholder in the funded company, or zero otherwise. The second dummy variable (Din) equals 1 from the moment a company receives VC funding onwards and zero before that event happens.

$$\left.\begin{array}{c} Employment \\ Net\quad sales \\ Gross\quad margin \\ Total\quad assets \\ Intangible\quad assets \\ Corporate\quad taxes \end{array}\right\rangle = F(Dwhile,\quad Din\quad GDP) \tag{1}$$

A positive, significant sign is expected for the second dummy or at least, for the first one, to reinforce the evidence of the relevant growth experienced by the economic variables in the sample.

To continue with the test of the second hypothesis, a second empirical model, that relates the evolution of the mentioned economic variables of the VC-backed firms to the cumulative VC investment, is posed. It is represented through the following equation (2), with employment, net sales, gross margin, total assets, intangible assets and corporate taxes being the endogenous variables of the different specifications:

$$\left.\begin{array}{c} Employment \\ Net\quad sales \\ Gross\quad margin \\ Total\quad assets \\ Intangible\quad assets \\ Corporate\quad taxes \end{array}\right\rangle = F(Cumulative\quad VC\quad investment,\quad GDP) \tag{2}$$

A positive sign of the slope related to the cumulative VC investment in a portfolio company to date is also expected.

Regarding the estimation method, there is a discussion as to whether the individual effects should be treated as fixed or random variables. However, this is not an important distinction because we can always treat the individual effects as random variables without loss of generality (Arellano and Bover, 1990). However, it is really important to determine whether or not these individual effects are correlated with the variables observed. To test for the existence of this correlation the Hausman test (1978) is usually used. If this test does not reject the null hypothesis that the individual effects are not correlated with the explanatory variables, the most suitable estimation would then be the random-effects model and the best estimator would be Balestra-Nerlove's (1966) generalised least squares estimator. If, however,

the null hypothesis is rejected, the within groups ordinary least squares estimator would then be the most suitable one.

The rest of this section describes both the data collection process and the data used to test the hypotheses. It should be noted that the research is based on the complete population of VC-backed firms in a specific area, which is a challenge due to the private nature of VC activity. Two proprietary databases are used in the research. First, to identify the companies that received VC in the period, we use the database of Prof. Martí (U. Complutense). This database keep records of the whole population of venture capital/private equity deals in Spain since 1988 and is the official source of information for the national (ASCRI) and the European (EVCA) VC associations.

The population is formed by companies that received VC funding[4] in the top three regions of Spain in the period 1989 to 1998. The top three regions, Madrid, Catalonia and the Basque Country, represent 48% of the total VC investments committed in the period and 36% of the VC-backed companies. Population for this paper is 369 VC-backed companies.

Once we identify the names of the VC-backed firms, the annual accounts of venture-backed firms, including profit & loss account, balance sheet, employment figures and other financial information, are collected from the SABI database (Bureau Van Dijk). This database includes the annual official accounts of more than 550,000 Spanish companies.

3.2.Venture Capital in Spain

The history of VC in Spain is quite recent compared to that of US or other Western European countries. Its introduction can be traced back to 1972 (Martí, 2002). Surprisingly, its roots lay in the need to provide financial assistance to Spain's less developed regions. These regions' economies were based on primary sectors and were suffering from the dramatic effects of lack of industrialisation. This contrasts with the development of VC in the US, which was driven by strong support for new inventions from top universities. The first VCs were dependent on public sector funding and did not have the same priorities as today's VCs. Private sector-related investors entered the Spanish market in the late eighties, becoming the leading players in the development of the Spanish VC industry as it stands today (Martí, 2002).

Table 1 summarises the key figures on the evolution of VC in Spain. Panel A shows the development of fundraising and the number of investors. Panel B presents figures on total money invested (in nominal terms) and the number of VC-backed companies. It differentiates those companies that were receiving funds for the first time.

[4] For the purpose of this research, Venture capital is defined in a broad sense, encompassing all investments reported to the EVCA's yearly surveys.

Table 1

Venture capital in Spain (1991-2003)

Panel A: Supply side

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Funds raised (€ million)	124	165	245	120	131	74	414	778	638	2,507	1,070	860	1,042
Capital under management (€ million)	822	944	1,180	1,197	1,274	1,311	1,553	2,188	2,570	5,025	6,076	6,820	7,492
Number of investors	46	48	54	56	53	52	53	56	58	70	84	94	94
of which state-owned (%)	29	26	36	35	33	33	32	22	23	12	10	11	11

Panel B: Demand side

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Funds invested (€ million)	129	116	97	136	165	213	286	350	717	1,309	1,241	969	1,337
Number of companies affected*	230	220	219	211	199	169	233	223	305	410	392	380	410
Initial investments	N/A	143	107	104	132	118	172	162	203	302	247	228	239

**Including follow-on investments*

Source: Prof. Martí database and webcapitalriesgo.com

3.3. Sample description

The sample of firms includes all those companies that are fully identified and for which separate financial accounts exist. The sample size is 323 firms, representing 88% of the population. This figure is well above the ones observed in previous studies, whose reach ranged from 2 to 15%.

The sample comprises data from companies that are no longer in business, therefore it is not affected by survivorship bias. On the other hand, some successful firms, that were acquired by strategic buyers and integrated into their Spanish operations, cannot be identified separately and so are not included. Accordingly, the sample misses some good, average and bad companies. In order to make sure that the sample is unbiased, we performed a chi-squared test of differences between proportions. Results in Panel A of Table 2, support the hypothesis of an unbiased sample.

Out of the 323 companies of the sample at the end of 2001, according to the SABI database and additional research, 247 of them are alive and active (76%), 26 are alive but merged (8%), 20 went bankrupt (6%) and for the remaining 30 the reason for their business inactivity is not clear.

Table 2, panels B to E, summarises the distribution of VC-backed firms, at the moment of the first VC round and the total amount of investment received in constant terms (base 2001). The total amount of funds includes the first round of financing and any VC round that took place before the total exiting of VCs from the company's equity.[5] The firms are classified according to four different characteristics: 1) Age of the firm (panel B); 2) Sector of activity (panel C); 3) Number of employees (panel D); and 4) Stage of development (panel E). The last panel (F) refers to the average holding period, including statistics for the 216 companies that were already divested.

[5] If the first round VCs fully exited a company, but the same year other VCs took an equity participation in the VC-baked firm, the firm is counted only once, and the total investment period considered is from the first round to the final exit of the last VC investor.

Table 2

Descriptive statistics of VC-backed firms in the sample (Spain, 1989-1998)

Panel A: Characteristics of the investment. Test of proportions of the population and the sample

Investment	Test statistics		
characteristics	Chi-squared	df	Asymp. Sig.
VCs size	2.123	2	0.346
Private vs. public funds	0.563	1	0.453
Type of vehicle (a)	0.622	1	0.430
Type of deal (b)	0.321	1	0.571
Type of divestment (*)	4.723	10	0.909
Stage of firm (**)	3.052	9	0.962
Year of first VC round	2.928	10	0.983
Number of employees	2.819	5	0.728
Company's location	0.831	2	0.660

(a) VC company vs. Management of VC funds

(b) Increase in capital vs. buy-out

(*) 5 cells (45.5%) have expected frequencies less than 5. The minimum expected cell frequency is 0.9.

(**) 3 cells (30.0%) have expected frequencies less than 5. The minimum expected cell frequency is 2.6.

Panel B: Age of VC-backed firm and amount of funds committed

Age	Number		Total venture capital investment (€ thousand base 2001)				
(First Round)	Firms	%	Mean	S. D.	Median	Min.	Max.
Less 1 year	85	27.0	2,893	5,908	542	2	29,240
1 year	33	10.5	2,062	5,021	765	42	28,874
2 years	18	5.7	524	507	381	10	2,034
3 years	16	5.1	2,109	2,862	1,033	9	9,965
4 to 10 yrs.	72	22.9	3,389	5,940	885	31	27,713
11 to 20 yrs.	33	10.5	5,292	14,488	1,309	24	83,492
More 20 yrs.	58	18.4	5,529	9,083	2,063	96	46,055
Unknown	8	-	-	-	-	-	-
Total	323	100	3,430	7,597	923	2	83,492

Panel C: Activity of VC-backed firm and amount of funds committed

Activity	Number		Total venture capital investment (€ thousand base 2001)				
(First Round)	Firms	%	Mean	S. D.	Median	Min.	Max.
Raw Materials	15	4.6	1,565	2,007	619	28	6,881
Industry	117	36.2	3,718	7,002	1,229	2	46,055
Technology	42	13.0	2,524	6,193	634	31	29,240
Services	91	28.2	4,010	10,114	874	9	83,492
Trade	49	15.2	3,720	6,188	979	26	28,874
N/A	9	2.8	218	99	172	102	426

Table 2 (Cont.)

Panel D: Employees of VC-backed firm and amount of funds committed

Employees	Number		Total venture capital investment (€ thousand base 2001)				
(First Round)	Firms	%	Mean	S. D.	Median	Min.	Max.
0 to 10	84	27.5	1,131	3,977	213	2	26,076
11 to 50	80	26.2	1,882	3,943	740	31	29,240
51 to 100	54	17.7	2,286	3,243	1,139	44	19,587
101 to 250	43	14.1	4,648	5,911	2,131	77	28,874
251 to 500	25	8.2	10,483	11,179	5,208	24	46,055
More 500	19	6.2	13,697	19,528	6,294	339	83,492
N/A	18	-	-	-	-	-	-

Panel E: Development stage of VC-backed firm and amount of funds committed

Stage	Number		Total venture capital investment (€ thousand base 2001)				
(First Round)	Firms	%	Mean	S. D.	Median	Min.	Max.
Early	104	32.2	1,574	4,616	327	2	29,240
Growth	166	51.4	3,633	8,391	1,107	9	83,492
Late	43	13.3	7,142	8,336	3,512	44	28,874
N/A	10	3.1	3,855	9,894	256	24	31,803

Panel F: Number of years from first round to VCs' exit (a)

	Firms	%	Mean	S. D.	Median	Min.	Max.
Years to exit	216	66.9	4.88	2.67	4,0	0	12

(a) Includes 38 write-offs. The remaining 107 firms have not been divested at the end of 2001.

The mean investment received, in constant terms, was €3.4 million, with a high dispersion (standard deviation of €7.6 million). The characteristics of the firm, at the time of the first round of financing, seem to affect the amount of funds received. Firms younger than one year received more funds that those between 1 and 4 years. However, this is not the case regarding the number of employees, where more employees translate in more funds. This latter result can be related to the fact that most of the VC-funded firms belong to the industrial sector, 36% of the sample, where the number of employees is closely related to size. The companies in the technology sector receive less funding than the sample's mean, probably because this group of companies is, in general terms, quite young. Finally, the amount of funds received grows with the stage of development of the firm. Firms in the late stage include buy-outs of large enterprises that, although limited in number, receive substantial funds.

Panel A in Table 3 presents the annual growth rate of the different economic variables of the sample companies from the event year '0' to '3'. Results are encouraging, showing a positive evolution of all variables considered. The growth rates are annual, therefore the total growth for the period analysed would be $(1 + CAGR)^3$. This means that, for example, employment in the sample's firms has almost doubled, corporate taxes are 1.7 times higher and investment in intangible assets, our proxy for innovation, triples in only three years.

Growth rates in Table 3, panel A, are not the same across the sample. Panel B includes the statistics for the non-parametric test of Kruskal-Wallis for different firm characteristics. Employment, corporate taxes and investment growth rates do not present significant differences within the groups formed for any of the characteristics, except for age in total assets and number of employees for intangible assets. On the other hand, sales and gross margin exhibit significant differences at 1% and 5% for all characteristics, excluding activity for gross margin.

Table 3

Evolution of the economic variable of the sample between year t and year t + 3

Panel A: Cumulated annual growth rate (CAGR) (a)

Variable	Employment	Sales	Gross Margin	Corp. Taxes	Total Assets	Intangible A.
Annual growth rate (%)	22.9	16.3	11.0	18.6	19.8	42.8

(a) The growth has been calculated adding up the value for each variable in year'0't and comparing this result with the aggregated value in year '3'. This method reduces the bias produced by very small companies that experience over 100% growth during the early years.

Panel B: Non-parametric test for equality of means within groups according to firm's characteristics (a)

Firm's Characteristic	Employment	Sales	Gross Margin	Corp. Taxes	Total Assets	Intangible A.
Age	6.8769	47.1548***	39.9314***	8.7754	12.0182*	7.3287
Activity	2.1101	10.487**	5.63	2.1821	6.8141	1.5174
Employees	2.0647	19.9377***	14.9181**	0.8213	8.1471	12.1993**
Stage	0.1061	22.6854***	13.7414***	0.3816	0.7141	0.139

*(a) Kruskal Wallis test. *, **, *** indicate statistical significance at the 10%, 5% or 1% level, respectively.*

3.4. Description of variables

As shown in Table 2, there is an enormous dispersion on the amounts invested in different VC-backed firms. In Panel A of Table 4, a similar pattern of dispersion is observed for the economic variables presented to measure the impact of VC funding. For example, sales go from none to almost one billion constant 2001 Euro, and employment from zero to almost seven thousand. Panels B and C report similar characteristics.

Since VC-backed firms differ in size and each one shows different growth, the problem of heteroskedasticity may arise. In addition to calculating robust standard errors when possible, it is advisable to transform all variables in logarithm terms. This change would, however, have significant consequences on the main independent variable presented in equation (2), which is the cumulative amount invested in a VC-backed company up to a given year. Since that variable would equal zero prior to the event year, all those observations would become missing values. As a result, the model would not measure the change in the observed economic variable before and after the initial round of financing.

In order to avoid this situation, the variable representing the cumulative VC investment is transformed as follows: we add 1 to the previous value of the variable. As a result, the natural logarithm of the transformed variable equals 0 when the original value of the variable representing the cumulative amount of money, in 2001 Euro, equals 0. Through this change of variable, we are able to keep track of the evolution of the endogenous variable prior to the event year and, thus, to better control for the change in that variable due to VC funding. In quantitative terms, this change is meaningless, since it represents the equivalent of € 1 thousand on figures that usually amount to € millions. Nevertheless, this change of variable must be reversed in order to explain the results obtained.

In the same way, in order to obtain a normal distribution for the growth figures to test the equality of means (Table 5), we need to transform the data to logarithm terms. The problem, in this case, is that growth rates can be negative for some companies, and so, a logarithm transformation would eliminate these values, leaving our sample with a clear positive bias. To avoid this problem we, first, add-up 100 to all growth rates, and then calculate their logarithms.

Table 4

Descriptive statistics of economic variables at 'year 0'

Panel A: Sample of VC-backed companies (€ thousand base 2001, number of employees)

Variable	Mean	S.D.	Median	Min.	Max.	25%	75%
Sales	23,561	77,997	5,934	0	947,110	673	19,502
Gross Margin	11,648	35,398	3,481	-5	412,524	790	10,154
Corp. Taxes	199	682	1	0	5.025	0	130
Assets	23,342	75,848	5,702	0	933,484	1,836	16,985
Intangible A.	792	1,685	188	0	13,573	32	689
Employees	159	521	43	0	6,615	9	124

Panel B: Sub-sample of VC-backed companies (1993-1998) (€ thousand base 2001, number of employees)

Variable	Mean	S.D.	Median	Min.	Max.	25%	75%
Sales	26,298	4,483	88,084	0	947,110	610	18,603
Gross Margin	12,363	2,986	39,474	-5	412,524	540	9,916
Corp. Taxes	206	1	750	0	5,025	0	120
Assets	27,423	5,976	86,214	4	933,484	2,008	19,992
Intangible A.	894	235	1,840	0	13,573	39	768
Employees	216	56	672	0	6,615	12	160

Panel C: Control Group (1993-1998) (€ thousand base 2001, number of employees)

Variable	Mean	S.D.	Median	Min.	Max.	25%	75%
Sales	34,367	259,104	3,284	0	3,063,544	384	11,285
Gross Margin	14,008	108,941	1,612	-7	1,296,786	185	4,532
Corp. Taxes	246	1,387	4	0	15.169	0	91
Assets	33,297	246,151	2,499	2	2,914,533	289	8,965
Intangible A.	1,213	10,054	23	0	113,664	1	116
Employees	363	2,507	32	1	23,097	9	82

4. Results

The apparent positive evolution of the selected economic variables in VC-backed companies needs to be compared with that of a control group, in order to be able to test our Hypotheses 1.a and 1.b. Table 5 states the results obtained for the sub-sample of VC-backed firms[6] and for the control group. Panel A shows the aggregated results, confirming the superior economic impact of the VC-backed companies in all variables analysed, except corporate taxes confirming H1.a.

The following panels in Table 5 corroborate H1.b, analysing the mean of the growth rates by stage of development, providing a test of equality of means. The companies have been grouped by phase of development because growth rates vary considerably across stages. While for companies at the start-up stage an annual growth over 100% might be considered normal, it would be exceptional in a late stage company.

[6] The sub-sample includes those VC-backed firms that had the first round of financing between 1993 and 1998 (included), as explained earlier in this section.

Table 5

VC-backed companies vs. control group

Panel A: Comparison of annual growth rates of sub-sample and control group (year 0 to year 3) (%) [(a) (b)]

Group	Sales	Gross Margin	Total Assets	Intangible A.	Employment
Sub-sample	23.8	18.8	26.1	45.8	19.0
Control Group	8.1	5.2	8.3	21.5	2.3

(a) Sub-sample refers to the group of VC-backed companies that received funding between 1993 and 1998.
(b) The growth has been calculated adding up the value for each variable in year 0 and comparing this result with the aggregated value in year 3. This method reduces the bias produced by very small companies experienced +100% growth

Panel B: Sales: annual growth rates for different development stages (%)

	VC-backed companies		Control Group		t-stat equality
Stage	Mean	S. D.	Mean	S. D.	of means [(a)]
Start-up	136.4	271.7	50.4	129.7	2.52**
Growth	23.9	26.2	4.5	13.9	3.72***
Late	8.4	14.8	27.9	34.6	-1.36

*(a) *, **, *** indicate statistical significance at the 10%, 5% or 1% level (two-tailed), respectively.*

Panel C: Gross Margin: annual growth rates for different development stages (%)

	VC-backed companies		Control Group		t-stat equality
Stage	Mean	S. D.	Mean	S. D.	of means [(a)]
Start-up	85.6	219.5	32.4	152.0	2.27**
Growth	23.6	29.8	3.9	14.1	3.46***
Late	5.9	27.4	11.7	7.9	-0.94

*(a) *, **, *** indicate statistical significance at the 10%, 5% or 1% level (two-tailed), respectively.*

Panel D: Total assets: annual growth rates for different development stages (%)

	VC-backed companies		Control Group		t-stat equality
Stage	Mean	S. D.	Mean	S. D.	of means [(a)]
Start-up	49.5	128.6	37.7	72.2	0.36
Growth	78.2	367.4	2.1	13.3	2.78***
Late	9.7	18.2	21.5	28.9	-0.96

*(a) *, **, *** indicate statistical significance at the 10%, 5% or 1% level (two-tailed), respectively.*

Panel E: Intangible assets: annual growth rates for different development stages (%)

	VC-backed companies		Control Group		t-stat equality
Stage	Mean	S. D.	Mean	S. D.	of means [(a)]
Start-up	192.0	707.3	18.0	78.2	2.24**
Growth	80.4	305.0	13.7	66.7	1.79*
Late [(b)]	-	-	-	-	-

*(a) *, **, *** indicate statistical significance at the 10%, 5% or 1% level (two-tailed), respectively.*
(b) One of the groups has less than 10 observations.

Panel F: Employment: annual growth rates for different development stages (%)

	VC-backed companies		Control Group		t-stat equality
Stage	Mean	S. D.	Mean	S. D.	of means [(a)]
Start-up	22.7	43.5	30.5	50.6	0.02
Growth	21.4	24.3	5.5	16.9	2.79**
Late [(b)]	-	-	-	-	-

*(a) *, **, *** indicate statistical significance at the 10%, 5% or 1% level (two-tailed), respectively.*
(b) One of the groups has less than 10 observations.

Results in start-up and growth stages verify Hypothesis 1.b of a higher impact of VC-backed companies, showing significant differences at the 1% and 5% levels for all variables but assets and employment in the start-up stage. Regarding late stage, significant differences between VC-backed and control group averages are not found. The limited number of companies belonging to the late stage group in the sample could be the reason for this result. Regarding corporate taxes, the number of zero values in year '0', plus the existence of tax credits, invalids the growth rate figure, in many cases and, therefore, the results are biased in both groups.

Regarding Hypothesis 2, from a panel data perspective, the results of the first model (1), aimed at identifying the existence of a positive impact of the presence of a VCs as shareholder of a firm, are shown in Table 6. In all cases, the coefficient of the GDP's natural logarithm is positive and significant at the 1% level, as expected. It should be noted that the coefficient of the variable that equals 1 from the moment a company receives VC funds onwards (Din_{it}) is positive and significant in three regards. Evidence of positive impact of the intervention of VCs on employment, on the volume of total assets and on the amount of corporate taxes paid, is found.

On the other hand, the coefficient of the variable that equals 1 while a VCs remains as a shareholder of the company ($Dwhile_{it}$) is positive and significant in the specifications that explain the natural logarithms of sales, gross margin, total assets and intangible assets.

It should be noted that both dummy variables are significant in the model focusing on the natural logarithm of corporate taxes paid. The first one being negative and significant at the 5% level while the second one shows a positive coefficient that is significant at the 1% level. This result could be explained by the fact that corporate taxes may diminish after a VC investment due to the decreasing earnings path that follows a growth process. Nevertheless, the pattern of earnings that follows results in a higher volume of the amount of corporate taxes paid. This outcome explains why the test on equality of means does not show significant differences in the averages of both groups, as growth rates are computed just up to 'year 3'. On the contrary, the panel data analysis takes into account all available observations before and after the event year.

Table 6
Impact of the presence of a VCs on a funded company

	$Lemp_{it}$ [(a)]	$Lsales_{it}$ [(a)]	$Lgrmrg_{it}$ [(a)]	$Lassets_{it}$ [(a)]	$Lintang_{it}$ [(a)]	$Lctaxes_{it}$ [(b)]
$Lgdp_t$	2.4686***	5.9164***	3.3888***	2.9106***	4.1318***	10.6328***
	0.2399	0.6562	0.2528	0.2589	0.7852	1.3057
$Dwhile_{it}$	0.0561	0.3977**	0.1117**	0.1696**	0.5325***	-0.6670**
	0.0579	0.1614	0.0514	0.0708	0.1648	0.2932
Din_{it}	0.2994**	-0.2038	0.0701	0.3005***	0.3833	1.1800***
	0.1247	0.2424	0.0807	0.1042	0.3013	0.4594
cons	-46.1836***	-104.0094***	-53.3414***	-43.5639***	-72.1193***	-208.0833***
	4.8020	13.1308	5.0606	5.1763	15.6899	26.1234
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	
Prob > chi2						0.0000
Hausman test	0.0002	0.0010	0.0000	0.0000	0.0256	0.2218
Observations	2.296	2.171	2.085	2.222	1.496	1.758
Companies	361	290	283	298	284	283

(a) Fixed-effects OLS regressions, with robust standard errors in small case. The endogenous variables are: $Lemp_{it}$ = Natural Logarithm of the number of employees of company 'i' at 't'; $Lsales_{it}$ = Natural Logarithm of the net sales of company 'i' at 't' in 2001 Euro; $Lgrmrg_{it}$ = Natural Logarithm of the gross margin of company 'i' at 't' in 2001 Euro; $Lassets_{it}$ = Natural Logarithm of the total assets of company 'i' at 't' in 2001 Euro; $Lintang_{it}$ = Natural Logarithm of the intangible assets of company 'i' at 't' in 2001 Euro.
(b) Random-effects GLS regressions, with standard errors in small case. The endogenous variables are: $Lsales_{it}$ = Natural Logarithm of the sales of company 'i' at 't' in 2001 Euro; $Lctaxes_{it}$ = Natural Logarithm of the corporate taxes declared by company 'i' at 't' in 2001 Euro.
*** = significant at 1%; ** = significant at 5%; * = significant at 10%;
The independent variables are: $Lgdp_t$ = Natural Logarithm of the Gross Domestic Product in 2001 Euro; $Dwhile_{it}$ = Dummy variable that equals 1 if the company 'i' has a VCs as a shareholder in year 't', or 0 otherwise; Din_{it} = Dummy variable that equals 0 before it gets funding for the first time from a VCs and 1 afterwards.

To further test Hypothesis 2 the empirical model represented by equation (2) aims to identify the real impact, on the mentioned economic variables, of the cumulative amount of money invested by VCs. The results are shown in Table 7. As was the case in Table 6, all coefficients of the control variable are positive and significant at the 1% level.

Regarding the variable that represents the natural logarithm of the cumulative investment received by a company, in constant Euro, in all cases except one the coefficient is positive and significant at the 1% level. Therefore, evidence is found on the positive impact of investments on the number of employees and on the volume of sales, gross margin, total assets and intangible assets. This evidence confirms the impressive evolution of the analysed variables that was presented in the descriptive analysis.

The coefficient of the natural logarithm of the amount of corporate taxes paid is also positive, but only at the 10% level. This result could be explained by the negative evolution of earnings in the first years after a VC investment due to the consequences of being involved in a rapid growth process. This result is coherent with the outcome of the same variable on Table 6.

Table 7
Impact of cumulative VC investments on a company's economic variables

	Lemp$_{it}$[(a)]	**Lsales$_{it}$[(b)]**	**Lgrmrg$_{it}$[(a)]**	**Lassets$_{it}$[(a)]**	**Lintang$_{it}$[(a)]**	**Lctaxes$_{it}$[(b)]**
Lgdp$_t$	2.2633***	4.4666***	2.9884***	2.3129***	3.1085***	11.9151***
	0.1999	0.5378	0.2003	0.1766	0.4244	1.1031
Lcumpeinv$_{it}$	0.0591***	0.0554***	0.0337***	0.0750***	0.1158***	0.0779*
	0.0171	0.0201	0.0069	0.0079	0.0175	0.0417
Cons	-42.0325***	-75.4558***	-45.3175***	-31.5350***	-50.8417***	-233.6792***
	3.9881	10.7772	4.0181	3.5407	8.5058	22.1120
Prob > F	0.0000		0.0000	0.0000	0.0000	
Prob > chi2		0.0000				0.0000
Hausman	0.0000	0.0994	0.0000	0.0150	0.0001	0.2187
Observations	2.240	2.168	2.085	2.219	1.849	1.755
Companies	361	289	283	297	276	282

(a) Fixed-effects OLS regressions, with robust standard errors in small case. The endogenous variables are: Lemp$_{it}$ = Natural Logarithm of the number of employees of company 'i' at 't'; Lsales$_{it}$ = Natural Logarithm of the net sales of company 'i' at 't' in 2001 Euro; Lgrmrg$_{it}$ = Natural Logarithm of the gross margin of company 'i' at 't' in 2001 Euro; Lassets$_{it}$ = Natural Logarithm of the total assets of company 'i' at 't' in 2001 Euro; Lintang$_{it}$ = Natural Logarithm of the intangible assets of company 'i' at 't' in 2001 Euro.
(b) Random-effects GLS regressions, with standard errors in small case. The endogenous variables are: Lsales$_{it}$ = Natural Logarithm of the sales of company 'i' at 't' in 2001 Euro; Lctaxes$_{it}$ = Natural Logarithm of the corporate taxes declared by company 'i' at 't' in 2001 Euro.
*** = significant at 1%; ** = significant at 5%; * = significant at 10%;
The independent variables are: Lgdp$_t$ = Natural Logarithm of the Gross Domestic Product in 2001 Euro; Lcumpeinv$_{it}$ = Natural Logarithm of the cumulative VC investment received by company 'i' until year 't'.

Nevertheless, a change of variable was performed to capture the evolution of the impact of economic data prior to the event of VC funding. When this change is reversed, in order to check if the real impact of the cumulative investment is positive, all coefficients remain positive.

5. Conclusion and discussion of results

The private nature of VC-backed companies has limited the scope for conducting in-depth research on the impact of such investments on the economy. The main flaw in previous studies is the survivorship and success biases, as well as the low reach of the samples analysed. Gompers and Lerner (2001) identify this issue as one of the three pending topics on VC research. This paper helps fill this gap in the literature, by providing empirical evidence of the positive impact of VC funding on the investee firms.

Two main hypotheses are tested. First, evidence is found that employment, sales, gross margin, total assets, intangible assets and corporate taxes grow faster in VC-backed firms. This hypothesis is verified when growth in those variables in a sample of VC-backed companies, over a three-year period, is consistently higher than those for comparable non-VC-backed firms. Relying on panel data, we find evidence of the positive impact of the presence of a VCs on the evolution of those economic variables over time. Second, our empirical model finds a significant, positive relation between the cumulative VC investment in a firm and the growth in employment, sales, gross margin, total assets, intangible assets and corporate taxes over time.

This paper has several implications. The theoretical implication is that it presents empirical evidence of the economic impact of venture capital in a specific area. The results are based on a country, Spain, where this source of financing is still developing, with a legal environment that is far from being ideal. Therefore, although if conclusions might not be generalised, countries with a more developed sector could expect to have at least similar results. Moreover, the paper opens up a new line of academic research, namely economic impact of venture capital investments.

From a practical viewpoint, regarding policy-makers, it has implications for regional development policies. This is a hot topic, since many countries are currently reviewing legislation affecting this type of investments. At the same time, policy-makers recognise that entrepreneurial ventures are vital in order to reduce unemployment. The results of this research are crucial to support initiatives focusing on increasing the supply of venture capital. Venture capital associations and policy-makers will count, for the first time, with quality data to support the enhancement of the venture capital industry.

Finally, and also from a practical perspective, there are implications for the key players of the sector, the venture funds and the portfolio companies. First, it will help the investors to better understand which initial characteristics might produce a bigger impact and, also, to have a historical benchmark to compare their results. Second, it will have implications on the decisions made by entrepreneurs that might be looking for venture capital in the future.

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