The survival of venture capital backed companies : an analysis of the French case

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Abstract

We analyze the impact of venture capital on firm performance ; more precisely, we investigate whether venture capital adds value to innovative French companies in terms of increasing their survival time. To this end, we use a hand-collected data set based on a sample of 139 French companies that went public at the "Nouveau Marché" between 1996 and 2002 to compare the survival rates of venture capital backed and non-venture capital backed companies. We develop two sets of econometric models to evaluate the factors that affect the fate of French initial public offerings. First, we estimate a discrete time duration model to explain the probability of exit. Second, we apply a competing risk model to account for heterogeneity in firm exit (liquidation versus merger/acquisition). Contrary to common wisdom, the estimates show that venture capital backed companies have a lower survival rate than non-venture capital backed companies and have a higher probability of being liquidated than other firms. Our results are comparable to those obtained in previous studies on Germany and Belgium which show that receiving venture capital does not improve firm survival.

JEL Classification : G24 ; O32.
Keywords : venture capital, survival, innovation, France.

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1 INTRODUCTION

The venture capital (VC) industry is an important source of funds for start-up firms. The industry has grown dramatically since the 1990s in both the US and Europe. According to the statistics provided by the European Venture Capital Association (EVCA[1]), the French VC industry is one of the most dynamic in Europe and is ranked second after the United Kingdom.

A key function of VC firms is to provide funding and expertise to innovative companies with high growth potential. These types of innovative companies are characterized by high failure rates (Storey and Tether, 1998) and one of the roles of VC firms is to contribute to reduce high failure rates of companies (Manigart *et al.*, 2002a). According to Jain and Kini (2000, p.1141), «since VCs specialize in providing financing and helping venture managers develop required competencies, their presence should help to reduce the failure rate of risky projects». Although this may be true of US firms (Jain and Kini, 2000), evidence for Belgium (Manigart *et al.*, 2002a) and Germany (Audretsch and Lehmann, 2004) does not support this statement. There is a lack of data for France, which means that we do not know whether VC improves the performance of French innovative companies and more precisely, we do not know whether the presence of VC firms helps or not to reduce failure rates among French innovative companies.

We try to address this gap in the empirical literature by investigating the following research question : does VC involvement improve the survival rates of French innovative companies ? To do so, we develop two sets of econometric models to evaluate the factors that affect the fates of French innovative firms. First, we estimate a discrete time duration model to explain the probability of exit. Second, we apply a competing risk model to account for heterogeneity in firm exits (failure *versus* merger/acquisition). Our analysis is based on hand-collected data for a sample of 139 French companies that went public at the "Nouveau Marché" between 1996 and 2002. One advantage of studying companies listed on the "Nouveau Marché" is that they belong to a small number of high-tech industries and are of fairly similar age. This makes them a relatively homogeneous group of companies, which allows us to compare the survival of VC backed and non-VC backed companies (Bottazzi and Da Rin, 2002[2]). In addition, thanks to the strict disclosure requirements of "Nouveau Marché" we have access to detailed information on French companies for the years from the initial public offering (IPO). Also, several papers have focused on the cohort of high-tech firms that went public in the period 1996-2002, which means we can compare the impact of VC support on firms among countries to determine whether the French situation regarding VC support and firm survival is closer to the European or the US situation.

Contrary to what is commonly assumed, estimates show that the rate of survival of VC backed companies is lower than for non-VC backed companies. If we take account of mode of exit, we see that among exiting VC backed companies there is a higher probability of the exit through liquidation. Our results are comparable with those obtained

[1]EVCA : http ://www.evca.eu/

[2]Like Bottazzi and Da Rin (2002) and Coackley *et al.* (2007), we do not match VC backed IPOs to non-VC backed IPOs based on a set of characteristics.

from studies on Germany and Belgium that show that VC support does not improve firm survival, but contrast with those from studies of US firms.

The remainder of the paper is structured as follows. Section 1 provides an overview of the literature on the role of VC firms. Section 3 describes the data, the sample employed and the methodologies used for our analyses. Section 4 presents the findings from the empirical analyses and section 5 concludes.

2 THEORETICAL FRAMEWORK AND HYPOTHESES

There are positive and negative aspects to financing by VC firms. In contrast to what is generally assumed, the presence of VC does not necessarily have a positive impact on the survival probability of a company.

i. The positive impact of VC firms

There are reasons to believe that VC backed companies will show higher economic performance and higher survival rates than non-VC backed companies.

First, VC firms make decisions based on specific investment criteria, which means they should be better placed to select the most promising ventures to support (Gompers and Lerner, 2004). For instance, according to Gifford (1997), US VC firms fund only around a dozen projects a year out of the thousands evaluated. In a sample of Canadian biotechnology companies, Baum and Silverman (2004) show that VC firms are able to choose the most promising companies with the highest probabilities of success.

Second, it is common knowledge that VC firms use control mechanisms to manage business risk and reduce agency conflicts inherent in the financing of innovative firms (Sahlman, 1990 ; Gompers and Lerner, 2004). Among these mechanisms, Lerner (1994) and Gompers (1995) identify strategies of syndication, use of specific control rights such as convertible securities[3], and the staging of capital infusions that allows projects to be abandoned at predefined stages (Sahlman, 1990). It should be noted that this ability to exercise efficient monitoring is especially valuable if the funded companies belong to industrial sectors where the assets are largely intangibles (e.g. R&D investments) (Gompers, 1995). Also, if inside investors, that is investors with close associations with the company, are involved, this can reduce the informational asymmetries and conflicts of interest that are inherent in innovative companies (Admati and Pfleiderer, 1994). Admati and Pfleiderer (1994, p.371) show that VC firms are better able to resolve agency problems than traditional investors such as banks[4] because the VC firm is : «an investor who not only provides capital but also works closely with the firm, monitors it frequently, and is generally very well informed about the firm's prospects and investment opportunities».

Third, because VC firms' investment processes are so selective (Sahlman, 1990), the receipt of VC should convey positive information about the company which in turn will

[3]See Schmidt (2003).

[4]More precisely, we are comparing VC firms with French or Anglo-Saxon banks which pay less attention to monitoring companies than do German or Japan banks.

provide access to cheaper sources of financing (Manigart *et al.*, 2002a). Thus, the better the reputation of (*i.e.* the longer established) the VC firm, the stronger will be the signal to other investors at the time of IPO (Megginson and Weiss, 1991). On a sample of US IPOs in the period 1983-1987, Megginson and Weiss (1991), show that venture capitalists play a crucial certification role at the time of the IPO. For instance, compared to non-VC backed companies, VC backed companies are able to raise higher amounts of funds at IPO and are introduced by more prestigious underwriters (investment banks). According to Megginson and Weiss (1991), the presence of VC in the company's capital structure at the time of IPO is a guarantee of the quality of the IPO and therefore reduces underpricing. Jain and Kini (2000) show that US VC backed companies have access to more prestigious investment banks than non-VC backed companies and they find that this variable positively influences the post-IPO survival time of VC backed companies. In the case of the US (Megginson and Weiss, 1991 ; Jain and Kini, 2000) and the UK (Rindermann, 2003 ; Chahine *et al.*, 2007), there is evidence that venture-backed firms are underwritten by higher quality investment banks than their non venture backed counterparts. However, in France (Rindermann 2003 ; Chahine *et al.* 2007) and Germany (Rindermann, 2003), VC firms do not act as certification and there is no evidence that VC backed firms are underwritten by higher quality investment banks than non-VC backed companies.

Finally, the involvement of VC firms adds value to the innovative firm (Sahlman, 1990 ; Gompers and Lerner, 2004). For instance, involvement of venture capitalist firms can add value through close relationships with the managers of portfolio companies (Sapienza *et al.*, 1996). VC firms can engage in face-to-face interaction with managers and have involvement on the boards of VC backed companies (Sapienza and Gupta, 1994 ; Fried *et al.*, 1998), in the recruitment of top managers, and strategy development (Hellman and Puri, 2002). They can also give companies access to their professionals networks (Sapienza *et al.*, 1996). These benefits seem to apply to the case of the UK and the US, but not Continental Europe. For a sample of VC firms based in the US, the UK, the Netherlands, and France, Sapienza *et al.* (1996) find that US and UK VC firms are the most involved in their investments, and add the most value to these firms. Comparatively, French VC firms are the least involved and add the least value. Manigart *et al.* (1997) and Manigart *et al.* (2002b) show also that Continental European VC firms (Belgium, Netherlands, France) are less involved in their portfolio companies and exert relatively lower levels of effort in monitoring them than their counterparts in the US and the UK.

If we assume that VC firms perform their roles well and add real value to the companies they finance or at least are able to select the most promising firms, we can propose the following hypothesis :

H1a : VC backed companies should have a higher probability of survival than non-VC backed companies.

There are various arguments for hypothesizing the reverse relationship between VC firm involvement and the survival of VC backed companies.

ii. The negative impact of VC firms

First, the high rates of return reaped by venture capitalists are due to their also financing risky companies. The rates of return required by a set of VC firms (located in the US, the UK, Belgium, France and the Netherlands) vary between 36%-45% for the riskiest early-stage investments, and 26%-30% for less risky later stage developments (Manigart *et al.*, 2002b). Companies that seek VC backing are smaller, younger, more innovative and thus more risky firms. Therefore, despite their better short-run growth opportunities, VC backed companies are on average more risky, their probabilities of survival will be lower and their failure rates higher than non-VC backed companies (Dimov and De Clercq, 2006). According to Dimov and De Clercq (2006) failure rates for new ventures are around 40% in the first year, rising to 90% over 10 years.

Second, VC firms may be denied the opportunity to invest in the most promising companies. In a theoretical article, Amit *et al.* (1990) argue that US VC funds provided very low rates of return in the 1980s (the mean internal rate of return was less than 10% at the end of 1985) because they have only the opportunity to fund the less skilled entrepreneurs and less profitable ventures. As a result of the adverse selection problem associated with asymmetric information, only the less able entrepreneurs (*i.e.* the less profitable ventures) will choose to involve VC firms in their capital structures. According to Amit *et al.* (1990), this could explain the reported low average returns and high failure rates of new US ventures in the 1980s. Manigart *et al.* (2002a), on the other hand, argue that the high rates of return imposed by VC firms makes this source of finance very costly and that the best projects will seek funding from other, less costly sources. As a consequence, only second best projects apply for VC funding.

Finally, the development of post-investment activities takes time and the VC firm faces the strategic choice between extended involvement in the post-investment management of its portfolio companies (Elango *et al.*, 1995), and optimization of outcomes. VC managers have limited amounts of time and attention to devote to their portfolio companies (Gifford, 1997), and optimizing outcomes may be at the expense of some firms (Dimov and De Clercq, 2006). Finally, the efficient allocation of time may mean that VC managers have no involvement in the post-investment management of portfolio companies whose prospects of high or even adequate returns are not excellent, and which do not create good exit opportunities for the VC firm (Ruhnka *et al.*, 1992). These companies may be self-sustaining in economic terms, but not viewed as sufficiently profitable to produce attractive final rates of return to warrant the continued involvement of the VC investor. Such firms are described by Ruhnka *et al.* (1992) as "living dead" companies. Manigart *et al.* (2002a) show that VC firms may decide either to try to turn-around these "living dead" portfolio companies or to liquidate them in order to devote their scarce time to star performers. In this context, Sapienza (1992) finds that there is a positive correlation between US VC managers' involvement and the perceived performance of portfolio companies. Sapienza *et al.* (1996) provide evidence that VC managers may decide strategically to devote more time to their better performing portfolio companies in order to maximize the returns on their time (Manigart *et al.*, 2002a).

These arguments lead to the counter-intuitive hypothesis that :

H1b : VC backed companies will have a lower probability of survival than non-VC backed companies.

3 DATA DESCRIPTION AND METHODOLOGY

i. Selection and description of the data

The analysis uses individually collected data, based on listing prospectuses and the annual reports of French companies that went public on the "Nouveau Marché" between 1996 and 2002. The "Nouveau Marché" opened in 1996, to deal with innovative, high growth companies, and was discontinued in 2005[5]. Listing prospectuses contain detailed information on the financial and business situations of companies. This information is not confined to the IPO year, but includes the previous three years. We use these prospectuses and annual reports to derive quantitative information on several financial and business variables. We also collected data for one post-IPO year from companies' annual reports, and supplemented this with data from the DIANE (Van Dijk) database if annual reports were not available. Similar to the methodologies used by Jain and Kini (2000) and Coakley *et al.* (2007), our final sample does not contain transfers from other stock markets or market tiers, foreign-incorporated companies, spin-offs, registrations at the time of a relisting after a firm was temporarily suspended, and financial companies. Our final sample contains 139 companies that went public on the "Nouveau Marché" between 1996 and 2002.

In line with Jain and Kini (2000), we define survivors as firms that continue to operate independently as public corporations. Thus, firms delisted from the "Nouveau Marché" due to failure or an acquisition or merger are classified as non-survivors. In this paper, we then relax the assumption of homogeneous exit by accounting for the mode of exit, namely firm liquidation, or firm acquisition/merger. According to Schary (1991) there are important economic differences between the various forms of exit and, when studying firm survival, we need to consider and separate exit types. Following Manigart *et al.* (2002a) and Cockbrun and Wagner (2007), we consider that at the difference of an event of liquidation, being involved in a merger or acquisition may be positive. The date of delisting and mode of exit were collected from official reports available on NYSE Euronext website and the economic newspaper *Les Echos*.

ii. The variables

The dependent variable in the survival models is time to failure, which is measured as the time interval (in years) from IPO date to delisting date. Survival time is the period between 1996 (the date of first listing on the "Nouveau Marché") and the year in which the company exited through liquidation or merger/acquisition. Survival time is right censored to 2009 since for continuing firms we do not have a recorded exit event.

[5]There were no IPO between 2002 and 2005.

We relate survival probability to a set of conditions for individual companies at the time of IPO. Our main independent variable is VENTURE CAPITAL, which is a dummy variable that takes the value one if the IPO firm is VC backed and zero otherwise. VC backed IPOs are defined as IPOs with venture capitalist involvement at the time of IPO. We identified VC firms from various sources : European Venture Capital Association (EVCA), Association Française des Investisseurs en Capital (AFIC), the French equivalent of EVCA and through venture capitalists website.

There is a set of conditions known to affect the survival probability of firms, including firm age, firm size, and firm growth (Evans, 1987). Following Audretsch and Lehmann (2004) and Cockbrun and Wagner (2007) analysis of IPO firm survival, we define AGE as the difference in years between the founding date of the company and the date of its IPO. The size variable (SIZE) is a variable based on the value of total assets at the time of IPO. The difference in the number of the firm's employees one year before and one year after IPO is the GROWTH RATE (measured as the difference in the natural logarithm).

We include two independent variables PATENT and INTANGIBLES/ASSETS to take account of some of the firm's intangible assets. Based on the types of companies listed on the "Nouveau Marché", the potential for innovation (i.e. the stock of intangible capital) of these companies would seem important. Indeed, Baum and Silverman (2002) and Villalonga (2004) highlight the strategic role of innovation in business survival. The variable PATENT is a dummy variable that takes the value one if the IPO firm owns one or more patent at the time of IPO and zero otherwise[6]. Due to the limited availability of accounting data and especially R&D expenses[7], we calculate the ratio of intangible assets to total assets in order to take account of the nature of the assets (Hasan and Wang, 2008) and a proportion of the intangible assets owned by the company (Villalonga, 2004). The variable INTANGIBLES/ASSETS is the capitalized amount of goodwill, patents, licenses, software, brands and advertising divided by total assets.

In order to control for differences in technology sectors and their influence on the survival rates of firms, we include aggregated industry dummy variables for six different industry sectors, based on the Euronext classification and the APE codes (French code for the sectoral classification of companies). We defined six dummy variables for the following sectors : ITS (comprising Internet, IT services, E-Commerce and software), BIOMEDICAL (comprising biomedical and pharmaceutical sectors), MEDIAS and ENTERTAINMENT, TELECOMMUNICATIONS, TRADITIONAL (product and service), TECHNOLOGY (other high-technology and electronics products and services).

To control for time effects, we include the IPO date as a dummy variable for the years 1998, 1999 and 2000. These three dummy variables allow us to take account of the hot issue market period and its possible impact on firm survival.

[6]This variable should be interpreted with caution because some of the firms in our sample were not able to protect their innovations by patents at the time of IPO. In contrast to the US system, the EU and especially the French legal system does not allow firms (easily) to obtain patents on software.

[7]Bottazzi and Da Rin (2002) collected data on R&D expenditure for a set of five European new markets. They explain that their sample of firms was reduced by almost half due to the lack of data on R&D expenditure.

iii. Survival analysis methodology

We use a survival analysis methodology to analyze the impact of the involvement of VC in firm's survival. Survival analysis originated in the bio-medical sciences and more recently has been applied to business to analyze the economic performance of new-technology based firms (Storey and Tether, 1998). The advantage of survival analysis is that it overcomes the problem of inadvertent survivorship bias. Survival analysis allows us to take account of the most and the least promising firms, with very high or very low economic performance. In contrast to ordinary least square (OLS) or logit and probit models, survival analysis can predict whether and when an event will occur (Jenkins, 2005). Unlike logit or probit models, survival analysis allows us to assess the conditional probability of failure given that the company has survived so far. Thus, survival analysis can cope with right censored data which represents situations where a failure event has not yet occurred, and with time-series data with different time horizons (Jenkins, 2005). The IPO market we study is characterized by both situations (Jain and Kini, 2000). The data are right censored since at any point in time a proportion of the companies that went public are still listed. Further, the time window is different for each firm depending on when in the sample period it went public : in our sample, firms went public between 1996 and 2002. Finally, survival analysis allows us to apply a competing risk model to account for heterogeneity in firm exit. While the literature identifies survival as indicative of positive performance and exit as representing negative performance (Caves, 1998), the mode of firm exit also needs to be considered. Here we consider here that at the difference of an event of liquidation, being involved in a merger or acquisition may well be positive.

In order to compare the survival profiles of VC backed and non-VC backed IPO firms, we develop two sets of econometric models : we estimate a discrete time duration model and compute a competing risk model to account for heterogeneity in firm exit[8].

We focus on the survival time of the firm, which is a duration variable[9]. Let T be the number of years that our companies have survived up to 2009. The cumulative distribution function of the duration time T is denoted as F and is defined as :

$$F(t) = Pr(T \leq t) \text{ with } t \geq 0.$$

This function gives the probability that the duration T is less than or equal to t. In our case, it is the probability that a company is delisted before t years after its IPO. The value of t ranges between 0 and 13 years.

The survival probability is given by :

$$Pr(T > t) = 1 - F(t) \equiv S(t)$$

It describes the proportion of IPO firms that survive in each successive time interval. It provides the likelihood that a randomly selected IPO company will survive longer than t which is a specific time period.

Then, the hazard function $h(t)$ is the conditional failure rate defined as the probability of exit during a very small time interval assuming the firm has survived to the beginning

[8]We use the methodology in Fontana and Nesta (2009).

[9]These explanations are based on Jenkins (2005).

of that interval. The hazard function is defined in terms of the probability density function and the cumulative distribution function. The hazard function is given by :

$$h(t) = \frac{f(t)}{S(t)} = \lim_{\Delta t \to 0} \frac{Pr(t<T\leq t+\Delta t|T>t)}{\Delta t}$$

where Δt is a very small time interval. This conditional probability is the probability that exit occurs in the time interval $[t, t+\Delta t]$, based on no exit before the beginning of time t.

Following Fontana and Nesta (2009), in this study, we estimate a discrete time duration model for data grouped into intervals following the approach proposed in Prentice and Gloeckler (1978). The hazard rate function for firm i at time $t > 0$ with $t = 1, ..., T$, is assumed to take the proportional hazard form : $\theta_{it} = \theta_0(t).\exp(X'_{it}\beta)$ where $\theta_0(t)$ is the baseline hazard function and X_{it} is the vector of the model parameters (Sueyoshi, 1995). The discrete time formulation of the hazard of exit for company i in time interval t is given by a complementary log-log function such as :

$$log(-log(1 - h_t(X_{it}))] = X'_{it}\beta + \theta(t)$$

$$h_t(X_{it}) = 1 - \exp\{-\exp(X'_{it}\beta + \theta(t))\} \quad (1)$$

where $\theta(t)$ is the baseline hazard function relating the hazard rate $h_t(X_{it})$ at the th interval with the spell duration (Fontana and Nesta, 2009). The model parameters are estimated using the maximum likelihood method. The model we estimate is a complementary log-log model with a baseline hazard function defined by the logarithm of time. This complementary log-log specification has the advantage of being the discrete-time counterpart of an underlying continuous-time proportional hazards model (Cox model with a Weibull hazard function) (Jenkins, 1995).

Then, a complementary log-log model allows us to relax the assumption of homogeneous exit by accounting for the mode of exit, namely firm liquidation, or firm acquisition/merger. In order to take account of the mode of exit, we compute a competing risk model (CMR). A CMR is an extension of a standard duration model with the possibility of exit to one of several destination state (Jenkins, 2005). In practical terms, we estimate a complementary log-log model similarly to (1) but allowing the full set of parameters to vary according to the different destinations :

$$h_t(X_{ijt}) = 1 - \exp\{-\exp(X'_{it}\beta_j + \theta_j(t))\} \quad (2)$$

where $j = 1$ or 2 respectively, depending on the mode of exit (liquidation versus merger/acquisition) where the two destinations are treated as independent[10] (Fontana and Nesta, 2009). This model (2) can be estimated by a multinomial logistic CRM in which forms of exit can be treated as independent (Jenkins, 2005). In order to test whether each exit can be treated as independent of all other alternatives we perform a Hausman test for independence of the irrelevant alternatives test (IIA). Additionaly, we perform a Wald test to test if the different categorical exits can or cannot be combined.

[10]For more details on CRM, see Jenkins (2005).

4 EMPIRICAL RESULTS

i. Summary statistics and graphical analysis

Summary descriptive statistics for these explanatory variables are reported in table 1.

TAB. 1: descriptive statistics.

Variable	Observations		Mean		SD		Min		Max		Significant difference between VC and NVC
	VC	NVC	VC	NVC	VC	NVC	VC	NVC	VC	NVC	
Age (years)	87	52	9.44	8.44	6.26	4.75	1	1	30	21	
Growth rate	87	52	0.79	0.81	0.78	0.67	-0.75	-0.89	3.85	3.37	
Size	87	52	40.46	28.63	40.22	23.22	2.20	5.27	172.85	143.82	*
Patent	87	52	0.29	0.11	0.45	0.32	0.00	0.00	1.00	1.00	** (**)
Intangibles/assets	87	52	0.11	0.09	0.14	0.09	0.00	0.00	0.64	0.35	

Notes : All firm level variables take the values at the time of the firm IPO. *** Significant at 1% ; ** significant at 5% ; * significant at 10%. A Student's t-test and a (non-parametric Mann-Whitney tests) are conducted for testing the differences in mean (median) between VC and non-VC backed companies.

Our sample contains 87 VC backed and 52 non-VC backed companies that went public on the "Nouveau Marché" in the period 1996-2002. The average age and growth rate of VC and non-VC backed firms is fairly equivalent. VC backed firms on average are larger than non-VC backed firms. The most important difference between the two types of firms is for the dummy variable PATENT. Firms that are financed by one or more venture capitalists are on average more innovative than others.

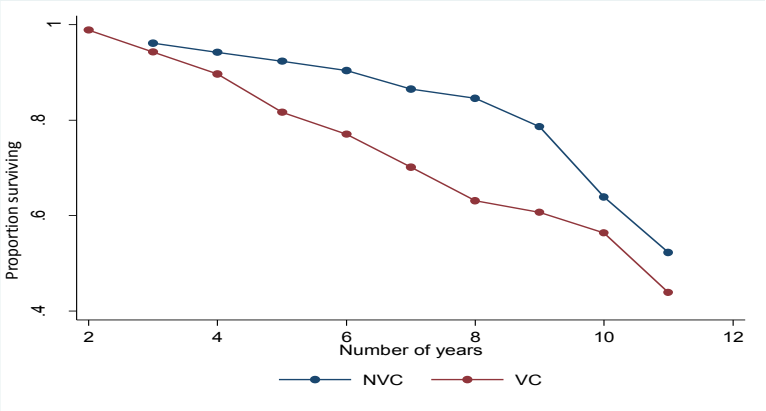
In order to test for differences in survival because of the presence of VC firms, we compare the survival functions of the group of VC backed firms with the group of non-VC backed firms. If VC involvement positively influences the survival profile of IPO firms, we would expect the survival function curve of VC backed firms to be above that of non-VC backed firms.

This graphical analysis indicates that VC involvement negatively influences the survival profile of IPO issuers[11]. If we compare the survival rates of the group of non-VC with the group of VC backed firms (see Table 5 in the appendix), we obtain that in general, survival rates decrease by about 3% in the 5-year period and by about 22% in the 10-year period. For non-VC backed firms, the percentage of firms that exited during our period of observation was 20.68, compared to 22.54 for VC backed firms. In almost every year, the estimated survival rate for VC backed firms was lower than for non-VC backed firms. Over time, these differences between groups increase as the survival rates of the two groups follow divergent paths[12]. These first results tend to support the hypothesis H1b and indicate a negative influence of the involvement of VC firms on firm survival.

[11]This graphical analysis is confirmed by the Wilcoxon test. The Wilcoxon test indicates a significant difference in survival functions among the two categories of firms (Pr>Chi2= 0.0816).

[12]See life-table estimates of survival rates presented in appendix Table 5.

FIG. 1: Survival function of VC and non-VC backed firms.



We corroborate these first results through multivariate analysis.

ii. Determinants of firm survival

In all the regressions, we consider 139 companies, 61 of which eventually exit the "Nouveau Marché". All firm level variables take the values at the time of firm's IPO. All duration models include a full vector of the industry dummy variables. Expanding the dataset by time intervals yields a total of 1155 observations[13].

A positive coefficient increases the value of the hazard function and indicates that the particular covariate increases the likelihood of the firm being delisted and thus reduces its trading period. A negative coefficient decreases the likelihood of the firm being delisted and increases its probability of survival.

We estimate five models using a discrete time duration model with a Weibull hazard function (see Table 2). In the first model we look at the impact of time duration on the hazard rate of exit. We then sequentially add AGE, SIZE and GROWTH RATE (model 2), VENTURE CAPITAL (model 3), PATENT (model 4) and INTANGIBLES/ASSETS (model 5).

The coefficient for AGE indicates that firm age always has a statistically significant and positive effect on survival, confirming the findings in the literature. In particular, age increases the expected survival time of a firm by 6% on average. The effect of growth rate is significantly positive in all models, increasing the expected survival time of a firm by 44% on average. The effect of size is only significantly positive in model 5 and with a

[13]These results are robust to alternative specifications of the hazard rate function (Table 6 in appendix) and to the inclusion of firms' unobserved heterogeneity (Table 7 in appendix).

Tab. 2: Duration model : complementary log-log

	(1)	(2)	(3)	(4)	(5)
Time(log)	0.719***	0.767***	0.807***	0.807***	0.872***
	[0.222]	[0.225]	[0.227]	[0.227]	[0.233]
Age (years)		-0.055*	-0.059**	-0.061**	-0.064**
		[0.028]	[0.028]	[0.029]	[0.029]
Growth rate		-0.429**	-0.438**	-0.438**	-0.440**
		[0.205]	[0.200]	[0.201]	[0.206]
Size (assets millions euros)		-0.005	-0.007	-0.007	-0.009*
		[0.005]	[0.005]	[0.005]	[0.005]
Venture Capital(dum)			0.653**	0.649**	0.620**
			[0.313]	[0.313]	[0.313]
Patent				0.119	0.238
				[0.416]	[0.426]
Intangibles/assets					2.448**
					[1.085]
Year 1998	1.151***	1.181***	1.270***	1.262***	1.289***
	[0.434]	[0.434]	[0.436]	[0.436]	[0.439]
Year 1999	0.370	0.506	0.585	0.560	0.572
	[0.513]	[0.520]	[0.520]	[0.527]	[0.526]
Year 2000	1.008**	1.152**	1.363***	1.339***	1.359***
	[0.454]	[0.481]	[0.495]	[0.502]	[0.506]
Constant	-4.983***	-4.220***	-4.680***	-4.720***	-5.234***
	[0.726]	[0.773]	[0.863]	[0.874]	[0.918]
Observations	1155	1155	1155	1155	1155
Nomber of firms	139	139	139	139	139
Number of exits	61	61	61	61	61
Log Likelihood	-227.721	-222.991	-220.679	-220.638	-218.373
Chi-square	22.077***	31.538***	36.162***	36.243***	40.774***
LR Chi-Square		9.461	4.624	0.081	4.530
Prob LR Chi-Deux		0.024	0.032	0.776	0.033

Number of observations : 1155. Discrete time duration model with Weibull hazard function. Standard errors in brackets. *** Significant at 1% ; ** significant at 5% ; * significant at 10%. All duration models include a full vector of sector dummy variables, not reported here for clarity.

marginal effect.

The variable PATENT shows no statistically significant effect but the coefficient of INTANGIBLES/ASSETS has a significant positive sign, suggesting that possessing a higher stock of intangible capital increases the probability of being delisted. However, it should be noted that this result may be due to the fact that a high stock of intangible capital may be an attractive asset for potential acquirers of the firm (Chaudhuri and Tabrizi, 1999). So, we have to consider the different modes of exit in order to mitigate our results and to have a better understanding of the role of this variable on firm exit.

Industry sectors never exert a statistically significant influence on survival. Dummy variables for the years 1998 and 2000 have a negative and statistically significant influence on firm survival.

The direct effect of the presence of venture capitalists on firm survival is expressed by the coefficient of the dummy variable VENTURE CAPITAL. This variable is always statistically significant and has a negative effect on survival. Being financed by one or more VC firm decreases expected survival time by 86% compared to non-VC backed firms. Clearly VC involvement negatively influences the survival profile of IPO firms. Our findings validate the hypothesis H1b but do not support hypothesis H1a of a positive influence of VC firms on survival. Our results are in line with those in Audretsch and Lehmann (2004) and Manigart *et al.* (2002a) for Germany and Belgium but not with those obtained by Jain and Kini (2000) and Cockbrun and Wagner (2007) for the US. Thus, our study reinforces the difference between US and European VC industries in terms of performance.

However, these results lead to the following question : is this negative effect of the presence of VC on firm survival the result of an exit through a merger/acquisition or through liquidation ? Being involved in a merger or acquisition may well be positive in contrast to liquidation. In order to have a better understanding of the role of VC firms in the financing and the performance of innovative companies, we relax the assumption of homogeneous exit by accounting for the mode of exit, that is, firm liquidation or firm acquisition/merger. We want to distinguish between these modes of exit in order to discover what determines firm liquidation and firm merger/acquisition.

iii. Determinants of mode of exit

Of the 139 companies that went public on the "Nouveau Marché" between 1996 and 2002, 78 (56.12%) still operating in 2009 ; 22 (15.83%) had exited through liquidation (*i.e.*, they failed) and 39 (28.05%) had been acquired by or merged with a third party.

We start our second empirical investigation by accounting for these different types of exit : by either liquidation or merger/acquisition. Table 3 reports the results for the multinomial logistic competing risk model.

Column (1) reports the results for the comparisons between the alternatives of exiting by merger/acquisition and surviving. Results of the comparison between exit by liquidation, and survival are reported in column (2). Column (3) compares the two alternatives

TAB. 3: Competing risk model : the determinants of the exit forms

	(1)	(2)	(3)
Time(log)	0.950***	0.875**	0.075
	[0.303]	[0.394]	[0.491]
Age (years)	-0.029	-0.129**	$0.099^{(a)}$
	[0.036]	[0.055]	[0.065]
Growth rate	-0.769**	-0.081	$-0.688^{(b)}$
	[0.307]	[0.302]	[0.425]
Size (assets millions euros)	-0.022**	0.001	-0.023**
	[0.009]	[0.006]	[0.011]
Venture Capital(dum)	0.416	1.005*	-0.589
	[0.395]	[0.575]	[0.688]
Patent	0.053	0.734	-0.680
	[0.577]	[0.719]	[0.908]
Intangibles/assets	3.281**	1.618	1.663
	[1.400]	[2.025]	[2.417]
Year 1998	1.177**	1.777**	-0.600
	[0.554]	[0.809]	[0.968]
Year 1999	0.640	0.611	0.029
	[0.649]	[0.973]	[1.159]
Year 2000	1.685***	0.986	0.699
	[0.638]	[0.932]	[1.118]
Constant	-4.883***	-25.864	19.981
	[1.123]	[0.000]	[0.000]
Observations	1155	1155	1155
Log likelihood	-248.470		
Hausman Test	0.599	0.290	
Wald Test (Combined)	26.297**	10630.597***	396.114***

Number of observations : 1155. Competing risk duration model. Standard errors in brackets. *** Significant at 1% ; ** significant at 5% ; * significant at 10%. All duration models include a full vector of sector dummy variables, not reported here for clarity.
(1) M&A *versus* Survival
(2) Liquidation *versus* Survival
(3) M&A *versus* Liquidation
Hausman test : the hypothesis H0 for independence of irrelevant alternatives test (IIA) is accepted.
(a) : p= 0.126 and (b) : p=0.106.

of exiting by merger/acquisition and exiting by liquidation.

Before discussing these results, we need to test for the existence of significant differences in exit types. The Hausman test of independence of irrelevant alternatives (IIA) implies that the outcomes "merger/acquisition and "survival (column 1) and the outcomes "liquidation and "survival (column 2) are independent of the third alternative. Next, the results for the Wald test are in line with the Hausman test. As a consequence, there are significant differences in the factors that drive the various outcomes in general, and between liquidation and acquisition outcomes in particular.

From the parameter estimates in column (1), we can see that GROWTH RATE and SIZE have a negative and significant coefficient, suggesting that larger firms and firms with higher growth rates have higher probabilities of surviving than of exiting by merger/acquisition. These results for firm size and firm growth are in line with those in Botman *et al.* (2004) and Fama and French (2004) for the US market. The coefficient of INTANGIBLES/ASSETS indicates that firms with high stocks of intangible assets (in total assets) have a higher probability of exiting by a merger/acquisition than of surviving. Thus, those companies that were merged or acquired during mainly the years 1998 and 2000, are comparatively smaller than those firms that survived, they have lower growth rates but a higher ratio of intangibles (in total assets). Firms with large stocks of intangibles may represent a threat but also an opportunity for larger firms to acquire valuable intangible capital and distinctive skills (Fontana and Nesta, 2009). Intangibles are difficult to acquire or develop (Villalonga, 2004) which makes patents, licenses, brands and other intangible assets attractive in highly competitive sectors such as ITS Chaudhuri and Tabrizi 1999).

From the parameter estimates in column (2), we see that AGE has a negative and significant coefficient indicating that younger firms have a higher probability of exiting by liquidation than of surviving. This result is in line with that obtained in Esteve-Pérez *et al.* (2010) in that younger companies have a higher probability of exiting by liquidation than of surviving. Our result is similar to the result in Cockbrun and Wagner (2007) that older firms at the time of IPO have a lower probability of being liquidated whereas age has no effect on the probability of exiting by merger/acquisition in comparison to surviving.

The positive significance of VENTURE CAPITAL in column (2) is interesting. The positive parameter estimate suggests that firms that are financed by VC firms have a higher probability of exiting by liquidation than of surviving. VC backed companies have a 2.73 times higher probability of being liquidated than of surviving. This result is comparable to that obtained by Manigart *et al.* (2002a) for Belgium which shows that VC backed companies have a higher probability of not surviving due to negative events (bankruptcy and closure). However, this result contrasts with that obtained by Cockbrun and Wagner (2007) for the US that VC backed firms have a higher probability of exiting by merger and acquisition than of exiting by liquidation when there is an exit event. In the case of France, it seems that the negative aspects linked to financing by a VC firm overcome the positive aspects : not only do VC backed companies have lower survival rates but, they also have a higher probability of being liquidated than of staying on the market. This result leads to the following questions : is this result anecdotal ? Is VC financing really decisive in explaining the probability of exiting by liquidation ?

To answer these questions, we compute the marginal effects of all the significant variables. Table 4 displays the predicted probability of each mode of exit[14]. We observe that for the median firm at the average IPO year, the overall liquidation rate is 0.3%, the probability of merger/acquisition is 2.07% and the survival probability is 97.63%[15].

At first sight, the overall probability of exit, either by liquidation or by merger/acquisition, seems low : the median firm has nine in ten chances of continuing to operate independently as a public listed company. Comparing this result with the overall exit rate for the whole period 1996-2002 suggests the presence of large effects at the margin for each independent variable. Following the methodology in Fontana and Nesta (2009), we compute the marginal effects of all the significant variables. Again following Fontana and Nesta (2009), we compute the discrete change in the predicted probability by imputing a variation of two quintiles around the median value of each continuous variable (i.e. from the 30th to the 70th) percentile holding all other variables constant. For the dichotomous variable VENTURE CAPITAL, we compute the discrete change from being non-VC backed to being VC backed. All changes are reported as absolute and relative changes in probability[16].

We observe first that all our significant variables have a large effect at the margins, and second, that the marginal effect of VENTURE CAPITAL confirms that the presence of VC firms is a determinant of the mode of exit. Receiving finance from one or more VC firms multiplies the hazard rate of exiting by liquidation by a factor of 2.6 : for a VC backed company, then, the probability of exit is three times as high as for a non-VC backed company[17]. Thus, the influence of VC involvement on firm survival is not anecdotal ; VC investors play a decisive role in determining a firm's survival and exit probabilities.

In our view, possessing a high stock of intangible assets (over total of assets) could also be an explanation for why a firm exits as the result of a merger/acquisition rather than liquidation, compared to staying in the market, while venture capital involvement is a more dominant reason for why a firm exits as the result of a liquidation rather than merger/acquisition compared to staying in the market.

Our analysis has the following empirical implications and contributes to the literature on VC and the effect on firm survival. Our analysis of the performance of French VC investors and their impact on the survival time of French innovative companies shows that although the French VC industry is one of the most dynamic in Europe, this dynamism does not imply good performance. If we compare the performance of the French VC industry to those in other European countries and the US, we see that the performance of the French VC industry is closer to performance in Europe than in the US. The European

[14]According to Fontana and Nesta's (2009) methodology, we compute the predicted probability using the median values of the continuous variables (time, age, growth rate, size, intangibles/assets) and the mean values of the dichotomous variables (venture capital, IPO year, sector dummy variables). All the marginal effects are computed as discrete change, holding all the other independent variables constant at their mean or median values.

[15]Note that the sum of the predicted probabilities equals unity.

[16]Note that we can compute the marginal effects of all the significant variables for the first discrete time duration model using a Weibull hazard function.

[17]If we compute the marginal effects for the complementary log-log model, we find that being financed by one or more venture capital firms multiplies the hazard rate of leaving the market by a factor of 1.8.

Tab. 4: Marginal effects of firm-level variables on the mode of exit

Predicted probability	M&A	LIQUIDATION	SURVIVING
	0.0207	0.0030	0.9763
TIME			
Predicted at the 30th percentile	0.0193	0.0022	0.9785
Predicted at the 70th percentile	0.0421	0.0045	0.9534
Absolute change	+ 0.0228	+ 0.0023	- 0.0251
Relative change	+ 118.13%	+ 104.54%	- 2.56%
AGE			
Predicted at the 30th percentile	0.0337	0.0049	0.9614
Predicted at the 70th percentile	0.0285	0.0023	0.9692
Absolute change	- 0.0052	- 0.0026	+ 0.0078
Relative change	- 15.43%	- 53.06%	+ 0.81%
GROWTH RATE			
Predicted at the 30th percentile	0.0374	0.0034	0.9592
Predicted at the 70th percentile	0.0241	0.0033	0.9726
Absolute change	- 0.0133	- 0.0001	+ 0.0134
Relative change	- 35.56%	- 2.94%	+ 1.39%
SIZE			
Predicted at the 30th percentile	0.0370	0.0033	0.9596
Predicted at the 70th percentile	0.0220	0.0035	0.9745
Absolute change	- 0.015	+ 0.0002	+ 0.0149
Relative change	- 40.55%	+ 6.06%	+ 1.55%
VENTURE CAPITAL			
VC =0	0.0244	0.0019	0.9738
VC =1	0.0364	0.0050	0.9586
Absolute change	+ 0.012	+ 0.0031	- 0.0152
Relative change	+ 49.18%	+ 163.15%	- 1.56%
INTANGIBLES/ASSETS			
Predicted at the 30th percentile	0.0282	0.0032	0.9685
Predicted at the 70th percentile	0.0394	0.0038	0.9568
Absolute change	+ 0.0112	+ 0.0006	- 0.0117
Relative change	+ 39.71%	+ 18.75%	- 1.20%

The predicted probability is computed using the median values of the continuous variables (time, age, growth rate, size, intangibles/assets) and the mean values of the dichotomous variables (venture capital, IPO year, sector dummy variables). All marginal effects are computed as discrete change, holding all other independent variables constant at their mean or median values.

VC industry seems to be quite homogeneous in terms of performance.

Our findings have implications for the French VC industry. It is believed that VC firms fulfill a valuable role in the economy because they are financial institutions that provide funding and expertise specifically to innovative companies. However our results do not indicate that VC firms make a positive contribution in terms of survival of funded firms. We need to encourage greater professionalism among French VC firms in order to improve their selection, monitoring and value adding performance.

5 CONCLUSION

This paper analyses the survival of a unique sample of 87 VC backed and 52 non-VC backed companies that went public on the "Nouveau Marché" in the period 1996-2002. We looked at firms' hazard rates by considering exit as a homogeneous event. In line with studies on Germany and Belgium (Audretsch and Lehmann, 2004 ; Manigart *et al.*, 2002a) but in contrast to findings for the US (Jain and Kini, 2000 ; Cokbrun and Wagner, 2007), we find that receiving VC does not improve the survival profiles of IPO firms. Receiving VC funding is negatively related to the duration of the period of listing on the "Nouveau Marché". We extended our analysis to the case of heterogeneous exit (*i.e.* by liquidation versus merger/acquisition). Contrary to the Cockbrun and Wagner's (2007) findings, our results show that VC involvement improves the probability of IPO firms being liquidated rather than continuing to operate independently as public listed companies.

Our study has some limitations. First, we focus on the most successful companies that went public ; our data do not cover all the companies financed by VC firms in the period 1996-2002. Second, the bubble period of 1998-2000 figures is included in our period of analysis perhaps has led to some overestimation of the poor survival of VC backed firms. However, our period of analysis is comparable to that in Audretsch and Lehmann (2004) for Germany and Cokbrun and Wagner (2007) for the US, therefore, this cannot be the main reason for VC backed firms showing a lower probability of survival than non-VC backed firms.

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APPENDIX

Tab. 5: Survival rates by sample (%)

Year	VC	NVC
1	99.98	100
2	99.13	99.48
3	98.31	99.19
4	96.58	98.84
5	95.39	98.43
6	93.15	97.40
7	90.23	96.73
8	88.87	93.87
9	85.62	84.79
10	77.46	79.32
Number of firms	87	52
Number of exits	41	20
Percentage of failures	22.54	20.68

Note : Life-table estimates of survival rates.

Tab. 6: Hazard rate functions

	(1)	(2)	(3)	(4)
Age (years)	-0.064**	-0.064**	-0.064**	-0.066**
	[0.029]	[0.029]	[0.029]	[0.030]
Growth rate	-0.440**	-0.440**	-0.452**	-0.456**
	[0.206]	[0.206]	[0.208]	[0.216]
Size (assets millions euros)	-0.009*	-0.009*	-0.009*	-0.009*
	[0.005]	[0.005]	[0.005]	[0.005]
Venture Capital(dum)	0.620**	0.618**	0.590*	0.628*
	[0.313]	[0.313]	[0.314]	[0.322]
Patent	0.238	0.234	0.297	0.237
	[0.426]	[0.426]	[0.424]	[0.445]
Intangibles/assets	2.448**	2.439**	2.461**	2.512**
	[1.085]	[1.088]	[1.090]	[1.141]
Year 1998	1.289***	1.263***	1.312***	1.339***
	[0.439]	[0.441]	[0.466]	[0.454]
Year 1999	0.572	0.541	0.478	0.586
	[0.526]	[0.529]	[0.549]	[0.542]
Year 2000	1.359***	1.322***	1.343**	1.413***
	[0.506]	[0.510]	[0.530]	[0.522]
Constant	-5.234***	-5.326***	-15.288	-5.291***
	[0.918]	[0.976]	[640.750]	[0.953]
Link function	C log-log	C log-log	C log-log	Logit
Hasard function	Weibull	Polynomial	Non Par.	
Observations	1155	1155	1127	1155
Number of firms	139	139	139	139
Number of exit	61	61	61	61
Log Likelihood	-218.373	-218.919	-211.406	-218.399

Number of observations : 1155. Standard errors in brackets. *** Significant at 1% ; ** significant at 5% ; * significant at 10%. All duration models include a full vector of sector dummy variables, not reported here for clarity. Baseline Hazard Function : : (1) log of time (Weibull) ; (2) polynomial of order 2 ; (3) fully non parametric ; (4) logit model.

Tab. 7: Unobserved heterogeneity

	(1)	(2)	(3)
Age (years)	-0.066**	-0.068**	-0.067*
	[0.031]	[0.032]	[0.037]
Growth rate	-0.474**	-0.489**	-0.605
	[0.229]	[0.237]	[0.378]
Size (assets millions euros)	-0.009*	-0.010*	-0.011
	[0.006]	[0.006]	[0.007]
Venture Capital(dum)	0.656*	0.669*	0.761*
	[0.335]	[0.345]	[0.460]
Patent	0.246	0.243	0.247
	[0.462]	[0.480]	[0.592]
Intangibles/assets	2.567**	2.646**	2.892*
	[1.190]	[1.250]	[1.608]
Year 1998	1.391***	1.445***	1.724**
	[0.483]	[0.498]	[0.820]
Year 1999	0.606	0.625	0.741
	[0.561]	[0.578]	[0.726]
Year 2000	1.499***	1.552***	2.044*
	[0.559]	[0.575]	[1.193]
Constant	-5.613***	-5.657***	-6.306***
	[1.061]	[1.089]	[1.928]
Link function	C log-log	Logistic	C log-log
Hasard function	Wweibull	Weibull	Weibull
Observations	1155	1155	1155
Number of firms	139	139	139
Number of exit	61	61	61
Log Likelihood	-218.373	-218.399	-218.013
LR test for frailty	0.302	0.302	0.198

Number of observations : 1155. Standard errors in brackets. *** Significant at 1% ; ** significant at 5% ; * significant at 10%. All duration models include a full vector of sector dummy variables, not reported here for clarity. Distribution of Unobserved Heterogeneity : (1) et (2) Normal ; (3) Gamma.