Patenting behavior prior to IPO and the survival of European software firms in the aftermarket

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Abstract

The aim of this empirical study is to test whether the Pre-IPO firm characteristics impacts the likely of software companies (USSIC 737) to survive after their IPO in 6 European markets. We examine the characteristics of software firms undertaking IPOs, using firm level data from Bureau van Dijk's Zephyr database, Questel-Orbit QPAT patent database, financial documents available on the company's websites and specialized websites. This study collects all the software's IPOs deals from the United-kingdom, Germany, France, Sweden, Italy and Spain from 1st January 1997 to 31st December 2005 in Bureau van Dijk's Zephyr database. To estimate the probability to survive, this study uses a semi-parametric approach, based on competing risk stratified Cox model, controlling for other determinants of survival. Results suggest that characteristics at IPO (experience, patent behavior, sales, profitability and solvability ratios but also market conditions) are related with different modes of exit aftermarket. Research findings reflect that additional patent applications before IPO reduce the risk of exiting through both mechanisms. In contrast, the quality of the patent portfolio increases the attractiveness of a European software company as an acquisition target while reduce the hazard rate of exit through business failure.

Keywords: European software firms, patent metrics, Initial Public Offering (IPO), survival, Start-ups.

1. Introduction

Literature considers Initial Public Offerings (IPOs) as an important event in a firm's life cycle. Small companies usually go public for several reasons related to their growth as for example to improve their innovative capabilities through raising a high amount of cash which help to finance valuable projects, capture a first-mover advantage, and facilitate takeover activity, among others (see Ritter and Welch 2002; Brau and Fawcett, 2006). IPO can also help the firm to attract other valuable resources as a more skilled and versatile workforce and alliance partners capable to support rapid innovation process and the post-IPO performances. In addition, IPO also gives venture capitalist (VCs) the opportunity to exit (Black and Gilson, 1998) and remunerate entrepreneurship activity.

IPOs are also related with new firm's challenges and threats capable to affect overall level of innovative activity, the firm's organization and its survival. Innovative companies going public are involved in exploratory search projects which are usually unprofitable and highly risky. Through IPO they improve their access to funding but at the same time they are confronted to multitude of new requirements that leads to decreased management flexibility and an increased need to manage shareholders' earnings expectations (Wu, 2011). In this context, the last years have been characterized by an unprecedented decline in the quality of high-tech firms going public (Peristiany and Hong, 2004) while their number remarkably increased. The market euphoria

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reached its height on the dot-com in 2000 during which the equity value in stocks markets of industrialized nations rose rapidly as well as the number of IPOs. As a consequence, a considerable number of highly risky firms went public while they were usually unprofitable, unsolvable, with complex business models and poor business plans. However, after their IPO many of these companies were quickly delisted because they were acquired, come into a bankruptcy, or their stock price collapsed (Peristiany and Hong, 2004; Fama and French, 2004, Wagner and Cockburn, 2010). Thus, firms' characteristics at IPO may be strongly related with the firm survival in the new market environment.

The aim of this empirical study is to test whether pre-IPO characteristics of a European software companies are related with their future likelihood to survive after IPO while paying attention to the different mechanisms of exit. Thus, this empirical study addresses a double gap concerning the value and nature of different firms' characteristics at IPO observing software aftermarket survival in Europe. The first inquiry is: do patents improve the probability to survive of European software companies after their IPOs? The number of patents studies dealing with software companies is quite limited and particularly underdeveloped, primarily due to the paucity of data and because historically software industry had a weak patent protection (Mann and Sager, 2007; Bessen, 2003; Bessen and Hunt, 2007). This is particularly true for the European software industry because computer programs "as such" are excluded from patentability in Article 52(3) of the EPC. However a growing number of software companies in Europe are filling patents that include a large number of inventions in this field (Rentocchini, 2011). The second inquiry is: what is the value of pre-IPO firm's characteristics and market conditions as predictors of aftermarket survival in Europe? Over the past few years, scholars, industrials and policy makers have claimed to improve the framework conditions to support growth of European SMEs and European innovators. It is usually claimed that in the European software industry there are few success stories (NESSI, 2008; Syntec informatique, 2008). In fact, software companies founded in Europe have rarely become large global leaders. Even more, generally European SMEs have serious problems to growth and there are few medium-sized firms and young large leading innovators comparing with the US (Veugelers and Cincera, 2010). In this way, factors improving the survival of software IPOs could be important to improve European software firm's performance, growth and success.

This paper seeks to provide new evidence concerning the impact of different software firms' metrics as predictors of aftermarket survival in Europe while considering that firms face a risk of acquisition and a risk of failure jointly. For this purpose, we match software firms' IPO information (USSIC737) from Bureau van Dijk's Zephyr database with patent information from Questel-Orbit QPAT database. Then, we asset the fundamentals of software companies that went public in 6 European countries (United-kingdom, Germany, France, Sweden, Italy and Spain) from 1997 to 2005. During those years, new highly risky firms with poor business plans, had access to liquidities to support its business development through going public in Europe. European software companies going public were particularly risky, display signals of financial weakness and inexperience at IPO. Thus, 2/3 of the software companies going public were young (less of 10 years of experience at IPO) and 1/2 were small companies (less of 10 million of revenues). It is also remarkable the high number of unprofitable and unsolvable software companies going public in European markets. Then, 47% of the software IPOs companies declare looses on the previous year at IPO. As a result, it seems that this fragility exposed by European software companies at IPO is related with their aftermarket performance in terms of survival. Besides, the influence of the pre-IPO characteristics on firms' survival is different depending of different type of exit. Successfully software companies in terms of financial ratios have also lower failure rates in a short duration. Similarly, patenting prior to IPO improves the survive likelihood but highly quality patent portfolio increase the risk of acquisition while reduce the risk of failure.

The paper is organised as follows: Section 2 reviews the theoretical and empirical studies on the factors that influence firm exit aftermarket by failure or M&A. Section 3 briefly summarizes previous findings on patenting in the software industry, focusing in Europe. Section 4 describes the data used to construct our dataset. Section 5 present the methodology applied for the estimation of survival probability and we present the empirical results in section 6. Finally, section 7 concludes and discusses some implication of our findings.

2. Firm characteristics, innovation and survival after IPO

Innovation and firm life-cycle literature have broadly contributed to the analysis of different processes influencing the growth and the failure of firms. Empirical evidence has shown that firms' characteristics are related with market entry and exit rates. It is commonly argued that exit rates decline with firm age and size (Evans 1987; Dunne et. al., 1989; Audretsch, 1991; 1995) and financial fragility (Klepper, 1996; Cooley and Quadrini, 2001). Survival rates of new firms also vary systematically across industries and regions (Dunne et. al., 1989; Audretsch, 1995) and they are related with the firms' ability to learn about their market environment (Gerosky, 1995).

The roles of different selections mechanisms of heterogeneous firms and learning process have been also wildly analysed. Nelson and Winter (1982) postulates that through innovative and imitative investments, firms attempt to boost their relative position in the distribution of productivity levels and their chances of success in the competition process. Hall (1997) observes that R&D intensity expenditure increases firms' survival. Similarly, Ericsson and Pakes (1998) suggest that firms which actively invest in research improve their efficiency, profitability and their chances of survival. Christensen et al. (1998) for the hard disk industry show that architectural innovation reduces the firm's likelihood of exit. Perez et al. (2004) suggest that performing R&D improves the competitive position and survival of Spanish manufacturing firms. Cefis and Marsili (2006) found that innovation has a positive and significant effect on the probability of firms' survival of manufacturing firms in the Netherlands. They found that innovation is particularly important for survival of young and smaller firms. Concerning patent behavior, Audretsch and Lehmann (2004) found that the number of patents, the firm's human capital (board of directors), and the firm size improve the likelihood of survival of firms from various industries listed on the German Neuer Markt. Wagner and Cockburn (2010) have shown that patenting was positively associated with survival for US internet related IPOs at the height of the stock market bubble of the late 1990s. They argue that patents conferred competitive advantages that increase the probability of survival.

Financial and Managerial literature has also extensively contributed to the analysis of firm survival. The literature has shown important differences between M&A and other mechanisms of exit. Thus, bankruptcy and voluntary liquidation are usually considered as forms of firm failure while the circumstances or characteristics that promote the acquisition of a company are different (Peel and Wilson, 1989; Schary, 1991). Through the analysis of different mechanisms of exit, literature has highlighted that the relationship between innovation and survival is more complex than a simple positive effect. Thus, some recent empirical studies has shown that through innovation firms increase their stock of knowledge and capabilities and as a consequence their attractiveness as acquisition targets (Cefis and Marsili, 2007; Wagner and Cockburn, 2010). Indeed, firm's knowledge and capabilities can be regarded as strategic assets which improve firm's performance (Nelson & Winter, 1982; Winter, 1987) reducing the risk of failure and increasing the risk of acquisition. This finding may be particularly important in a context in witch large firms (but not only) expand their own portfolios of patents in response to potential hold-up problems in markets for technology (Ziedonis, 2004). Thus, it can be expected that in the presence of markets for technology with highly fragmented ownerships, as in the software industry, the quality of the patent portfolio increases the attractiveness of a company as an acquisition target. A company with highly quality patents may be an attractive acquisition target for many companies interested for several reasons related with those patents as for example the exploitation of cross-licensing agreements, reduce hold-up problems and improve their bargaining power.

Thus, there is little evidence about the mechanism related with the survival of the European software companies after the Dot.com Boom and the financial instability characterising the last decade. As similar, little is known about the relationship between patents and survival of software companies, especially in Europe. The value of patents in the software industry has been widely documented but there if little evidence related to firms' survival. Indeed, software is a complex and cumulative technology characterised by very fast technical change and short effective life on innovation. In this context, patents may be characterized by a lower effectiveness for preventing imitation but may have different potential effects on firm's performance. Next section, summarize the controversies related with patenting in the software industry.

3. Patenting in software industry

The software industry is relatively young high innovative industry which has driven much of the innovation in other industries in recent decades. However, the role of patents in software industry is a historically highly controversial issue for academics, industrials and policy makers.

Since its origins, in the mid-1960s (Campbell-Kelly, 2003), the software industry emerged without patents, under a "weak IP regime"[2] (Dosi et al. 2006). At that time, the few companies producing software protects their IP mostly through copyrights and US courts considers software as a "concatenation of unpatentable algorithms" (Cohen and Lemley, 2001). However, under the pressures of some segments of the industry, a number of judicial and administrative decisions have established a more "expansive approach to the breadth and strength of software patents" (Mann and Sager 2007). In particular, conditions for obtaining software patents were relaxed after the 1981 Supreme Court's decision in "Diamond vs. Diehr" which considers patentable inventions with new and nonobivous aspects that did not consist entirely on software. Additionally, real differences in patentability of software and other inventions were eliminated after the appeals court decision "In re Alapat" in the 1994 (Bessen and Hunt, 2004). Thereafter, companies interested in software patents needed only to define their claims in terms of computer programs implemented in a machine (Cohen and Lemley, 2001). Thus, the number software patents increased spectacularly. However, the vast majority of software patents don't come from software industry but from manufactures (Bessen and Hunt, 2004).

Literature has shown that effectiveness of patents which varies across firms and industries is related to the specificities of the technology and the R&D process, as well as on the nature of the market and on the patterns of competition (for a nice description see: Orsenigo and Sterzi, 2010). Indeed, software is a complex and cumulative technology in which new products and process are composed of several component innovations from different firms. Complex technologies are naturally more difficult to replicate and consequently the value of a patent to prevent imitation is lower (Roycroft and Kash 1999; Kingston 2001). The software industry is also characterised by very fast technical change and short effective life on innovation. As a consequence, patents may not adequately reward innovators, especially if the grant procedure is long (Orsenigo and Sterzi, 2010). In the software industry, firms commonly use a combination of different mechanisms to

[2] This point is also controversial, Mann (2005) and Merges (1996) consider that "United States has traditionally embraced strong protection for computer software" because copyright provided relatively strong protection for software until the late 1980s.

appropriate retours from their innovations as for example: copyright, trademark laws, trade secrets, lead times, learning curves, complementary assets, confidentiality procedures, and contractual provisions (Mansfield et al. 1981; Levin et al. 1987; Cohen et al. 2001). So, in the software industry patents are usually considered as ineffective because the rapid sequential innovation and fast technology progress may become a technology obsolete before obtaining the patent.

Literature also considers that in cumulative technologies, where research is sequential and builds upon previous discoveries, patents may impede rather than promote innovation. In such industries, the emergence of "thickets" of fragmented property rights may impede R&D activities by constraining the ability of firms to operate without extensive licensing of complementary technologies (Hall and Ziedonis, 2001; Noel and Schankerman, 2006). Bessen and Hunt (2007) suggest that software patents are strategically used, especially by established firms to build "thickets" for anticompetitive reasons. Thus, some firms may accumulate patents "tickets" or set up patents pools in order to increase their market power and pose entry barriers or disincentives to others innovators (Bessen and Meurer, 2008). The strategic use of patents in cumulative and complex technologies may take different forms as for example cross-licensing, negotiations purposes and to prevent hold-up (defensive patenting). Critics also argue that any positive effect of stronger patents will be annulled by higher transaction cost and multiplied threat of litigation allowed by several blocking patents (Jaffe and Lerner, 2004; Bessen and Meurer, 2008). Indeed, stronger patents may discourage subsequent research on valuable inventions which might be potentially infringing (Merges and Nelson, 1990; Scotchmer, 1991).

As a result, why software companies uses patents and which is its value for those companies continue to be an unsolved problem for researchers. Olsson & McQueen (2000) summarize seven factors influencing patenting in small computer software producing companies. The first is the usual wisdom that patents are considered effective in discouraging imitators from introducing similar products to the market to take advantage of R&D investments made by others. Second, a patent portfolio may convince investors that a company may be worth investing in since the portfolio may both indicate the technical level of the company and "lock" the rights to the technologies claimed in the patents to the company. Third, patents can be an effective means to reduce the risk and impact of people leaving the company to become new competitors. Four, software firms might be interested in licensing out patented technology to generate income from a technology that is not at the heart of the business model. The fifth factor is that filing a patent application, concerning a technology that the company does not intend to exploit, may block or delay a competitor. The sixth factor is related with patenting as a way to motivate and stimulate the inventiveness of employees. The seventh factor is patenting to promote the image of the company or its products. In our point of view, factors influencing patenting in software industries are related with a competitive advantage which reduce the risk of failure and increase the risk of acquisition.

3.1 Patenting prior to IPO in European software industry.

Despite the impressively grown of economic literature on intellectually property right over the past 30 years, there still little empirical evidence concerning the role of patents in the European Software industry. Historically, at the European level computer programs have been mainly protected under copyright as 'literary works'[3]. A belief widely established is that European Software companies cannot use patents because computer programs "as such" are excluded from

[3] See: Council Directive 91/250/EEC of 14 May 1991 on the legal protection of computer programs, *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0250:EN:HTML*

patentability in Article 52(3) on patentable inventions of the European Patent Convention[4]. Indeed, article 52 excludes several categories of inventions, among them scientific theories, mathematical methods, aesthetic creations, methods for performing mental acts, doing business o playing games, presentation of information and programs for computers "as such". However, European patents, shall be granted by the European Patent Office (EPO) or national patent offices, "for any inventions, in all fields of technology, provided that they are new, involve and inventive step and are susceptible of industrial application". Additionally, an invention must also be technical in order to qualify for patent protection[5].

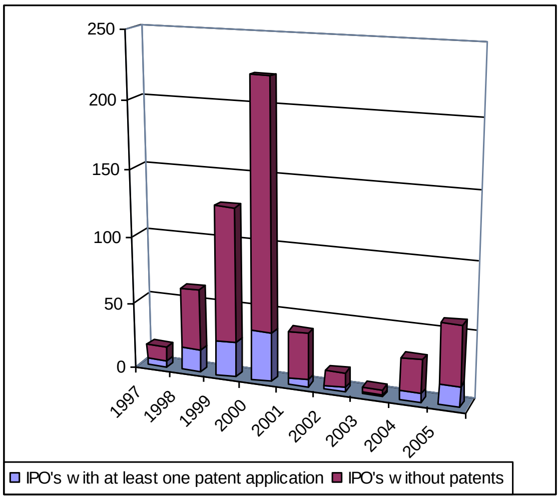
Literature has shown that the technical criterion is usually considered as the decisive factor for patentability of a computer program in Europe (Bakels and Hugenholtz, 2002; Boon, 2009; Turle and Knight, 2008). Thus, a series of decisions of the Technical Boards of Appeal at EPO allowed to better distinguish between unpatentable inventions involving computer programs "as such" and patentable computer program related inventions. For Example, in the *Vicom/Computer-related invention* case in 1987 which considers a method of digitally processing an image sufficiently technical to be patentable despite that it is based on a mathematical method[6]. In the *Koch & Sterzel* decision in 1988 the EPO Board of Appeal consider that the software used to control X-ray equipment was sufficiently technical to qualify for patentability[7]. In the 1995 *SOHEI* case, it was established that even a business problem with technical considerations would not become non-statutory because of the fact that a business method is involved[8]. However, the EPO indicate that the involvement of a machine by itself is not sufficient to give a business method invention a technical character[9]. In the same way, in the 1997 *IBM/Computer Program Product cases* the EPO Board of Appeal consider for the fist time whether a computer program could be the subject of a patent per se. The EPO[10] consider that "*a computer program claimed by itself is not excluded from patentability if the program, when running on a computer or loaded into a computer, brings about, or is capable of bringing about, a technical effect which goes beyond the "normal" physical interactions between the program (software) and the computer (hardware) on which it is run."* Then, the EPO Board's in the *IBM case* decisions indicate that computer program products may obtain a patent. This decision implicates that unauthorised sale of such a patented computer program amounts to direct patent infringement (Bakels and Hugenholtz, 2002). In the 2000 *Pension Benefits System Partnership case*[11], the EPO Board's refuse a business method executed by a computer system but considers that the product claim was not excluded of patentability because the computer system did define technical features. However, the EPO Board's consider that "the improvement envisaged by the invention is essentially an economic one i.e. lies in the field of economy, which, therefore, cannot contribute to the inventive step".

Recent literature has shown that a large number of inventions in this field have been patented through the EPO and through the national patent offices in Europe. Most of these patents are had been applied for particular sectors as electronics and IT hardware (Rentocchini, 2011) in which embedded software is particularly important while for software companies the access to patents continue to be particularly restraint. Figure 1 shows that most of the European software companies have not filed patents prior to IPO, only one fifth of the companies applied for at

[4] http://www.epo.org/law-practice/legal-texts/epc.html
[5] See European Patent Convention Rule 27
[6] T208/84, Official Journal of the EPO 1987,14.
[7] T26/86, Official Journal of the EPO 1988,19.
[8] T769/92, Official Journal of the EPO 1995, 525.
[9] T854/90, Official Journal of the EPO 1993, 669.
[10] T935/97 and T1173/97, *Official Journal of the EPO* 1999, 609.
[11] T931/95, Official Journal of the EPO 2000.

least one patent. Besides, companies interested on patents apply for very few patents before going public.

Figure 1. Patenting prior to IPO in European software industry



Source: Author's estimations

On this context, there is little evidence on how patents reward European innovators. The aim of this empirical study is to test the "value" of patent behavior prior to IPO on the survival aftermarket of companies introduced into 6 European stocks markets. The "value" of patents on survival time might be useful for a wider circle of potential users, in particular small and medium size software firms. The following section presents the methodology used in this study.

4. Data description

4.1. Sample creation

The sample considered for the analysis was built through matching two main databases. First, the Bureau van Dijk's Zephyr database which is the most comprehensive database of deal information concerning M&A, IPO, private equity and venture capital deals of European companies. Zephir database also contains information on the current situation of the company after its IPO (whether or not a firm is still listed), the last deal status update date, and the current main exchange market position. This information is used to characterize the modes of firm exit and the survival definition and duration. We also use Questel-Orbit QPAT database to analyse the characteristics of the patent portfolio of the companies at the moment of the initial public offering. QPAT database has developed a family definition (FamPat family) which provides comprehensive family coverage of worldwide patent publications[12].

Basically, the sample was built through six steps.

1. We use the USSIC737 code (Computer programming, data processing, and other computer related services) to identify software firms in ZEPHYR database. Then, we identify 991 software IPOs deals from Germany, United Kingdom, France, Sweden, Italy and Spain, between 1st January 1997 to 31st December 2005. Considering only companies with available information considering Pre-IPO characteristics, our sample is composed of 578 software IPOs

[12] http://www.questel.com/Prodsandservices/FamPat.htm

2. We match Bureau van Dijk's Zephyr database and Questel-Orbit QPAT database by firm name. “Weak” matches were verified by looking the content of the patents (the inventor names, address information, citations to other patents, and the content of abstracts).

3. We collect all the software M&A deals from 1997 to 2011 (12848 deals). IPO information is matched with M&A deals to identify which companies were acquired after the IPO and the date of the acquisition.

4. Information concerning the current status of the company after its IPO (whether or not a firm is still listed) was used to identify companies delisted for another reason different to M&A.

5. A significant effort was made to identify companies that were to bankruptcy or voluntary liquidation process after their IPO. Thus, Bureau van Dijk's Zephyr information was completed and verified with several publicly financial documents available on the company's websites and specialized websites such as Listofcompanies.co[13], FE Investegate[14] for UK companies, Bloomberg Business week, Nasdaqomx[15], among others. We also searched the web for companies acquired for more detail on several business cases. This, laborious process allow as to better approach the complexity of exit process and to identity many companies acquired while they were on liquidation process.

6. We also searched the web (on firm's websites and specialized websites) for companies that survive to verify if they continue to operate in the financial markets.

Considering only companies with available information considering Pre-IPO characteristics, our sample is composed of 578 software IPOs from 6 European countries that went public between 1997 and 2005.

5. Empirical strategy

To estimate the relationship between several firms' pre-IPO quality metrics and the survival in the aftermarket, this study uses a cross sectional Cox hazard regression model (Cox, 1972; Cox and Oakes, 1984). A semi-parametric approach based on Cox regression is often used to describe the relation between the empirical exit rate and "background variables". This model expresses the exit rate to a destination state as a rather simple function of observed and unobserved explanatory variables and the elapsed duration in the current state. Survive time is usually defined as a non-negative random T, the failure rate at time t and the hazard function h(T) is defined as the limit

$$h_{(t)} = \lim_{\Delta t \to 0} \frac{p(t \leq T < t + \Delta t | T \geq t)}{\Delta t};$$

Thus, the different survival models are estimated using is a vector of covariates X_i for the firms characteristics at IPO and the regression coefficient β_k are to be estimated from the data. Thus, the hazard function of a firm i is expressed as:

13 http://listofcompanies.co.in/about-us/
14 http://www.investegate.co.uk/About.aspx
15 http://nordic.nasdaqomxtrader.com/newsstatistics/corporateactions/Stockholm/Changes_to_the_List/

$$h(t \mid \mathrm{x_i}) = h_0(t)\exp(\beta_k X_i)$$

On this expression, $h_0(t)$ is an arbitrary and unspecified baseline hazard function reflecting the probability of failure conditional on the firm having survived till time *t* after its IPO. Cox regression uses the proportional hazard assumption, which assumes that all groups of firms face a hazard function of the same shape. The shape of the hazard function remains unspecified and it can take any form. The only difference between two groups, for example, is that hazard functions of one group can be some constant proportion higher or lower then the hazard function of the other group. In the presence of hazards that do not satisfy the proportional assumption the estimates can result biased and inefficient for all the parameters. As a consequence, to check for this assumption is imperative.

However, it is possible to deal with nonproportionality through the stratification of the covariate of interest. Under this alternative, the impact of the remained independent variables (covariates) on the conditional hazard is assumed to be constant across strata, but separate baseline hazard are estimated for the *j* different groups:

$$h(t \mid \mathrm{x_i}) = h_{0j}(t)\exp(\beta_k X_i)$$

In the stratified Cox regression, we assume that two groups of firms may have different risks of exit. Additionally, we use a specification which includes time-invariant covariates like firm characteristics at the IPO (including the patenting characteristics). Negative coefficients and risk ratios less than one imply that the hazard rate decreases and the probability of survival increases with increases in the value of the variable, while positive coefficients and risk ratios greater than one imply an increase in the hazard rate function and a decrease in the probability of survival. The main hypothesis of this paper is that the observable firm characteristics of European IPOs before the offering are related with firm's survival in the public market.

5.1. Definition of the dependent variables

It is usually accepted that a company survive after IPO if the company still listed on the stock market (Henseler, Rutherford and Springer 1997; Kauffman and Wang, 2003; Wagner and Cockburn, 2010). In this way, two kinds of dependent variables in our empirical model are used: the duration of the observations in the sample and a binary variable indicating the firm's mode of exit. The duration is considered from an initial date (IPO date) until the date of the event (modes of exit) on a daily basis[16]. As claimed before, we study the aftermarket survival of companies going public from the 1st January 1997 to 31st December 2005. If the software IPO was not delisted by one of the modes of exit before December 31, 2011 it was considered as censored at that date. There are two modes of exit used on this study. *The first mode is through M&A deals* which is also the main mechanisms of exit the stock markets in Europe (239 IPOs)[17]. As claimed in the methodology, IPO information is matched with M&A deals information on the Bureau van Dijk's Zephyr database to identify the companies that were acquired after its IPO and the date of the deal. *The second mode of exit is through bankruptcy or voluntary liquidation* (82 IPOs)[18]. Bankruptcy and voluntary liquidations are usually viewed as varieties of firm failure (Buehler,

16 We also transform our duration variable on a month basis

17 Literature often claims the diversity of causes and forms of M&A deals. A successfully company can be a precious investment for another firm because it runs a profitable business, control valuable technologies, assets or markets. Otherwise, a collapsed company might be purchased because of its assets but not because of its operations (Wagner and Cockburn, 2010). In our sample, companies that were acquired while they were in the process of liquidation were coded as acquired.

18 A firm can be also delisted of a particular public stock change if it is taken private or if the company decides to change of stock market. It was the case for some European companies in this sample.

Kaiser and Jaeger, 2005). Previous literature highlight different reasons related to firms' failure as the absence of profitability, the stock price collapse, the firms' debts or the external business conditions (stock market uncertainty, economic crisis), among others (Henseler, Rutherford and Springer 1997; Kauffman and Wang, 2003; Peristiani and Hong, 2004; Wagner and Cockburn, 2010).

5.2 Patent information

As claimed before, on our analysis, IPO information of each firm is matched with the number of the firm's patents filed with priority date from the Qpad database to obtain several metrics characterising patent behavior prior to IPO. First variable AT LEAST ONE PATENT APPLICATION is dummy variable coded one if the company apply for at least one patent before IPO. Second variable PATENTAPPLIED is the number of patents applications with "priority date" prior to IPO. The number of patents applications reflects the total inventive output before IPO. On this paper, we didn't evaluate "software patents" [19] which their definition can be arbitrary (Mann, 2005) but all the innovative input that might emerge in a complex innovation process with others' firms, providers, and clients in the different business segments in which software companies operate. Third variable PATENTOBTAINED is the number of patents obtained prior to IPO. Fourth variable FORWARD CITATIONS is the number of forward citations received within 3 years after the date of the IPO. Fifth variable INTERNATIONAL APPL (PCT) is the number of international applications (PCT applications). Table 1 summarizes the international characteristics of the patents filed by European software companies. It should be pointed out that 37.9% of the patents applications prior to IPO had a US extension while 31.5% were international applications. It is shows the importance of the US market for European growing-up companies.

--Insert table 1 about here—

5.3. Controls and main determinants

This study incorporates 5 types of variables: firm's patent portfolio characteristics (patent applied and obtained, forward citations, international applications), pre-IPO financial performance characteristics (sales, profitability and solvability ratios), others firm's related characteristics (age, size), firm's industry related segment (internet, services, developer) and market conditions.

5.3.1. Financial ratios

Here, we use common ratios of profitability and solvability which are used by investors to analyse financial firm performances, in order to control firm heterogeneity and financial performance. The variable RETOURN ON SALES was built to comparing the business's ability to generate earnings as compared to its expenses and other relevant costs incurred during the previous year of registration filing to the IPO. The analyses also include a dummy variable called RETOURN ON SALES (>95th p) which is equal to one if the quoted company has a profitability ratio superior to 95% of companies and zero otherwise. We also include the return on assets ratio

[19] There exits 3 methodologies to identify software "software related patents". The first, as defined by Graham & Mowery (2003), is using the International Patent Classification (as G06F; 3/; 5/; 7/; 9/; 11/; 12/; 13/; 15/; G06K; 9/; 15/and H04L9). The second, as claimed by Bessen and Meurer (2007) uses search query keywords as: (("software" in specification) OR ("computer" AND "program" in specification)) AND (utility patent excluding reissues) ANDNOT ("chip" OR "semiconductor" OR "bus" OR "circuit" OR "circuitry" in title) ANDNOT ("antigen" OR "antigenic" OR "chromatography" in specification). The last methodology is to combine the two techniques in order to minimise potential errors as claimed by Hall and MacGavie (2010).

which is a widely used ratio defined as net income after taxes divided by total assets. It is expected that firms with higher profitability have a lower hazard ratio, and as a result, ceteris paribus, the likelihood of survival of a firm is positively associated with its profitability performance. The model also includes the variable called EQUITY RATIO which is defined as the shareholders' funds in proportion to total assets. This ratio can produce a confidence factor for unsecured creditors. Generally speaking, the lower a company's equity ratio, the greater the probability that the company will default on its debt obligations. Debt holders are paid first during bankruptcy proceedings. A high equity ratio provides security to shareholders in the event a company is liquidated while the first to be paid during a bankruptcy proceeding are debt holders. It is expected that the likelihood of survival of a firm is positively associated with its equity ratio performance.

5.3.2. Venture capital support

Bureau van Dijk's Zephyr database also contains information on the venture capital support. The dummy variable VCAP indicates whether the IPO was backed by one or more venture firms (=1) or not (=0). Jain and Kini (2000) and Wagner and Cockburn (2010), find that the presence of venture capitalists reduce the likelihood of exit of newly listed firms in US. However, empirical literature on European countries founds that receiving VC does not improve the survival exit of newly listed firms in German Neuer Market (Audretsch and Lehmann, 2004), Belgium (Manigart et al., 2002) and France (Pommet, 2012).

5.2.3. Assets, revenues and age at IPO

The analysis also controls for the size of the company including a log transformed variable of total assets and turnover in the previous year at IPO called LOG (ASSETS) and LOG (SALES TO ASSETS), respectively. The market value of a firm should be positively related with the size of the firm in terms of total assets and the company's efficiency to use of its assets in generating sales revenue. The dummy variable SMALL SIZE indicates whether the software company quoted is introduced is a small company with sales inferior to €10 million in Europe.[20] It is remarkable that 50.8% of the software companies quoted were small companies.

The variable AGE AT IPO is calculated as the difference between the effective date of IPO and the date of legal incorporation. If the date of incorporation was not available from Bureau van Dijk's Zephyr database it was obtained from publicly financial documents on the company's website or through specialized magazines. The company age at IPO is expected to be a good proxy for financial riskiness. It is expected that companies with more experience before going public have lower failure rates than young companies and the oldest firms have higher failure rates.

5.3.4. Firm's industry related segment

Literature has shown that the likelihood of survival vary systematically from industry to industry (Dunne et. al., 1989; Audretsch, 1995). Intra-industrial differences might be important in aftermarket survival of new software firms because there is an important heterogeneity across

[20] See the EUROSTAT definition of SME for Europe: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-NP-06-024/EN/KS-NP-06-024-EN.PDF

industry segments related to their innovation capabilities, IP appropriability, profitability, size and markets. Indeed, software firms operate in multiple sectors activities: developer and consultancy services, solutions and services providers, financial services, software developer, internet, video games, among many others. Then, we introduce 7 dummy variables related with the company's principal and secondary major sectors while using the NACE Rev.2 codes. Table 2 reports the major sector classification used on the analysis. We are aware that the use of statistical classifications of activities is not free of problems, because the definition of software industry is fuzzy and software companies may be operating in more than one industry segment.

--Insert table 2 about here—

This paper also distinguish between internet related software firm's and other software firms trough the company business description in Bureau van Dijk's Zephyr database. The Dummy variable INTERNET RELATED if company's business activity is related to with this segment.

5.3.5. Temporal and Geographical effects

Lastly, this study uses temporal and geographical differences in IPO deals. It has been documented that IPOs tend to come in waves, characterized by periods of hot and cold markets. Year and geographic dummies are included to take in account for variations in cycle and any country-specific characteristics. The dummy variable 1997-1999 is coded one if the company was introduced between 1997 and 1999, and so on. It is expected to control for differences in the selection process at IPO after the dot-com in 2000. This study also includes five dummies to take into account geographical effects on dependent variable. The dummy variables coded 1 or 0 to differentiate companies according to their geographical locations. "UK", "DE", "FR", "SE", "ITES" represent the dummies of IPOs in British, German, French, Sweden, Spanish and Italian together, stock exchanges respectively.

Tables 3 and 4 in Appendix report the summary and correlation statistics. It should be pointed out, the high correlation (0.71) between the number of patent application and the number of forward citations (see table 4) which might indicate multicollinearity problems. Then, we perform variance inflation factors on our regression and we find that the highest VIF[21] was inferior to 3.8.

--Insert tables 3 and 4 about here—

6. Empirical Results

6.1 Proportional hazard assumption tests

Cox proportional hazards models assume that the hazard ratio is constant over time. That's mean that if, par example, the hazard ratio of exit is higher for small companies compared with big companies, it is the same at 1 month, at 2 months, or at any point on the time scale. This is a strong hypothesis of Cox model which is constrained to follow this assumption. If the assumption is violated, alternative modelling as the stratified Cox regression would be more appropriate (Box-Steffensmeier and Zorn, 1998; Statacorp, 2009). For that reason it is important to evaluate potential specifications errors (Keele, 2010) and the validity of the proportionality assumption through several types of test (Grambsch and Therneau, 1994). We implement 3 related types of test to detect the correct model specification and identify potential nonproportionality while considering that there are competing risks involved. We consider

[21] See methodological appendix A

competing risks through fitting models separately for each type of failure, treating other failure as censored (Kay, 1986; Lunn and McNeil, 1995).

First, we implement a test for proportional hazard through a nonzero slope in a generalized linear regression of the scaled Schoenfeld residuals on time. In this test the null hypotheses of zero slope is equivalent to test that the log hazard-ratio is constant across time (Grambsch and Therneau, 1994). Table 5 present the results for this test while considering competing risks specifications. For these model configurations, the PH assumption has been violated[22]. In the Cox proportional specification, SME and DE (Germany) violate the PH assumption for acquired (First event) while VENTURE BACKED (measure of "success" before IPO), LOG (ASSETS) (size specific covariate) and SE (Sweden) violate also the PH assumption for fail (Second event). Then, it is quite reasonable to stratify both models by country covariates, size and a measure of success before IPO and test again the PH assumption.

A second way to detecting a violation of proportional hazard assumption in Cox model is estimate separate Cox regression models for log-time interactions with each of the potentially non-proportional variables. Table 6 presents the results for this test while considering competing risks specifications. Then, through this test we confirm that is necessary to stratify both models by country covariates, size and at least one patent application and test again the PH assumption.

Finally, we evaluate the validity of the HP assumption although examination of graphical plots. Then, we observe whether the HP assumption holds for patenting versus not patenting (Figure 1 and 2) and for small software companies versus medium size and big companies (Figure 3 and 4). The left part of the figure shows the graph of the log (-log(survival)) versus log of survival time graph. These graphics are often referred to as "log–log" plots. If the plotted lines are "reasonably parallel", the proportional-hazards assumption has not been violated. Additionally, the right part of the figure shows Kaplan–Meier observed survival curves and compare them with the Cox predicted curves for the analyzed covariate. For these plots, when the predicted and observed curves are close together, the proportional-hazards assumption has not been violated. The different graphs show that the variable AT LEAST ONE PATENT APPLICATION and SMALL COMPANY seems to reasonably violate the proportional-hazards assumption. One hazard ratio describing the effect of these covariates would be inappropriate. We definitely would want to stratify on these variables in our Cox model.

6.2. Stratified Cox Model while considering competing risk

Table 7 shows the result of a stratified Cox estimation while considering heterogeneity in terms of risk across countries, firms size (small company or not) and patenting (at least one patent application). Our estimation considers competing risks through fitting models separately for each type of failure, treating other failure as censored (Kay, 1986; Lunn and McNeil, 1995). Lunn and McNeil (1995) claim that a drawback of this method is that it does not treat the different types of failures jointly, complicating the comparison of parameter estimates corresponding to different failure types.

Table 7 also shows changes on the unit of time measured (days and months). Thus, models 1 and 2 perform regressions while considering the number of days from the IPO to the acquisition or fail, respectively. Likewise, models 2 and 3, consider the number of months from the IPO to the acquisition or fail, respectively. Results show that when considering changes in the unit of time measured there are not changes on the significance of the variables and hazard ratio vary very little. We also present the overall test of proportional hazard assumption based on the basis of

[22] Covariate-specific tests shown in gray do not comply the proportionality assumption at the 10% level.

Schoenfeld residuals after fitting the model[23]. Results are presented in form of relative risks (hazard ratios) that is the ratio of the predicted hazard given a one-unit increase in the independent variable relative to the hazard without that change (holding everything else constant). Hazard ratios greater than 1 indicate an increased risk of exiting the sample and are related to shorter durations. Hazard ratios smaller than 1 indicate a lower risk of exiting the sample and they are related to longer survival duration.

--Insert table 7 about here—

Results indicate that an additional patent application[24] reduces the hazard of exiting the sample on 6.2% through a merger and 40% through business failure. In contrast, the quality of the patent portfolio (forward citation received within 3 years after the date of the IPO) increases the probability of exit through a merger/ acquisitions (0.06% for an additional forward citation) while reduce the hazard rate of exit through business failure on 15.8%. This is in line with the findings of Wagner and Cockburn (2010) which observe that highly cited patents are particularly valuable assets or signals that the exiting firm's technology is high quality. Additionally, through the different models results shows that international patent applications and a higher share of patents obtained before going public were not statistically significant on the hazard of exit in a short duration through the different mechanisms.

In the same way, Models 1 and 2 shows that bigger firms in terms of total assets at IPO have lower hazard ratios of exit through business failure (24.1%) but it was not significant for acquisitions. Besides, an additional year of experience in terms of age at IPO reduces the hazard of exit on 1.5% through acquisitions and 6.8% through business failure model. Also, an increase on sales reduces hazard ratio of exit trough acquisition on 11.2% but it was not significant for business failure.[25] Further, results also indicate that one additional point on the equity ratio on the previous year at IPO reduce on 0.01% the hazard ratio of exit through bankruptcy while it is not statistically significant on the hazard of exit through M&A. Furthermore, firms with positive returns on sales before IPO were 41.9% less likely to fail in a short duration while it is not statistically significant on the probability of acquisition.

Additionally, it should be pointed out that the effect of the venture capital support is not statistically significant on the hazard of exit through the different mechanism in Europe. Regressions also show the importance of firm's business segment and market conditions on the survival probabilities. Thus, internet related companies have higher hazard ratios of exit through acquisitions (47.7%) and business failure (63.4%). Moreover, companies on industry activity 3 (Administrative and support services activities, education, Gambling and betting activities) were more likely to be acquired than companies on the publishing industry division. In the same way, industry activity 3 and 4 (manufacturing companies) were more likely to fail compared with publishers. In addition, companies that went public between 1997 and 1999 were 33.7% more likely to be acquired that companies introduced in 2000.

6.3. Competing risks-stratified Cox Model

[23] See the methodological appendix B

[24] We also use the number of patents obtained prior to IPO which is also statistically significant on the aftermarket survival for both types of risks. For the sake of brevity these regressions were not included.

[25] The quadratic terms of revenues, assets and age at IPO are not statistically significant. See methodological appendix C for this version

We also perform another method to analyze competing risks while considering that firm's face– a risk of acquisition and a risk of failure- jointly. The specific method that we use for the competing risks model follows Lunn and McNeil (1995). This approach involves data augmentation by duplicating the data for each failure type. Then, we estimate a Cox hazard regression stratified by type of failure[26]. This specification takes into account that the hazard rate is now subscribed by both events. That's mean that we have a different hazard rate for each type of event. The competing risks-stratified Cox model explains heterogeneity in terms of different baseline hazards of different exits modes. Therefore, table 8 shows results of the stratified Cox model to allow different baseline hazard across events. When we consider this configuration, the covariate effects are very similar to those of the previous models, in particular the direction of the relative risk does not change. The main difference concerning patent behaviour is that the effect of additional patent applications is slightly greater reducing the hazard of exiting trough failure in a short duration (40.2%). Thus, the covariate effects of firm's business segments are also slightly stronger on this configuration.

--Insert table 8 about here—

7. Conclusion and discussion

This empirical study test the effect of pre-IPO firm's characteristic on survival time on the stock market of software IPOs issued from 1997 to 2005 in Europe. We perform a cross sectional competing-risk stratified Cox hazard regression model to test the effect on firms' survival of 5 types of variables: firm's patent portfolio characteristics (patent applications, forward citations, PTC patents), pre-IPO financial performance characteristics, others firm's related characteristics (age, size), firm's industry related segment and market conditions.

Thus, this paper contributes in several dimensions to the literature on innovation and firm performance. First, it is the first paper to analyze the value of patenting prior to IPO on the survival of European software IPOs aftermarket. In this way, patenting behavior seems to be more than a signal for investors. Thus, an additional patent application reduces the risk of exiting through a merger and business failures.

Second, in line with previous literature on IPOs firms' survival, a higher quality of the patent portfolio makes the firm more attractive for acquisitions. Wagner and Cockburn (2010), who found a similar result for US internet related companies, pointed out that highly cited patents are valuable assets that improve the competition situation of the firms. In contrast, a higher quality of the patent portfolio reduces risk of failure. On the light of these results, we argue that in industries related with complex technologies as the software industry, highly quality patents increases the attractiveness of a company as an acquisition target because those patents might increase the competitive position of the acquirer as for example the exploitation of cross-licensing agreements, reduce hold-up problems and improve their bargaining power.

Third, the results support the idea that the financial characteristics of software companies at IPO are related with their likelihood of survival. Thus, companies with positive profitability ratios reduce the risk of failure in a short duration while less solvable companies have higher probabilities of failure. Thus, pre-IPO profitability and solvability are strong indicators of the ability of firms to operate prosperously aftermarket. In the same way, as expected our analysis

[26] See methodological appendix D

confirms that the influence of the pre-IPO characteristics is different depending of different type of exit. Thus, bigger firms in terms of total assets at IPO have lower ratios of exits through business failure but it was not statistically significant for acquisitions. Besides, the ability to generate revenues before IPO reduces the hazard ratio of exit through acquisitions but it was not significant through business failure.

In this paper, we are aware that the analysis of the effect of firms' characteristics at IPO (time invariant covariates) on the risk of experiencing an event provides considerable insights but also some limitations. A higher or lower risk is interpreted as relative and proportional to the hazard rate. That's means that the hazard rate is constant across time for some firms relative to others. However, the inclusion of time-varying parameters should leads to more complex modeling and interpretations. With time-varying parameters, the hazard risk is proportional across time until the covariate changes as a consequence new insights can emerge concerning the nature of European software firms' survival. Then, future research on European firm's survival should introduce time-varying covariates to analyze its impact on the hazard rate.

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Appendix

Table 1. International characteristics of European software IPO patents' portfolio

IPO country	Number of patents *(On average)*	USTPO patents *(On average)*	Share extended to US	International Applications *(On average)*	Share of PTC patents
GB	1,269	0,742	0,406	0,330	0,356
DE	0,692	0,217	0,179	0,273	0,387
FR	0,755	0,430	0,371	0,291	0,343
ITES	3,395	0,105	0,400	0,026	0,100
SE	1,234	0,469	0,462	0,422	0,498
Total	1,142	0,471	0,364	0,315	0,337

Table 2. Software Industry activity distribution and variable codification

Variable codification	Industry Activity	Industry division	N. of firms
Industry activity 0	J. INFORMATION AND COMMUNICATION	58. Publishing activities	42
Industry activity 1	J. INFORMATION AND COMMUNICATION	61.Telecommunications	55
		62. Computer programming, consultancy and related activities	342
		63. Information service activities	21
Industry activity 2	M. PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	69. Legal and accounting activities	28
		70. Activities of head offices; management consultancy activities	
		71. Architectural and engineering activities; technical testing and analysis	
		73. Advertising and market research	
Industry activity 3	N. ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	82. Office administrative, office support and other business support activities	25
	P. EDUCATION	85. Education	
	R. ARTS, ENTERTAINMENT AND RECREATION	92. Gambling and betting activities	
Industry activity 4	C. MANUFACTURING	26. Manufacture of computer, electronic and optical products	27
		28. Manufacture of machineryand equipment n.e.c.	
Industry activity 5	K. FINANCIAL AND INSURANCE ACTIVITIES	64. Financial service activities, except insurance and pension funding	15
Industry activity 6	G. WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45. Wholesale and retail trade and repair of motor vehicles and motorcycles	23
		47. Retail trade, except of motor vehicles and motorcycles	
Total			578

Table 3. Summary statistics

	EUROPE			UK	GERMANY	FRANCE	SWEDEN	ITES
VARIABLE	**Mean**	**Min**	**Max**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
SURVIE TIME (days to exit)	2826,59	55,0	5445,0	2429,3	2983,3	3038,7	2935,5	3113,2
DELISTED	0,56	0,0	1,0	0,62	0,51	0,53	0,55	0,55
ACQUIRED	0,41	0,0	1,0	0,36	0,40	0,43	0,50	0,50
BANKRUPCY/ VOLUNTARY LIQUIDATION	0,14	0,0	1,0	0,25	0,11	0,10	0,05	0,05
AT LEAST ONE PATENT APPLIC.	0,20	0,0	1,0	0,19	0,19	0,21	0,25	0,13
PATENTAPPLIED	1,13	0,0	137,0	1,27	0,69	0,75	1,23	3,39
PATENTOBTAINED	0,81	0,0	117,0	0,87	0,37	0,47	0,97	3,26
FORWARD CITATIONS	6,24	0,0	1359,0	8,92	1,20	8,25	6,86	3,34
INTERNATIONAL APPL (PCT)	0,30	0,0	32,0	0,33	0,27	0,29	0,42	0,03
USPTO PATENTS	0,46	0,0	99,0	0,74	0,22	0,43	0,47	0,11
RETURN ON SALES (t-1)	-60,29	-17514,20	1882,71	-3,09	-0,53	2,67	-539,66	-1,97
POSITIVE RETURN ON SALES RATIO	0,53	0,0	1,0	0,46	0,57	0,62	0,48	0,47
RETURN ON ASSETS (t-1)	-7,73	-4314,5	4,8	-24,37	-0,07	-0,07	-0,16	-0,07
EQUITY RATIO (t-1)	-3,76	2337,7	1,0	-12,85	0,27	0,47	0,63	0,45
VENTURE BACKED	0,11	0,0	1,0	0,09	0,09	0,13	0,13	0,18
AGE AT IPO	8,47	0,0	62,3	5,25	10,41	8,68	11,48	10,71
LOG (TOTAL ASSETS) (t-1)	9,86	1,1	16,1	9,11	10,22	10,18	9,34	11,74
LOG(REVENUES)	8,79	14,2	4,0	8,56	9,09	9,35	6,54	10,31
SMALL COMPANY	0,51	0,0	1,0	0,54	0,48	0,44	0,78	0,24
1997-1999	0,36	0,0	1,0	0,10	0,53	0,42	0,58	0,29
2001-2002	0,09	0,0	1,0	0,16	0,04	0,11	0,00	0,08
2003-2005	0,17	0,0	1,0	0,32	0,04	0,13	0,19	0,03
Number of companies	578			182	143	151	64	38

Table 4. Correlation matrix of the variables used in the regressions.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 TIME TO EXIT	1,000																	
2 ACQUIRED	-0,515	1,000																
3 BANKRUPCY/ VOLUNTARY LIQUIDATION	-0,289	-0,341	1,000															
4 AT LEAST ONE PATENT APPLIC.	0,072	0,057	-0,116	1,000														
5 PATENTAPPLIED	0,093	-0,039	-0,051	0,281	1,000													
6 FORWARD CITATIONS	0,053	0,001	-0,038	0,192	0,718	1,000												
7 INTERNATIONAL APPL (PCT)	0,089	-0,032	-0,057	0,318	0,688	0,742	1,000											
8 RETURN ON SALES	0,047	-0,066	0,022	0,029	0,009	0,006	0,009	1,000										
9 POSITIVE RETURN ON SALES RATIO	0,122	-0,014	-0,125	0,017	0,077	0,064	0,069	0,074	1,000									
10 EQUITY RATIO	0,067	0,035	-0,103	0,018	0,006	0,004	0,006	0,008	0,047	1,000								
11 LOG (ASSETS)	0,114	0,160	-0,254	0,031	0,121	0,108	0,091	-0,026	0,247	0,182	1,000							
12 LOG (REVENUES)	0,103	0,046	-0,135	0,058	0,092	0,079	0,054	0,203	0,283	0,084	0,649	1,000						
13 AGE AT IPO	0,162	0,003	-0,171	0,121	0,037	0,020	-0,013	0,035	0,132	0,041	0,115	0,166	1,000					
14 VENTURE BACKED	-0,031	-0,012	-0,031	0,062	0,061	-0,024	-0,002	-0,166	0,028	0,013	0,045	-0,032	-0,050	1,000				
15 SMALL	-0,048	-0,116	0,122	-0,056	-0,063	-0,065	-0,026	-0,058	-0,265	-0,043	-0,536	-0,744	-0,136	-0,034	1,000			
16 1997-1999	0,181	0,160	-0,116	0,064	0,068	0,045	0,006	0,043	0,026	0,031	0,161	0,104	0,221	-0,098	-0,056	1,000		
17 2001-2002	0,031	-0,125	0,091	-0,041	-0,029	-0,029	-0,032	0,017	-0,044	-0,130	-0,159	-0,058	-0,088	-0,074	0,078	-0,239	1,000	
18 2003-2005	-0,270	-0,092	0,005	0,034	-0,039	-0,034	-0,018	0,025	-0,028	0,017	-0,146	-0,065	-0,053	0,127	0,076	-0,332	-0,143	1,000

Table 5. First test of HP Assumption: nonzero slope of the scaled Schoenfeld residuals on time

	Competing risks specification Days to exit			
VARIABLES	ACQUIRED	PH (Prob>chi2)	FAILURE	PH (Prob>chi2)
AT LEAST ONE PATENT APPLIC.	1.036	0.3024	0.945	0.6812
	(0.316)		(0.798)	
PATENTAPPLIED	0.956**	0.8375	0.805	0.2018
	(0.0206)		(0.399)	
SHARE OF PATENTS OBTAINED	1.428	0.1456	1.313	0.6950
	(0.503)		(1.202)	
FORWARD CITATIONS	1.005***	0.5661	0.888	0.2033
	(0.00156)		(0.0864)	
INTERNATIONAL APPL (PCT)	0.899	0.7446	0.989	0.1723
	(0.0730)		(0.612)	
POSITIVE RETURN ON SALES RATIO	0.833	0.4180	0.607*	0.1412
	(0.117)		(0.157)	
EQUITY RATIO	0.999	0.5338	0.999**	0.1803
	(0.0213)		(0.000284)	
LOG (ASSETS)	1.049	0.7501	0.794***	0.0084
	(0.0500)		(0.0595)	
LOG (REVENUES)	0.896**	0.1183	1.024	0.2064
	(0.0383)		(0.0805)	
SME	0.542***	0.0465	0.630	0.6513
	(0.117)		(0.228)	
AGE AT IPO	0.988	0.5735	0.938***	0.7588
	(0.00855)		(0.0216)	
VENTURE BACKED	0.858	0.7697	0.880	0.0139
	(0.195)		(0.349)	
1997-1999	1.384*	0.1974	1.117	0.6238
	(0.238)		(0.374)	
2001-2002	0.611	0.8623	0.755	0.4789
	(0.187)		(0.250)	
2003-2005	1.169	0.9216	0.805	0.1656
	(0.274)		(0.299)	
INTERNET RELATED	1.501**	0.2323	1.620*	0.4349
	(0.241)		(0.416)	
Industry activity 1- NACE Rev.2 (61-63)	1.679	0.7679	1.614	0.7109
	(0.530)		(0.827)	
Industry activity 2- NACE Rev.2 (69-73)	1.632	0.5954	1.454	0.6665
	(0.713)		(1.072)	
Industry activity 3- NACE Rev.2 (82-92)	3.399***	0.6784	3.913**	0.6785
	(1.484)		(2.649)	
Industry activity 4- NACE Rev.2 (26-28)	1.613	0.3935	4.687**	0.2915
	(0.740)		(3.454)	
Industry activity 5- NACE Rev.2 (64)	2.326*	0.7526	2.859	0.8609
	(1.181)		(2.094)	
Industry activity 6- NACE Rev.2 (45-47)	1.321	0.4698	0.691	0.4901
	(0.585)		(0.560)	
DE	0.717	0.0085	0.617	0.7074
	(0.149)		(0.209)	
FR	0.747	0.7469	0.601	0.7074
	(0.144)		(0.209)	
SE	0.826	0.3035	0.313**	0.0268
	(0.213)		(0.169)	
ITES	0.815	0.6267	0.446	0.8572
	(0.209)		(0.360)	
Observations	496		339	
N_fail	239		82	
ll	-1363		-415.8	
chi2	53.10		207.4	
risk	1485337		1167516	
GLOBAL HP TEST		0.7115		0.3892

Robust seeform in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Covariate-specific tests shown in gray do not comply the proportionality assumption at the 10% level.

Table 6. Second test of Proportional Assumption: time-varying covariates

	Competing risks specification Days to exit			
VARIABLES	main	Xi * ln(time)	main	Xi * ln(time)
AT LEAST ONE PATENT APPLIC.	0.733	1.000	0.191	1.001**
	(0.346)	(0.000139)	(0.254)	(0.000338)
PATENTAPPLIED	0.950**		0.750	
	(0.0231)		(0.484)	
SHARE OF PATENTS OBTAINED	1.498		1.277	
	(0.558)		(1.246)	
FORWARD CITATIONS	1.006***		0.861	
	(0.00187)		(0.103)	
INTERNATIONAL APPL (PCT)	0.901		1.096	
	(0.0766)		(0.766)	
POSITIVE RETURN ON SALES RATIO	0.842		0.600**	
	(0.120)		(0.155)	
EQUITY RATIO	0.997		0.999**	
	(0.0214)		(0.000317)	
LOG (ASSETS)	1.044		0.800***	
	(0.0496)		(0.0607)	
LOG (REVENUES)	0.898**		1.001	
	(0.0378)		(0.0836)	
SME	0.828	1.000*	0.416	1.000
	(0.284)	(0.000127)	(0.230)	(0.000220)
AGE AT IPO	0.988		0.938***	
	(0.00869)		(0.0201)	
VENTURE BACKED	0.858		0.889	
	(0.197)		(0.348)	
1997-1999	1.373*		1.124	
	(0.237)		(0.380)	
2001-2002	0.619		0.766	
	(0.191)		(0.255)	
2003-2005	1.176		0.836	
	(0.277)		(0.314)	
INTERNET RELATED	1.514**		1.595*	
	(0.244)		(0.413)	
Industry activity 1- NACE Rev.2 (61-63)	1.680		1.574	
	(0.532)		(0.813)	
Industry activity 2- NACE Rev.2 (69-73)	1.711		1.494	
	(0.758)		(1.105)	
Industry activity 3- NACE Rev.2 (82-92)	3.211***		4.262**	
	(1.408)		(2.939)	
Industry activity 4- NACE Rev.2 (26-28)	1.635		4.878**	
	(0.745)		(3.597)	
Industry activity 5- NACE Rev.2 (64)	2.364*		2.839	
	(1.213)		(2.099)	
Industry activity 6- NACE Rev.2 (45-47)	1.332		0.683	
	(0.595)		(0.559)	
DE	1.206	1.000*	1.110	1.000
	(0.424)	(0.000162)	(0.678)	(0.000303)
FR	0.606	1.000	0.592	1.000
	(0.228)	(0.000163)	(0.430)	(0.000316)
SE	0.779	1.000	0.0343**	1.001*
	(0.370)	(0.000204)	(0.0463)	(0.000521)
ITES	0.449	1.000	0.588	1.000
	(0.227)	(0.000206)	(0.592)	(0.000393)
Observations	496	496	339	339
N_fail	239	239	82	82
ll	-1356	-1356	-411.4	-411.4
chi2	70.54	70.54	226.8	226.8
risk	1485337	1485337	1167516	1167516

Robust seeform in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Covariate-specific tests shown in gray do not comply the proportionality assumption at the 10% level

Graphically assess proportional-hazards assumption

Figure 1

Patenting versus not patenting (days to acquired)

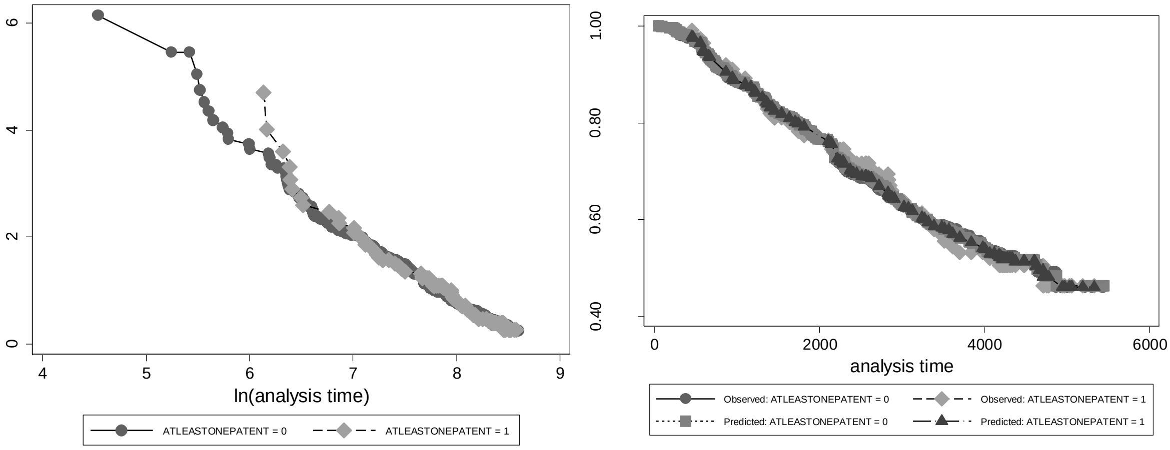

Figure 2

Patenting versus not patenting (days to failure)

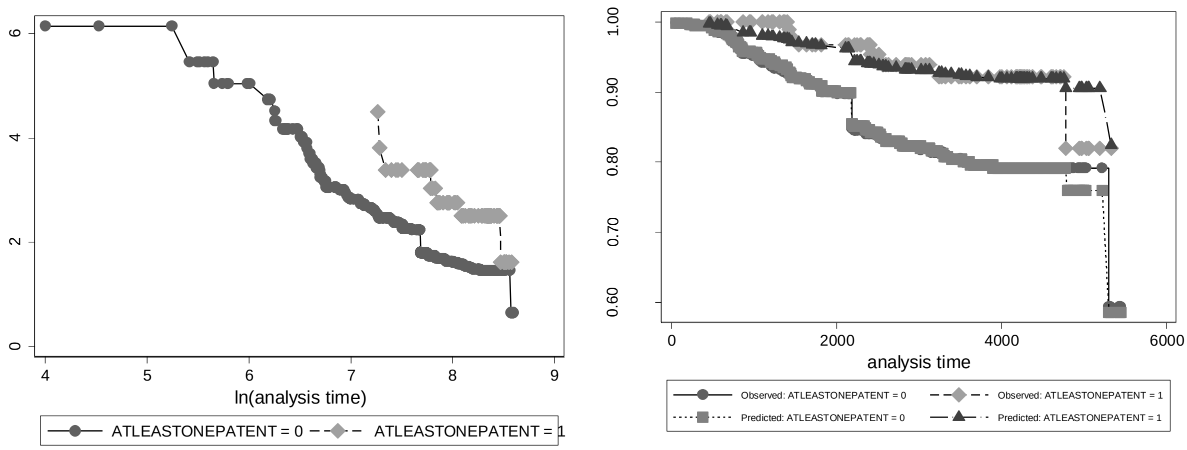

Figure 3

Small software company versus big company (days to acquired)

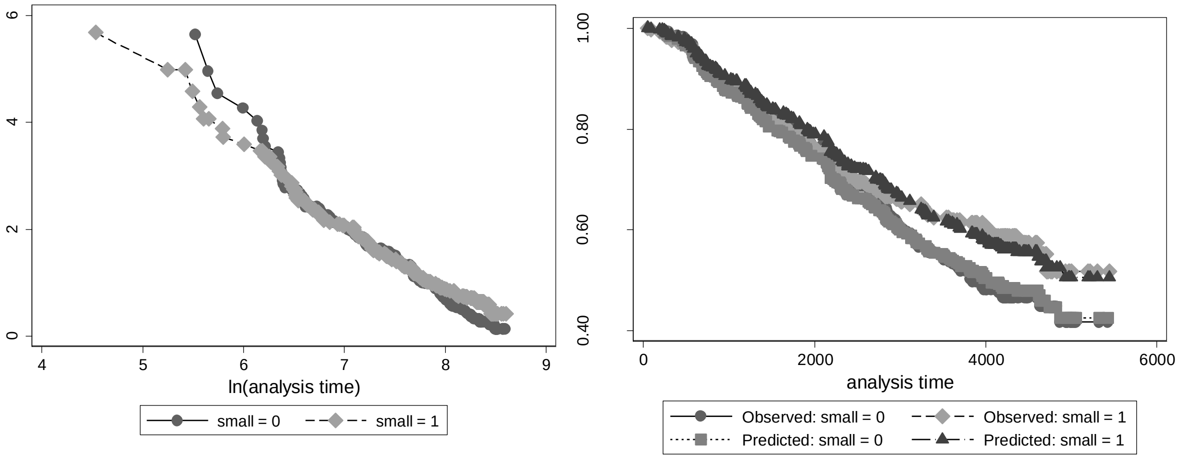

Figure 4

Small software company versus big company (time to failure)

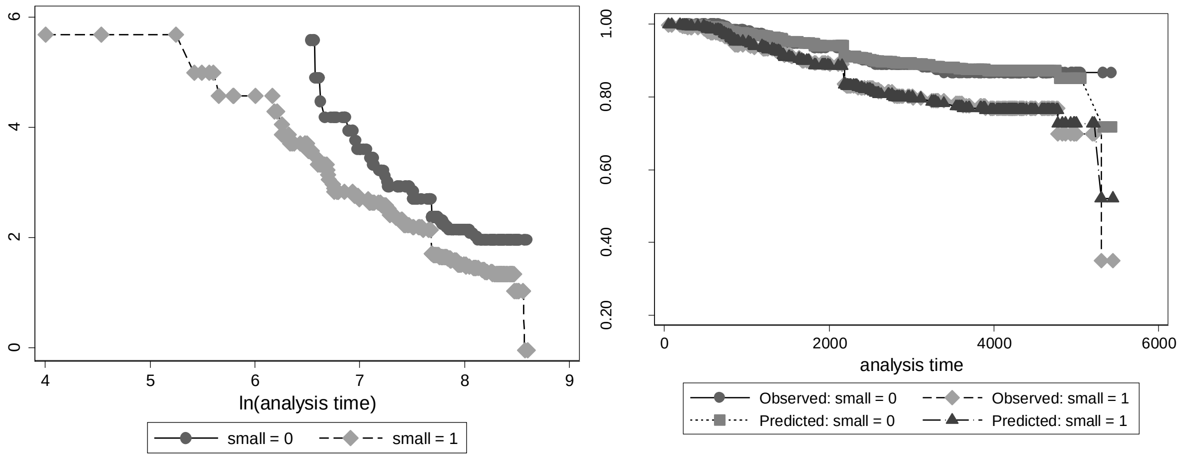

Table 7. Results from a stratified Cox Proportional Hazards Regression

	(1)	(2)	(3)	(4)
	Days to exit		Months to exit	
VARIABLES	ACQUIRED	FAILURE	ACQUIRED	FAILURE
PATENTAPPLIED	0.938**	0.600*	0.938**	0.602*
	(0.0252)	(0.168)	(0.0254)	(0.169)
SHARE OF PATENTS OBTAINED	1.757	1.306	1.777	1.309
	(0.692)	(1.398)	(0.701)	(1.402)
FORWARD CITATIONS	1.006***	0.842*	1.006***	0.843*
	(0.00177)	(0.0856)	(0.00177)	(0.0855)
INTERNATIONAL APPL (PCT)	0.917	1.432	0.919	1.429
	(0.0975)	(0.724)	(0.0969)	(0.721)
POSITIVE RETURN ON SALES RATIO	0.877	0.581**	0.875	0.584**
	(0.122)	(0.143)	(0.121)	(0.144)
EQUITY RATIO	1.001	0.999*	1.001	0.999*
	(0.0217)	(0.000325)	(0.0217)	(0.000324)
LOG (ASSETS)	1.041	0.810***	1.042	0.811***
	(0.0487)	(0.0644)	(0.0482)	(0.0643)
LOG (REVENUES)	0.888***	0.943	0.891***	0.943
	(0.0344)	(0.0813)	(0.0344)	(0.0810)
AGE AT IPO	0.985*	0.932***	0.985*	0.932***
	(0.00856)	(0.0230)	(0.00857)	(0.0230)
VENTURE BACKED	0.873	0.879	0.868	0.869
	(0.201)	(0.336)	(0.198)	(0.332)
1997-1999	1.337*	0.966	1.333*	0.964
	(0.226)	(0.327)	(0.224)	(0.326)
2001-2002	0.623	0.709	0.622	0.699
	(0.186)	(0.231)	(0.185)	(0.227)
2003-2005	1.145	0.923	1.142	0.921
	(0.274)	(0.337)	(0.273)	(0.336)
INTERNET RELATED	1.477**	1.634*	1.465**	1.635*
	(0.233)	(0.414)	(0.229)	(0.413)
Industry activity 1- NACE Rev.2 (61-63)	1.641	1.475	1.637	1.470
	(0.514)	(0.739)	(0.512)	(0.737)
Industry activity 2- NACE Rev.2 (69-73)	1.594	1.423	1.552	1.416
	(0.683)	(1.026)	(0.664)	(1.016)
Industry activity 3- NACE Rev.2 (82-92)	3.128***	4.357**	3.139***	4.332**
	(1.322)	(3.139)	(1.325)	(3.117)
Industry activity 4- NACE Rev.2 (26-28)	1.720	4.708**	1.720	4.685**
	(0.756)	(3.707)	(0.751)	(3.687)
Industry activity 5- NACE Rev.2 (64)	2.234	2.850	2.236	2.788
	(1.157)	(2.031)	(1.156)	(1.988)
Industry activity 6- NACE Rev.2 (45-47)	1.452	0.992	1.465	0.998
	(0.624)	(0.720)	(0.628)	(0.724)
Firms	496	339	496	339
Exits	239	82	239	82
Log likelihood	-728.2	-246.9	-730.1	-247.3
Wald chi2	58.67	97.24	57.95	97.48
Time at risk	1485337	1167516	48586	38233
Test of proportional-hazards assumption (Prob>chi2)	0.9815	0.9248	0.9825	0.9298

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Results from a competing-stratified Cox model Regression

	(5)	(6)	(7)	(8)
	Days to exit		Months to exit	
VARIABLES	ACQUIRED	FAILURE	ACQUIRED	FAILURE
PATENTAPPLIED	0.938**	0.598*	0.938**	0.600*
	(0.0252)	(0.167)	(0.0253)	(0.167)
SHARE OF PATENTS OBTAINED	1.761	1.312	1.776	1.313
	(0.694)	(1.414)	(0.705)	(1.418)
FORWARD CITATIONS	1.006***	0.843*	1.006***	0.843*
	(0.00177)	(0.0854)	(0.00178)	(0.0853)
INTERNATIONAL APPL (PCT)	0.917	1.429	0.918	1.424
	(0.0976)	(0.724)	(0.0977)	(0.721)
POSITIVE RETURN ON SALES RATIO	0.878	0.578**	0.877	0.580**
	(0.123)	(0.143)	(0.122)	(0.143)
EQUITY RATIO	1.001	0.999	1.001	0.999*
	(0.0218)	(0.000326)	(0.0218)	(0.000337)
LOG (ASSETS)	1.041	0.810***	1.042	0.812***
	(0.0489)	(0.0651)	(0.0488)	(0.0651)
LOG (REVENUES)	0.887***	0.943	0.888***	0.944
	(0.0344)	(0.0824)	(0.0347)	(0.0823)
AGE AT IPO	0.985*	0.932***	0.985*	0.932***
	(0.00858)	(0.0232)	(0.00861)	(0.0233)
VENTURE BACKED	0.869	0.908	0.864	0.901
	(0.201)	(0.348)	(0.199)	(0.345)
1997-1999	1.338*	0.969	1.337*	0.967
	(0.226)	(0.329)	(0.226)	(0.328)
2001-2002	0.623	0.745	0.625	0.738
	(0.187)	(0.249)	(0.187)	(0.246)
2003-2005	1.145	0.910	1.147	0.912
	(0.275)	(0.340)	(0.277)	(0.341)
INTERNET RELATED	1.483**	1.638*	1.478**	1.636*
	(0.234)	(0.420)	(0.234)	(0.419)
Industry activity 1- NACE Rev.2 (61-63)	1.648	1.493	1.649	1.491
	(0.517)	(0.747)	(0.518)	(0.747)
Industry activity 2- NACE Rev.2 (69-73)	1.594	1.433	1.561	1.427
	(0.684)	(1.040)	(0.671)	(1.034)
Industry activity 3- NACE Rev.2 (82-92)	3.133***	4.472**	3.148***	4.453**
	(1.325)	(3.240)	(1.335)	(3.225)
Industry activity 4- NACE Rev.2 (26-28)	1.724	4.823**	1.728	4.806**
	(0.758)	(3.815)	(0.759)	(3.798)
Industry activity 5- NACE Rev.2 (64)	2.231	3.059	2.227	3.008
	(1.156)	(2.171)	(1.154)	(2.133)
Industry activity 6- NACE Rev.2 (45-47)	1.458	0.973	1.480	0.977
	(0.629)	(0.708)	(0.638)	(0.710)
Firms	578	578	578	578
Exits	239	82	239	82
Log likelihood	-727.6	-245.5	-728.4	-245.6
Wald chi2	58.80	96.09	57.83	95.75
Time at risk	1633767	1633767	53439	53439
Test of proportional-hazards assumption (Prob>chi2)	0.9809	0.9817	0.9205	0.9240

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Results are competing-stratified Cox proportional estimates where the Efron method was employed for handling ties. All models were stratified by country, at least one patent application, SME and the competing risk.

Methodological Appendix

A- The Variance Inflation Factor tests

As claimed in the paper, we perform variance inflation factors on our regression to seek for multicollinearity problems. The Variance Inflation Factor tests for the two groups do not have extremely high values and the tolerance of variances are not close to zero, thus one can conclude that explanatory variables are independent and multicollinearity is not an issue.

Variance Inflation factors

VARIABLE	VIF	1/VIF	VARIABLE	VIF	1/VIF
ACQUIRED	1.11	0.901160	BANKRUPCY/ VOLUNTARY LIQUIDATION	1.16	0.860659
PATENTAPPLIED	2.56	0.390690	PATENTAPPLIED	2.55	0.392317
SHARE OF PATENTS OBTAINED	3.59	0.278609	SHARE OF PATENTS OBTAINED	3.59	0.278534
FORWARD CITATIONS	2.87	0.348965	FORWARD CITATIONS	2.86	0.349567
INTERNATIONAL APPL (PCT)	2.75	0.363636	INTERNATIONAL APPL (PCT)	2.75	0.363977
POSITIVE RETURN ON SALES RATIO	1.17	0.854519	POSITIVE RETURN ON SALES RATIO	1.17	0.853081
EQUITY RATIO	1.06	0.939809	EQUITY RATIO	1.07	0.938153
LOG (ASSETS)	2.22	0.449877	LOG (ASSETS)	2.26	0.442790
LOG (REVENUES)	3.32	0.301084	LOG (REVENUES)	3.29	0.303871
AGE AT IPO	1.23	0.815286	AGE AT IPO	1.23	0.810579
VENTURE BACKED	1.11	0.897420	VENTURE BACKED	1.11	0.898051
1997-1999	1.51	0.661446	1997-1999	1.49	0.671188
2001-2002	1.25	0.802188	2001-2002	1.24	0.806048
2003-2005	1.36	0.734596	2003-2005	1.36	0.733399
INTERNET RELATED	1.33	0.753315	INTERNET RELATED	1.33	0.751713
Industry activity 1- NACE Rev.2 (61-63)	3.18	0.314532	Industry activity 1- NACE Rev.2 (61-63)	3.16	0.316147
Industry activity 2- NACE Rev.2 (69-73)	1.68	0.596663	Industry activity 2- NACE Rev.2 (69-73)	1.67	0.597628
Industry activity 3- NACE Rev.2 (82-92)	1.62	0.618048	Industry activity 3- NACE Rev.2 (82-92)	1.61	0.621222
Industry activity 4- NACE Rev.2 (26-28)	1.68	0.594309	Industry activity 4- NACE Rev.2 (26-28)	1.69	0.592534
Industry activity 5- NACE Rev.2 (64)	1.44	0.693579	Industry activity 5- NACE Rev.2 (64)	1.44	0.695049
Industry activity 6- NACE Rev.2 (45-47)	1.57	0.635442	Industry activity 6- NACE Rev.2 (45-47)	1.57	0.635166
DE	1.76	0.566659	DE	1.77	0.564323
FR	1.62	0.617898	FR	1.63	0.611655
SE	1.63	0.614135	SE	1.65	0.606420
ITES	1.36	0.733181	ITES	1.37	0.729815
AT LEAST ONE PATENT APPLIC.	3.77	0.264984	AT LEAST ONE PATENT APPLIC.	3.79	0.264059
SMALL SIZE	2.41	0.415421	SMALL SIZE	2.38	0.420513
Mean VIF	1.93		Mean VIF	1.93	

B- Proportional hazard assumption Tests for Cox Proportional Hazards Regression

Our previous analysis, shows as that is necessary to stratify our model. On the final results presented into the paper, we stratify by country, small company and at least one patent application (models 1 to 4) and we stratify also by the competing risk (models 5 to 8). On the first 4 models, we stratify our model to take into account differences on baseline hazard across countries, firms size and patenting behavior. In the stratified estimator, the hazard at time t for a subject in group i is assumed to be:

$$h_i(t) = H_{0i}(t)\exp(\beta_1\chi_1 + \beta_2\chi_2 + .. + \beta_K\chi_K)$$

Table 9 presents the covariate-specific and global tests of Proportional Hazard assumption (PH assumption) of models 1 to 8 presented in the paper. The tests suggest that Proportional Hazard assumption it is not violated.

Table 9. Covariate-specific and global tests of PH assumption for Cox stratified PH Regression

	Model 1	Model 2	Model 3	Model 4
VARIABLE	PH (Prob>chi2)	PH (Prob>chi2)	PH (Prob>chi2)	PH (Prob>chi2)
PATENTAPPLIED	0.9607	0.9466	0.8107	0.8155
SHARE OF PATENTS OBTAINED	0.3590	0.3447	0.7712	0.7631
FORWARD CITATIONS	0.8026	0.8054	0.8152	0.8173
INTERNATIONAL APPL (PCT)	0.8281	0.8125	0.7215	0.7259
POSITIVE RETURN ON SALES RATIO	0.3770	0.3825	0.1097	0.1077
EQUITY RATIO	0.6849	0.6815	0.5194	0.5094
LOG (ASSETS)	0.9852	0.9783	0.1694	0.1755
REVENUES	0.1097	0.1192	0.6240	0.6306
AGE AT IPO	0.5520	0.5436	0.3281	0.3299
VENTURE BACKED	0.7008	0.7166	0.1524	0.1519
1997-1999	0.1659	0.1665	0.6380	0.6459
2001-2002	0.6937	0.7017	0.6172	0.6076
2003-2005	0.7446	0.7185	0.8822	0.8746
INTERNET RELATED	0.5328	0.5484	0.3823	0.3903
Industry activity 1- NACE Rev.2 (61-63)	0.6399	0.6365	0.5953	0.6006
Industry activity 2- NACE Rev.2 (69-73)	0.6263	0.6243	0.8454	0.8605
Industry activity 3- NACE Rev.2 (82-92)	0.7653	0.7627	0.8020	0.8096
Industry activity 4- NACE Rev.2 (26-28)	0.2225	0.2159	0.5889	0.5933
Industry activity 5- NACE Rev.2 (64)	0.9195	0.9241	0.9387	0.9689
Industry activity 6- NACE Rev.2 (45-47)	0.4033	0.4002	0.8076	0.8135
GLOBAL TEST	0.9815	0.9825	0.9248	0.9298

	Model 5	Model 6	Model 7	Model 8
VARIABLE	PH (Prob>chi2)	PH (Prob>chi2)	PH (Prob>chi2)	PH (Prob>chi2)
PATENTAPPLIED	0.9606	0.9471	0.8040	0.8066
SHARE OF PATENTS OBTAINED	0.3593	0.3432	0.7876	0.7855
FORWARD CITATIONS	0.8033	0.8128	0.8207	0.8223
INTERNATIONAL APPL (PCT)	0.8283	0.8195	0.7280	0.7324
POSITIVE RETURN ON SALES RATIO	0.3784	0.3823	0.1136	0.1126
EQUITY RATIO	0.6804	0.6779	0.5265	0.5408
LOG (ASSETS)	0.9818	0.9752	0.1742	0.1831
REVENUES	0.1065	0.1169	0.6365	0.6398
AGE AT IPO	0.5535	0.5586	0.3197	0.3161
VENTURE BACKED	0.7052	0.7202	0.1474	0.1459
1997-1999	0.1663	0.1722	0.6428	0.6503
2001-2002	0.6932	0.6902	0.6039	0.5991
2003-2005	0.7376	0.7176	0.9484	0.9405
INTERNET RELATED	0.5353	0.5524	0.3751	0.3804
Industry activity 1- NACE Rev.2 (61-63)	0.6377	0.6330	0.5751	0.5773
Industry activity 2- NACE Rev.2 (69-73)	0.6260	0.6336	0.8402	0.8427
Industry activity 3- NACE Rev.2 (82-92)	0.7671	0.7736	0.7834	0.7946
Industry activity 4- NACE Rev.2 (26-28)	0.2227	0.2140	0.5713	0.5738
Industry activity 5- NACE Rev.2 (64)	0.9208	0.9253	0.8601	0.8804
Industry activity 6- NACE Rev.2 (45-47)	0.4007	0.3892	0.8058	0.8079
GLOBAL TEST	0.9809	0.9817	0.9205	0.9240

C- Robustness checks models with quadratic terms

Table 10. Results from a Cox Proportional Hazards Regression with quadratic terms

	Months to exit		Months to exit		Months to exit	
VARIABLES	ACQUIRED	FAILURE	ACQUIRED	FAILURE	ACQUIRED	FAILURE
PATENTAPPLIED	0.937**	0.615*	0.938**	0.617*	0.938**	0.600*
	(0.0266)	(0.163)	(0.0251)	(0.163)	(0.0254)	(0.166)
SHARE OF PATENTS OBTAINED	1.762	1.720	1.782	1.391	1.782	1.317
	(0.704)	(1.859)	(0.711)	(1.620)	(0.709)	(1.415)
FORWARD CITATIONS	1.007***	0.829*	1.006***	0.851	1.006***	0.843*
	(0.00179)	(0.0865)	(0.00178)	(0.0975)	(0.00179)	(0.0852)
INTERNATIONAL APPL (PCT)	0.914	1.497	0.918	1.338	0.917	1.419
	(0.0989)	(0.738)	(0.0993)	(0.766)	(0.0981)	(0.720)
POSITIVE RETURN ON SALES RATIO	0.852	0.599**	0.884	0.648*	0.877	0.581**
	(0.120)	(0.151)	(0.122)	(0.161)	(0.122)	(0.144)
EQUITY RATIO	0.999	0.999	1.006	0.999***	1.001	0.999*
	(0.0213)	(0.000350)	(0.0224)	(0.000312)	(0.0219)	(0.000336)
LOG (ASSETS)	1.013	0.770***			1.042	0.813***
	(0.0546)	(0.0564)			(0.0491)	(0.0647)
REVENUES	1.000	1.000				
	(5.98e-07)	(7.07e-06)				
REVENUES Q	1.010	3.17e-09*				
	(0.0126)	(3.46e-08)				
AGE AT IPO	0.984*	0.927***	0.985*	0.927***	0.984	0.932**
	(0.00875)	(0.0241)	(0.00867)	(0.0242)	(0.0126)	(0.0274)
AGE AT IPO Q					1.841	0.197
					(5.416)	(2.667)
VENTURE BACKED	0.927	0.901	0.898	0.974	0.863	0.901
	(0.216)	(0.342)	(0.204)	(0.356)	(0.199)	(0.345)
1997-1999	1.292	1.062	1.386*	0.950	1.337*	0.965
	(0.217)	(0.360)	(0.234)	(0.332)	(0.226)	(0.327)
2001-2002	0.586*	0.737	0.629	0.752	0.625	0.739
	(0.184)	(0.246)	(0.188)	(0.249)	(0.187)	(0.246)
2003-2005	1.097	0.872	1.120	1.028	1.151	0.905
	(0.270)	(0.311)	(0.271)	(0.376)	(0.278)	(0.350)
INTERNET RELATED	1.465**	1.663**	1.480**	1.768**	1.473**	1.638*
	(0.232)	(0.430)	(0.234)	(0.456)	(0.235)	(0.421)
Industry activity 1- NACE Rev.2 (61-63)	1.679*	1.434	1.726*	1.683	1.653	1.489
	(0.527)	(0.752)	(0.551)	(0.901)	(0.521)	(0.748)
Industry activity 2- NACE Rev.2 (69-73)	1.521	1.606	1.667	1.478	1.558	1.421
	(0.658)	(1.216)	(0.725)	(1.098)	(0.669)	(1.036)
Industry activity 3- NACE Rev.2 (82-92)	3.088***	3.817*	3.296***	5.333**	3.150***	4.455**
	(1.318)	(2.777)	(1.429)	(3.968)	(1.335)	(3.233)
Industry activity 4- NACE Rev.2 (26-28)	1.817	4.326*	1.813	4.817*	1.734	4.799**
	(0.790)	(3.264)	(0.806)	(4.021)	(0.764)	(3.784)
Industry activity 5- NACE Rev.2 (64)	2.219	3.092	2.066	3.325	2.230	3.011
	(1.167)	(2.351)	(1.058)	(2.506)	(1.155)	(2.134)
Industry activity 6- NACE Rev.2 (45-47)	1.442	1.154	1.550	1.086	1.462	0.976
	(0.650)	(0.811)	(0.680)	(0.805)	(0.629)	(0.712)
ASSETS			1.000	1.000**		
			(1.74e-07)	(4.40e-06)		
ASSETS Q			1.009	0.000454		
			(0.0120)	(0.00597)		
LOG (REVENUES)			0.894***	0.872*	0.889***	0.942
			(0.0352)	(0.0642)	(0.0349)	(0.0824)
Observations	578	578	578	578	578	578
N_fail	239	82	239	82	239	82
ll	-731.1	-242.6	-727.6	-243.7	-728.3	-245.6
chi2	49.88	99.32	65.49	79.09	57.89	96.53
risk	53439	53439	53439	53439	53439	53439

Robust seeform in parentheses

Notes: Cox proportional regressions while including the quadratic terms of revenues (models 1, 2), assets (3, 4) and age at IPO (5, 6). The quadratic terms of revenues, assets and age at IPO are not statistically significant.

D- Cox regression stratifying by failure type

Lunn and McNeil (1995) show that by augmenting the data using a duplication method Cox regression can be adapted to take account of the failure types. The procedure that they develop runs Cox regression stratified by type of failure, $\delta = 0$ or 1. In this case the partial likehood is:

$$\prod_{t_i,\delta_i=0}\left(\frac{e^{b'xi}}{\sum_{Ri} e^{b'x}}\right)\prod\prod_{t_i,\delta_i=1}\left(\frac{e^{b'xi+\theta x_i}}{\sum_{Ri} e^{b'x+\theta' x}}\right),$$

treating the survival times of the two types of failure separately. In each case the risk set R_i consists of those firms with the appropriate stratum identifier $\delta = 0$ for the first product and $\delta = 1$ for the second.