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Are patents signals for the IPO market? Evidence for an empirical analysis of the US and the European software industry

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Abstract

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Jelcodes:O32,O34

Are patents signals for the IPO market? An EU-US comparison for the software industry[1]

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Abstract

The purpose of this empirical study is to test whether patenting behavior impacts the way investors perceive software firms' (USSIC 737) potential through a higher amount invested at Initial Public Offering (IPO) in US and Europe. This study develops econometric models of the relationship of various metrics of firm quality contained in patents (applied, obtained, pending, forward citations, international applications, etc) prior to IPO and the amount of cash collected at IPO, while controlling other factors that may influence IPO performance. The study finds significant and robust positive correlations between various metrics of patenting which reduces problems of asymmetric information and the amount collected at IPO. The power of patenting prior to IPO as a signal is significantly different between the US and Europe. For example, results indicate that an additional patent obtained prior to IPO increases the IPO proceeds by about 0.90% in US and 1.06% in Europe. However, higher availability of cash at IPO in US is associated with higher estimated return in cash for the different quality metrics. A higher impact of different metrics of patents as a signal in Europe is most likely related to the difficulty of European firms to file and obtain patents before going public. Research findings reflect that the magnitude of the value of a signal (patent metrics, venture capital support, etc) for investors changes between regions and it is related to the difficulty to get the signal and its scarcity. This paper argues that less is "applicant friendly" a patent system, the value of a patent as a signal for investors is increased while problems of selection process at IPO are reduced.

Keywords: Software firms, Patents, Signals, Initial Public Offering (IPO), Venture Capital, Start-ups.

JEL classification: O34 intellectual property rights, O32 Management of Technological Innovation and R&D, G2 - Financial Institutions and Services

Introduction

The amount of cash collected at IPO is particularly important for small and medium size high-tech companies which are cash-constrained. A major issue for SMEs going public is how to signal their value to potential investors. Investors which are increasingly risk-averse have become more cautious in selecting firms with a high potential of growth, while they are usually young, unprofitable, unsolvable and with complex business models. They tend to measure investment potential based on analyzing considerable data gathered on firms' histories and their perceived

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market potential. Thus, the companies intending to go public have to convince investors that they are worth investing (Wilbon, 1999).

Literature has highlighted the value and the nature of different metrics of firm quality for investor in high-tech companies at IPO. Some of these metrics of firm value are considered as signals which help to reduce uncertainty and skepticism regarding an IPO firm's performance. The literature stresses for example that the influence of executives and boards of directors helps to reduce uncertainty surrounding the IPO process (Certo & al., 2007). The literature also focus the role of venture capital (Lerner, 1994; Gompers, 1995), the strategic alliances and interorganizational networks (Stuart & al., 1999), the firm's technology posture and executive level technology experience (Wilbon, 1999), the scientific status related with the presence of Nobel laureates (Higgins & al., 2011), the firm's internationalization (LiPuma, 2011), among others, reducing asymmetric information and improving IPO performance. Concerning the nature of the signal, Higgins & al. (2011) found that the importance of a signal changes over time and it is inversely related to the availability of cogent information on firm quality. Thus, the importance of status (presence of Nobel laureate) in the first window of IPOs (1990-1992) diminishes as other measures of firm quality (number of patents, products in clinical trials, etc) become available in the second IPO window (1996-2000). This change in maturity seems to be consistent with the hypothesis of Pisano (2006) that investors in biotechnology become more cautious that leading them to delay their investment until firms demonstrate more tangible research output. In this way, "disclosure of information" on firm's innovativeness and competences contained in patents, products in clinical trials and others metrics could help biotech firms to attract investors reducing problems of asymmetric information and their risky investments.

The purpose of this empirical study is to test whether patenting prior to IPO (and the availability of cogent information on firm quality contained in patents) impacts the way investors perceive software firms' potential through a higher amount invested at the time of the IPO in the US and Europe. The "disclosure of information" about the innovativeness and competences of a firm contained in patents is particularly rich. Thus, this empirical study addresses a double gap concerning the value and nature of patents as signals. First inquiry is on, do patents signal for IPO value in software industry? The role of patent protection in software industry is strikingly controversial[3] (Merges and Nelson, 1990; Scotchmer, 1991; Jaffe and Lerner, 2004; Bessen and

[3] Opponents of patents argue that when research is sequential and builds upon previous discoveries, as in the software industry, the enhanced ability to enforce patents may impede rather than promote innovation. Indeed, stronger patents may discourage subsequent research on valuable inventions which could be potentially infringing (Merges and Nelson, 1990; Scotchmer, 1991). Critics also argue that any positive effect of stronger patents will be annulled by the higher

Meurer, 2008) and it could be a contradictory signal for investors. The evidence on performance and patenting of software start-ups is quite limited and particularly underdeveloped, primarily due to the paucity of data (Mann and Sager, 2007) and historically weak patent protection of the software industry (Bessen, 2003; Bessen and Hunt, 2007). In this way, this study also seeks to analyze whether non-homogenous financial markets provide incentives for growth-up software companies to multiply patent applications before going public. Second, considering that patenting technologies associated with software industries are not homogenous over space, it is also expected to find differences in the value of patents and other metrics of "quality" as signals to evaluate software IPOs in two different geographical regions (US and Europe). The analysis should reflect the differences in the value of patents as signals for investors (receptors of signals) and also the differences in the importance given to the use of patents and its accessibility by the industry (emitters).

The main hypothesis of this paper is that the degree of importance of a signal changes between the US and Europe and it is related to the scarcity of the signal. Thus, the value of a signal (different metrics of patenting, venture capital support, etc.) in two different geographical regions (US and Europe) should reflect the availability of cogent information on firm quality supported by the signal and the difficulty to get access to that signal. That's means that rarity of a signal increases its value (degree of importance) in reducing asymmetric information at IPO. To address this hypothesis, this research paper develops econometric models on the relationships between various metrics of firm quality contained in the patents (applied, obtained, citations, geographic extension) prior to IPO and the amount of cash collected at IPO moment, including controls for other factors that may influence IPO performance (Brau & Fawcett, 2006; Ritter & Welch, 2002; Kim & Ritter, 1999). This study collects all the software industry IPO deals (USSIC 737) from the United States, Germany, the United-Kingdom, France, Sweden, Italy and Spain, between 1st January 2000 to 31st December 2009 on the Bureau van Dijk's Zephyr database. These IPOs are matched with the information related to patent behavior of the firm prior to IPO from Qpad patent database to analyze IPO amounts collected by 476 software firms (234 from the US and 242 from the EU). The information from these two databases is used to better understand the differences in the patent behavior of software firms and its implications on the amount raised at IPO. The analysis indicates that innovative companies which applied and obtained more patents raise significantly more money at their IPOs, holding other factors fixed. Thus, an additional patent obtained prior to IPO increases the IPO proceeds by about 0.90% in US and 1.06% in Europe, holding other factor fixed. Based on

transaction cost, multiplied threat of litigation allowed by several blocking patents (Jaffe and Lerner, 2004 ; Bessen and Meurer, 2008). Critics also consider that patents have a negative effect on the open source software innovation model.

this coefficients and on the fact that there is a higher availability of cash at IPO in US than in Europe (the median value of cash collected at IPO is €158 millions in the US and €68.5 million in Europe), we can infer that an innovative software company raise an additional €1.41 and €0.72 million for an additional patent obtained prior to IPO in the US and Europe, respectively. Furthermore, an additional patent applied prior to IPO is associated with an additional €0.82(0.52% more cash) and €0.60 (0.89% more cash) million in the US and Europe respectively, holding other factors fixed. A higher impact of patents as a signal in Europe is most likely related to the difficulty of European firms to file and obtain patents before going public. Results reflect that the degree of importance of a signal (patents, venture capital support, etc.) for investors varies between two regions and it is related to the scarcity of the signal (24% of the European software companies applied for at least one patent prior to IPO for 2.07 patents applied on average against 73% companies with at least one patent applied prior to IPO and 14.01 patents applied on average in US).

The outline of this paper is as follows. Section 2 briefly reviews the role of patents as signals for investors in high-tech companies. The importance of the "information disclosure" contained in patents to attract venture finance will be particularly stressed. Section 3 discusses the fact that patenting technologies associated with software industries are not homogenous over the space, introducing the hypothesis that value of patents varies between two regions. Section 4 discusses the methodology and data. Regression results, alternative models and Robustness checks are provided in Section 5. A discussion on the main results and the conclusions are presented in Section 6.

2 The role of patents as a signal for investors in high-tech software companies

Innovation literature proposes that the value of patents is a signal (Hsu & Ziedonis, 2007). As discussed in the previous section, the impact of patenting in software firms performance is a controversial topic in economics of innovation. In this study, we have a special concern on how software firms can reap indirect benefits from the patent system. In line with Ziedonis (2008), one way is though information exposed during the patenting process which is usually called "information spillovers". The data contained in patents are supplied on a voluntary basis which "exchanges for disclosure" a temporary monopoly rights (Hall & al., 2001). Thus, the patent system "also aims to foster innovation through the disclosure of information about new inventions (in detailed drawings and descriptions contained in published patent documents) that otherwise might be held secret or be more difficult for outsiders to unravel" (Ziedonis, 2008). However, there are serious limitations to the use of patents to evaluate innovation and technology protection because

not all inventions are patented and others mechanisms of appropriability are used. This is particularly true in software industry in which firms commonly use a combination of copyright and trademark laws, trade secrets, confidentiality procedures and contractual provisions to protect their proprietary rights.

As reported in literature, patents are considered as a signal for investors because they could persuade them that the owner firm of patents may be a good investment. For example, Olsson & McQueen (2000) summarize seven factors influencing patenting in small computer software producing companies. The first is usual wisdom about 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, 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 effect of people leaving the company to become new competitors. Four, software firms could be interested to license 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 in order to promote the image of the company or its products.

In the literature, there are also empirical analyses on the role of patents as signals for venture capital financial support and IPO firm's valuation in high-tech sector. Mann (2005) reports qualitative empirical work seeking the role of patents in facilitating the finance of software firms. Mann's work suggests that patents have a variety of potential positive effects, depending on the stage of firm's development. Mann (2005) also argues that the software industry includes many sub-sectors in which patents have different values. Mann and Sager (2007) found different effects on patenting through the venture capital cycle. Cockburn and MacGarvie (2009) also provide evidence that patents significantly affect the likelihood of obtaining funding for early stage firms. They found that firms in "thicketed" markets with large number of patents are less likely to receive VC funding or corporate funding compared with those in markets with fewer patents. They also found that the number of patents pending is positively associated to the probability of obtaining funding, while the number of patents already granted is not.

As claimed earlier, some studies have also sought to determine the relationship between various metrics of firm quality in terms of innovation and IPO performance. However, patents have been analysed as ancillary even though they became a key element in the evaluation of firms by investors because they could be a rich source of information about the innovativeness, competences and strategy of a firm. In this way, "disclosure of information" contained in different metrics of patents could help firms to attract investors through reducing problems of asymmetric information, which could be particularly important for innovative start-ups and SME software companies.

3. The value of patents through space

To my knowledge, the analysis of the role of patents as a signal for investors in the software industry across different geographical spaces is an untouched area of research. Even more, there is a little literature addressing the role of patents in the European software industry. An opinion widely established is that European software companies cannot use patents because computer programs "as such" are excluded from patentability in Article 52(3) of the EPC. Nevertheless, recent literature clarified this "misconception" (Beresford, 2001) by showing that a large number of inventions in this field have been patented through the EPO and national patent offices in Europe (Rentocchini, 2011). Thus, technologies associated with software industries are not patented in the same way in different geographical spaces. The literature highlights the important differences in patent systems in Europe and the US (Hart et al., 1999; Beresford, 2001; Graham et al., 2002, van Pottelsberghe de la Potterie, 2010). For example, the main differences between patents systems refer the allowable subject matter (especially concerning patentability of computer programs and business models), the requirements for patentability[4], and the administrative procedures[5] that ensures the "quality of patents", among others.

Although a complete analysis of the differences of the regulation framework related to patent protection in the software industry in the US and Europe is beyond the scope of this paper, we provide a brief summary here and refer the reader to Hart et al (1999), Freedman, (2000), Beresford (2001), Graham et al (2002), van Pottelsberghe de la Potterie (2010) and Rentocchini (2011), among others, for more detail. This study considers that several elements related with the differences in the "legal standards" of the patent systems and theirs "operational designs" (see van Pottelsberghe de la Potterie, 2010) are related with the abundance and the difficulty to get access to

[4] The patentability requirements are broadly similar but not identical between the USTPO (novelty, usefulness, and non-obviousness) and the EPO (novelty, industrial application, and inventive step)(Graham et al., 2002)
[5] Related with the examination and re-examination procedures (Graham et al., 2002), the schedule of fees across patent offices (Rassenfosse and van Pottelsberghe de la Potterie, 2010), etc.

the signal affecting its value for investors. Thus, the increase in the number of applications is commonly associated with a drop in their average quality, especially in US, which could be associated with a less value as a signal for investors.

A software company interested in obtaining a patent concerning a particular technology has to deal with differences in the patent selection process across the patent systems. Thus, considering the patentable subject matters, the US Patent and Trade Office (USTPO) seems to have a less rigorous approach while compared with de European Patent Office (van Pottelsberghe de la Potterie, 2010). The USPTO is characterized for a few number of restrictions in terms of patentable subject matter which is associated with an increase in patent filings (Gallini, 2002). At the opposite at the EPO, according to Article 52 (2) (c) and (3) of the European Patent Convention (EPC), computer programs "as such" are among non-patentable subject-matter.[6] However, if a "computer-implemented invention" makes a "technical contribution to the prior art", patentability should not be denied merely on the ground that a computer program is involved in its implementation (Freedman, 2000; Rentocchini, 2011).

A patent application at the USPTO is also characterized by a lack of research reports and the applicant's identification of prior art. In the US the software company must to summit a "comprehensive and relevant" list of prior art which could be particularly difficult to identify for new software technologies for which there is lack of codification of previous inventions. van Pottelsberghe de la Potterie (2010), claims that the USTPO is subject to potential "drafting behaviors" that consists in not listing relevant prior art, or hiding it in a long list of irrelevant references. In contrast at the EPO, the examiner is in charge of identifying the prior art to establish the relevant research report which not exclude the applicant to include prior references in the submitted document.

The USTPO is also considered as more "patent applicant friendly" while considering the called "grace period" which allows the authors of the published materials or public disclosure at conferences prior to the filing date to 'reserve' for six months the invention without the inconvenience or cost of filing a patent. In Europe, the absence of grace period protects more the

[6] At the EPO, 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". Bergstra and Klink (2007) highlight that at the EPO "a software patent concerns an invention about a software based computer implementation, while a computer implemented invention is about an invention that may be implemented in software". However, as claimed by Rentocchini (2011) a clear legislative distinction remains to be drawn between "pure" software patents and computer implemented inventions in Europe.

interest of third parties (van Pottelsberghe de la Potterie, 2010). At the USTPO a software company has also a high "degree of flexibility" related with number and content of claims during the examination process and the possibility to hide applications[7]. The USPTO is also characterized by the "first to invent" principle[8], a single working language and no opposition process. At the USPTO the patentability condition called the "non-obviousness" criterion is considered as less strict than the EPO "inventive step" criterion. Finally, the USTPO has also a relatively low quality or rigour of the examination process related to a high turnover of examiners, a heavily workload per examiner, a soft identification of prior art, the lack of an opposition process and lowest fees (see van Pottelsberghe de la Potterie (2010) for a more detailed description of the EU-US patent systems differences).

In any case, patents in Europe seem to remain harder to get in comparison to the US (Jaffe and Lerner, 2004, Guellec and van Pottelsberghe de la Potterie, 2007). All these differences may have a strong impact on the power and effectiveness of the patents as signals for investors. Then it can be expected a different magnitude in the value of patents as a signal in different geographies. The main hypothesis of this paper is that the importance of a signal which may vary between regions is related to the scarcity of the signal and the difficulty to get access to that signal. Thus, the value of a signal (patents, VC support, etc.) in two different geographies (The US and Europe) should reflect the availability of cogent information on firm quality supported by the signal and the difficulty to get access to that signal. This paper argues that a more "applicant friendly" patent system is associated with a lower magnitude of the value of patents metrics as signals for IPO markets. As suggested by literature an increase in the number of patents applications can partly be associated to a lower examination standards at the USPTO (Gallini, 2002; Bessen and Meurer 2008). Thus a more "applicant friendly" patent system is associated with a less rigorous selection mechanism and inexpensive patents which reduce the value of patents as signal for investors at IPO. To address this hypothesis, this study develops econometric models of the relationship of various metrics of firm quality contained in patents (applied, obtained, pending, forward citations, international applications, etc) prior to IPO and the amount of cash collected at IPO, while controlling other factors that may influence IPO performance (Kim and Ritter, 1999; Ritter and Welch, 2002; Braw and Fawcett 2006).

[7] The USTPO is characterized by presence of continuation applications (CAPs) and continuation in parts (CIPs), while CIPs are not allowed in Europe. The CIPs lead a strong adaptation through the addition, modification and withdraw of claims to the original application.

[8] According with van Pottelsberghe de la Potterie (2010) with this rule the inventor does not need to patent in order to keep a claim on the market related with its invention. This rule could be also more effective in reducing duplicative research efforts. In Europe the useful principle is the *"first to file"* which has the advantage of stimulating an early disclosure of the invention. This principle could be also provides more incentives to firm to stay in a technological race.

4. Research design and measures

Our approach to build the dataset was to identify software IPO deals from the United States, Germany, the United Kingdom, France, Sweden, Italy and Spain, between 1st January 2000 to 31st December 2009 in ZEPHYR[9] database. IPO information of each firm is matched with the number of the firm's patents filed (patents with priority date) from the Qpad database [10]. This study uses the USSIC (Standard Industrial Classification System of the US government) code USSIC737 (Computer programming, data processing, and other computer related services) to identify software firms in ZEPHYR database. After having cleaned up the database for this study, the sample is composed of 476 software firms (234 from the US and 242 from the EU).

4.1 Econometric model

Traditional measures of IPO performance are based on the amount of cash collected by the firm at IPO (Chemmanur and Fulghieri, 1994; Ritter and Welch, 2002; Higgins et al., 2011), the pre-money valuation of the firm (Stuart et al., 1999; Gulati & Higging, 2003), and the age of the venture at IPO (Chang, 2004). This study includes an OLS model using the amount of cash collected by firms at their IPOs as the dependent variable. This measure of IPO performance avoids potential problems of over allocation in the pre-money valuation (Ritter and Welch, 2002; Higgins et al., 2011). This study also includes an alternative dependent variable of Tobin's Q as a function of the knowledge assets intensity. The Tobin's Q is used as a firm-level IPO market value equation that is linear and additively separable (following Griliches, 1981; Hall et all., 2005; Hall and MacGarvie, 2010). The Tobin's Q model proposed is a variation of the methodology of Hall et all., 2005 and Hall and MacGarvie, 2010. The Tobin's Q IPO market valuation is defined as the total proceeds raised at IPO related with the total assets in the previous year at IPO. A log-transformed variable of IPO valuation and Tobin's Q is used to addresses the valuation data skew and reduce its heterogeneity.

[9] ZEPHYR databases has a coverage of 267,217 deals in Western Europe and 16,447 deals in North America. In ZEPHYR database IPO is *"always just the FIRST time a company's shares are lis*ted on a stock exchange - if a company has a listing on another market or in another country, then the listing is NOT an IPO, merely a secondary, or additional, listing. A secondary listing can be coded as either a Capital increase, if new shares are being sold or as a Minority stake, if old shares are being sold. Often a company raises money through the sale of newly issued shares as *part of its IPO".* Additionally, the name of the stock exchange must be included if it is known.

[10] Questel-Orbit QPAT is a patent database which allows the users to build and organize patent portafolio and examine individual patents.

4.2 Patents filed, obtained and their information available

The literature has recognized patents as a very rich and potentially fruitful source of data for evaluate innovation, technological change and firm quality (Schmookler, 1966; Scherer, 1982; Hall & al., 2000; Hall & al., 2001; Jaffe & al., 2005). This study uses several variables related with patent behavior prior to IPO. First variable PATENTAPPLIED is the number of patents applications with "priority date" prior to IPO. Second variable PATENTOBTAINED is the number of patents obtained prior to IPO. Third variable PATENTPENDING is the difference between the patents applied and the patents obtained prior to IPO. Fourth variable CITATIONS AT IPO is the number of forward citations to the patents applied prior to IPO. Fifth variable INTERNATIONAL APPL(PCT) is the number of international applications (PCT applications). The last two variables are also weighted by the number of patents applied prior to IPO. Finally, the natural log of the firm's number of different patent metrics at IPO plus one.

4.2.1 Patents applied, granted and pending

Successful patent applications counts have been empirically used as an observable proxy for R&D "success" (Hall & al., 2000). This study uses the number of patents applications with "priority date" that the firms did since the creation of the firm until the effective date of IPO. The "priority date[11]" is considered to be "the effective date of filing" to establish requirements for patentability of a particular invention considering the prior art. In other words, the "priority date" of a patent application is the date which controls what prior art affects the patentability of the invention. This article addresses problems that can be anticipated in patent data collection prior to IPO, for example, if the IPO company A acquired another company B after its effective IPO, the existing patent portfolio of Firm B is not part of the portfolio of patents applications or patents obtained prior to IPO of the Firm A. The share of software companies with patents filed prior to their IPOs was 73.5% for US while only 24% for 6 selected European countries. On average, the number of patents filed prior to IPO was 2.07 patents for the European companies and 14.01 patents for US companies. The second variable PATENTOBTAINED is the number of patents obtained prior to IPO. Companies interested in patenting may choose the patent application date whereas the grant date depends up the review process at the patent office. Thus, the variable PATENTPENDING is the difference between a patent filed and obtained prior to IPO. PATENTENPENDING is related with the time between the beginning of the innovation process (the innovation experience), the R&D success, the application date, the review process and the IPO date. On average, the number of

[11] http://www.wipo.int/treaties/en/ip/paris/trtdocs_wo020.html#P83_6610

patents obtained prior at IPO was 1.58 patents for the European companies and 6.85 patents for the US ones. Additionally, the difference between the patents applied and the patents obtained prior to IPO was on average 7.25 patents for the US companies and 0.50 patents for the European ones. Finally, the variables LOG PATENT APPL.INTENSITY RATIO and LOG PATENT OBT.INTENSITY RATIO are defined as the natural log of the firm's number of patent applied and patent obtained stock at IPO plus one related to the total assets on the previous year of the IPO. The patent intensity ratios are created to measure the business's ability to consolidate a patent portfolio related to its total assets.

4.2.2 Forwards citations and international applications

Patents citations are often used to study spillovers because they introduce a way of capturing a part of the enormous heterogeneity in the "value" or "importance" of patents (Trajtenberg, 1990; Hall et al., 2005). To capture part of these heterogeneity four variables were selected in this study. The variable CITATIONS AT IPO which is the number of forward citations until the date of IPO to the patents obtained prior the IPO. The variable FCITATIONS is the number of forward citations received within 3 years after the date of IPO. The variable SELF-CITES is the number of citations to a firm's owns patents within 3 years after the date of IPO. Previous literature provide evidence that self-citations are more valuable that others citations because if a firm cites its own patents, those patents have probably been important in a particular technological area to the exploitation by the firm (Hall et all., 2005; Hall and MacGarvie, 2010). Patent data publicly available also provide geographical location of the patent protection. Indeed, a patent is a temporary legal monopoly which is also geographically located. This paper considers that an international application also capture a part of the heterogeneity in the "value" of patents. An international application could be more valuable because automatically leads to the publication of the patent and its international search report. Thus, the variable INTERNATIONAL APP (PCT) is the number of international applications (PCT applications). The variables concerning the forward citations and number of international applications are considered as signals to evaluate the "quality" of the patent portfolio and the firm quality.

4.3 Financial ratios

This study looks into the financial literature to select explanatory variables that are expected to influence the proceeds that the firm expects to raise via the IPO. Krinsky & Rotenberg (1989) and Ritter (1984) have shown a positive relationship between historical accounting information and

firm value. Indeed, investors usually consider specific ratios as helpful tools to make an investment decision. This research paper uses 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 model includes the return on assets ratio which is a widely used ratio defined as net income after taxes divided by total assets. Higher is the ROA ratio better is the company to convert its investment in profit. It is expected that firms with higher profitability have a greater IPO valuation, and as a result, ceteris paribus, the market value of a firm is positively associated with its profitability performance. It is remarkable the high number of unprofitable software companies going public: 63.67% in US and 30.38 in Europe have a negative ROA ratio. The literature highlights that the US offering firms show a marked deterioration in profitability in the 1990s (Peristiani and Hong, 2004). The model also includes the variable called EQUITY RATIO which is ratio 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. It is expected that the market value of a firm is positively associated with its equity ratio performance.

4.4 Age at IPO, venture capital and corporate venture capital support

Bureau van Dijk's Zephyr database also contains information on IPO firm's date of legal incorporation, the venture capital and the corporate venture capital support. The 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 Zephyr database it was obtained from publicly financial documents such as the annual report form 10-K for US companies and on the company's website or through specialized magazines such as Business Week. It is expected that companies with more experience before going public have greater IPO performance than young companies. European software companies going public are younger (6.34 years on average) than US companies (8.43 years on average).

This study also considers that the presence of Venture Capital could be a sign of confidence for investors and performance of the company in terms of management, technology and capabilities. The dummy variable VCAP indicates whether the IPO was backed by one or more venture firms (=1) or not (=0) while CORPVCAP, the other dummy in this group, is equal to one if the IPO was backed by one or more Corporate Venture Capitalist (CVC) and zero otherwise. Masulis and Nahata (2009) have shown that CVC managers have weaker performance incentives compared to Traditional Venture Capitalist (TVC) partners. In terms of quality and higher support provided to

start-ups, CVC are considered strategically-motivated investors which are endogenously less prone to build value-added support capabilities in comparison to TVC (Hellmann, 2002; Masulis & Nahata, 2009). It is expected that venture backed companies have greater IPO performance than ventures quoted without similar funding support.

4.5 Revenues and Assets

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 €25 million in US or €10 million in Europe.[12] It is remarkable that 40.59% and 58.26% of the software companies quoted, in US and Europe respectively, are small companies. The percentage of small software companies with at least one patent application at IPO is 26.5% in US and 13.63% in Europe. On average, the number of patent applications of software start-up is 2.43 in US and 1.00 in Europe.

4.6 Industry effects

The analysis also includes an industry dummy variable to take into account industrial differences. Industrial differences were included using the "statistical classification of economic activities in the European Community" (NACE) for European companies and USSIC (Standard Industrial Classification System of the US government) for US software companies. When a firm is a software publisher, the dummy variable SIC (7172) or NACE (58.2) is coded as one and zero otherwise. Industrial differences could be important because various levels of present and future profitability and intellectual property appropriability are related to industry differences (Levin, Cohen, & Mowery, 1985). Use of statistical classifications of activities is not free of problems because the definition of software industry is fuzzy. However, this classification can give us a general appreciation of how investors evaluate software publishers with respect to IT services companies.

[12] See the US Small Business Administration for the definition of Small Business Enterprise for U.S software companies: http://www.sba.gov/content/table-small-business-size-standards . 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

4.7 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 dummies are coded as “Y2000” to "Y2009" indicating whether the IPO was in that year .It is expected that periods of hot markets have greater IPO performance than periods of cold markets. This study also includes seven dummies to take into account geographical effects on dependent variable. Seven dummy variables coded 1 or 0 to differentiate companies according to their geographical locations. “UK”, “DE”, “FR”, “SE”, “ITES”, “NASDAQ” and “NYSE” represent the dummies of IPOs in British, German, French, Sweden, Spanish and Italian together, NYSE and NASDAQ stock exchanges respectively.

Table 1

Summary statistics

Variable	US software companies n = 234			European software companies n = 242		
	Mean	Min	Max	Mean	Min	Max
LOG (PROCEEDS)	11,19	8,51	16,34	9,33	3,14	14,75
LOG (TOBIN'S Q)	0,49	-3,29	5,06	0,43	-5,02	4,73
PATENTAPPLIED	14,10	0,00	481,0	2,07	0,00	131,0
PATENTOBTAINED	6,85	0,00	317,0	1,58	0,00	102,0
PATENTPENDING	7,25	0,00	421,0	0,50	0,00	30,0
CITATIONS AT IPO	106,22	0,00	5137,0	6,86	0,00	539,0
FCITATIONS	152,46	0,00	5802,0	12,29	0,00	676,0
SELF-CITES	23,72	0,00	889,0	0,78	0,00	82,0
INTERNATIONAL APPL (PCT)	5,68	0,00	305,0	1,17	0,00	91,0
ROA RATIO	-0,30	-9,91	0,73	-0,23	-13,16	0,70
EQUITY RATIO	0,22	-5,79	0,94	0,13	-6,34	0,90
LOG (SALES TO ASSETS)	-0,38	-7,37	2,42	-0,14	-6,12	3,09
SMALL SIZE	0,41	0,00	1,00	0,58	0,00	1,00
LOG (ASSETS)	10,70	6,01	16,97	8,90	3,53	16,47
AGE AT IPO	8,43	0,12	46,47	6,34	0,01	30,18
VCAP	0,24	0,00	1,00	0,20	0,00	1,00
CORPVCAP	0,14	0,00	1,00	0,03	0,00	1,00
SIC(7372) or NACE(58,2)	0,50	0,00	1,00	0,34	0,00	1,00
Y2000	0,31	0,00	1,00	0,28	0,00	1,00
Y2001	0,03	0,00	1,00	0,05	0,00	1,00
Y2002	0,08	0,00	1,00	0,03	0,00	1,00
Y2003	0,06	0,00	1,00	0,01	0,00	1,00
Y2004	0,12	0,00	1,00	0,11	0,00	1,00
Y2005	0,10	0,00	1,00	0,14	0,00	1,00
Y2006	0,11	0,00	1,00	0,19	0,00	1,00
Y2007	0,16	0,00	1,00	0,11	0,00	1,00
Y2008	0,01	0,00	1,00	0,05	0,00	1,00
Y2009	0,04	0,00	1,00	0,03	0,00	1,00
NASDAQ	0,86	0,00	1,00			
NYSE	0,12	0,00	1,00			
UK				0,48	0,00	1,00
DE				0,12	0,00	1,00
SE				0,08	0,00	1,00
FR				0,26	0,00	1,00
ITES				0,05	0,00	1,00

4.8 Summary Statistics

Table 1 reports descriptive statistics for the US and European software companies. The summary statistics are separated in order to emphasize differences on firm's characteristics between the US and European IPO deals[13]. Some characteristics related with patent behavior should be pointed out. First, 74% of the US software companies filed at least one patent prior to their IPOs while only 24% of European software companies did it. Second, US software companies filed on average 14.01 patents prior to IPO while European companies filed only 2.07 patents. Third, US software companies obtained on average 6.48 patents prior to IPO while European companies obtained only 1.58 patents. Fourth, the number of forward citations until the date of IPO is on average 106.22 in the US while it is only 6.86 in Europe. Fifth, the number of international applications was 5.68 in US and 1.17 in Europe. Sixth, 90% of the US VC-backed companies at least filed for one patent while this ratio is 30% in Europe.

5. Results

Several Chow tests were performed to determine whether the independent variables have different impacts on different subgroups of the population. A Chow test based on F (27, 422) with a 5% critical value of 1.52 fails to reject the constancy of the coefficients of the models in the two subgroups and confirms that separate regressions for both the US and Europe deliver a better modeling than a combined regression. Additionally, Chow tests indicate that there are not significant differences between the different European countries. Table 2 reports the results of the Pearson Correlation analysis of the independents variables for US (Panel A) and European (Panel B) IPO deals. A review of the correlations concludes that several of the variables are correlated with each other but none of the models uses highly correlated variables. Tests of multicollinearity were performed to confirm that the proposed explanatory variables are independents. 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. Table 3 shows the results of the linear regression analysis for IPO valuation with a dependent variable of the amount of cash collected by the firms at IPO. All models are significant at the 0.01 level and they are all robust which indicates there are no heteroskedasticity problems. Potential problems of endogeneity that might come from the correlation between regressors and residuals have also been tested. Nakamura Nakamura tests in for each of the potential endogeneity regressors were performed. This test indicates that endogeneity is

[13] The aim of this study is not to analyse the European diversity but regressions controls country effects.

not an issue[14]. Model 1 and Model 2, for US and European IPOs deals respectively, indicate that innovative companies which applied for more patents raise significantly more money at IPO, holding other factors fixed.

Based on the coefficients of PATENTAPPLIED in the models 1 (0.0052) and 2 (0.0089) for US and European IPOs deals respectively and on the fact that the median value of cash collected at IPO is €158 millions in the US and €68.5 million in Europe, we can infer that an innovative software company raise an additional €0.83 and €0.61 million in the US and Europe respectively, for an additional patent application prior to IPO, holding other factors fixed. The estimated return for an additional patent application is 0.52% and 0.89% higher in US and Europe, respectively. In the same way, Model 3 and Model 4 for the US and the European software IPO markets respectively, indicate that an additional patent obtained (PATENTOBTAINED) prior to IPO is associated with an additional € 1.41 million in the US and € 0.72 million in Europe, holding other factors fixed. An additional patent obtained prior to IPO increases the amount collected at IPO about 0.89% in US and 1.06% in Europe. A higher impact of patents as a signal in Europe is most likely related to the difficulty of European firms to file and obtain patents before going public. Model 5 indicates that an additional patent pending at IPO is associated with an additional € 0.90 millions of cash at IPO in US (0.57% more cash) while Model 6 shows that an additional patent pending at IPO does not impact significantly the amount of cash collected at IPO in Europe. Finally, additional patent citations at IPO are not related with higher IPO proceeds. Thus, the effect of additional forward citations received within 3 years after the date of IPO is not statistically significant. For sake of brevity these regressions were not included.

Results also indicate the importance of venture capital support on IPO valuation especially for European deals. Holding other factors fixed, a European venture backed IPO raise approximately 39.55% more cash than a company not supported by venture capitalist (model 1) while a US venture backed software company raise approximately 16.90% more cash than a non VC-backed company (model 3). These results confirm the role of venture capitalists as financial intermediaries that overcome problems of moral hazard and asymmetric information in financial markets (Gompers, 1995). Thus, coefficients also show that the value of VC support as a signal of firm quality changes between two regions and it is related to the scarcity of the signal. Equally important, the coefficient of LOG TOTALASSETS indicates that 1% increase in firm assets increases IPO software valuation by about 0.36% in US and 0.67% in Europe, models 1 and 2

[14] Results concerning Chow tests, Variance Inflation Factor tests and endogeneity tests are available upon request. C-tests were also performed to test the potential endogeneity of a group of regressors. The tests also suggest that the data not reject the use of OLS regression in favour of a IV technique. Results of this test are also available upon request.

respectively. Thus, 1% increase in firm sales to assets ratio (LOG SALES TO ASSETS) increase US software IPO valuation by about 0.11% while for European software IPO it is not statistical significant. Finally, another important result of these models is the importance of temporal and geographical effects on the amount raised at IPO. In fact, as claimed in earlier literature, market conditions strongly influence a firm's decision to going public (Lerner, 1994) and the amount collected at IPO. A company that went public in a "hot" period like before the burst of the Internet bubble in 2000, raised significantly more money than a comparable company quoted in the years that followed, holding other factor fixed. This is consistent with the idea that IPO firms take the advantages of bull markets and attempt to capture attractive stock prices (Brau & Fawcett, 2006). For European companies, being quoted in the French market is related with lower amounts of cash in comparison to the UK stock market, holding other factors fixed. In contrast, being quoted on one of the German stock market is related with higher amounts of cash in comparison to the UK. Coefficients of Spanish or Italian and Sweden stock market are not statistical significant.

Table 2

Panel A: Pearson correlation for variables used in the analysis of U.S IPO deals

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1 LOG (PROCEEDS)																											
2 LOG (TOBIN'S Q)	-0,031																										
3 PATENTAPPLIED	0,478 *	0,034																									
4 PATENTOBTAINED	0,446 *	0,039	0,773 *																								
5 PATENTPENDING	0,359 *	0,020	0,873 *	0,366 *																							
6 CITATIONS AT IPO	0,078	0,097	0,178 *	0,084	0,197 *																						
7 INTERNATIONAL APPL	0,453 *	0,039	0,885 *	0,880 *	0,623 *	0,127 *																					
8 LOG (ASSETS)	0,633 *	-0,794 *	0,265 *	0,241 *	0,203 *	-0,028	0,245 *																				
9 LOG (SALES TO ASSETS)	-0,059	0,242 *	0,036	0,038	0,024	-0,001	0,017	-0,224 *																			
10 ROA RATIO	0,265 *	-0,409 *	0,072	0,060	0,059	-0,034	0,039	0,478 *	0,217 *																		
11 EQUITY RATIO	0,209 *	-0,208 *	0,029	-0,024	0,060	0,065	-0,008	0,289 *	-0,115 *	0,529 *																	
12 VCAP	0,126 *	0,001	0,227 *	0,226 *	0,159 *	0,133 *	0,218 *	0,076	0,089	0,094	0,020																
13 CORPVCAP	0,075	-0,093	0,000	0,027	-0,022	-0,006	0,017	0,118 *	0,003	0,052	0,007	0,198 *															
14 AGE AT IPO	0,141 *	-0,152 *	0,034	0,043	0,016	-0,088	0,005	0,203 *	0,171 *	0,141 *	-0,055	-0,118 *	-0,004														
15 SIC(7372) or NACE(58,2)	-0,048	0,147 *	-0,040	-0,020	-0,043	0,099	-0,063	-0,143 *	0,143	-0,124 *	-0,057	0,075	0,069	-0,041													
16 Y2000	0,077	0,295 *	-0,081	-0,093	-0,047	0,070	-0,069	-0,181 *	-0,374 *	-0,200 *	0,219 *	-0,271 *	-0,109 *	-0,196 *	-0,087												
17 Y2001	0,043	-0,066	-0,025	-0,030	-0,014	0,001	-0,021	0,077	0,048	0,032	-0,013	-0,092	-0,027	-0,010	0,164 *	-0,108 *											
18 Y2002	-0,006	-0,135 *	-0,006	0,022	-0,026	-0,043	0,000	0,101	0,167 *	0,064	-0,029	-0,089	-0,047	0,025	0,099	-0,193 *	-0,047										
19 Y2003	-0,102	-0,070	-0,053	-0,048	-0,041	-0,011	-0,038	-0,007	0,042	0,058	0,085	-0,094	-0,019	-0,085	0,021	-0,162 *	-0,039	0,000									
20 Y2004	-0,037	0,037	0,108	0,005	0,154 *	0,030	0,046	-0,051	0,117 *	0,070	-0,007	0,138 *	0,016	0,016	-0,064	-0,241 *	-0,059	-0,104	-0,088								
21 Y2005	-0,100	-0,109 *	-0,049	0,015	-0,083	-0,046	-0,037	0,023	0,093	0,045	-0,084	0,080	-0,006	0,101	0,017	-0,220 *	-0,054	-0,095	-0,080	-0,119 *							
22 Y2006	-0,121 *	0,052	-0,007	-0,034	0,016	0,008	-0,010	-0,114 *	0,061	-0,136 *	-0,235 *	0,191 *	-0,025	0,074	-0,039	-0,231 *	-0,056	-0,100	-0,084	-0,125 *	-0,114 *						
23 Y2007	0,068	-0,119 *	0,001	0,004	-0,002	-0,016	-0,015	0,133 *	0,052	0,117 *	0,012	0,047	0,019	0,030	-0,019	-0,294 *	-0,071	-0,127 *	-0,107	-0,159 *	-0,145 *	-0,152 *					
24 Y2008	0,036	-0,097	-0,012	0,005	-0,021	-0,011	0,005	0,097	0,016	0,043	-0,003	0,201 *	0,579 *	0,003	0,039	-0,076	-0,019	-0,033	-0,028	-0,041	-0,038	-0,039	-0,050				
25 Y2009	0,070	-0,081	-0,006	-0,006	-0,004	-0,060	-0,033	0,106	0,042	0,080	-0,060	0,042	0,017	0,169 *	0,068	-0,133 *	-0,032	-0,058	-0,049	-0,072	-0,066	-0,069	-0,088	-0,023			
26 NASDAQ	-0,162 *	0,141 *	-0,088	-0,173 *	0,004	0,055	-0,120 *	-0,207 *	-0,073 *	-0,060	0,053	-0,056	-0,182 *	-0,199 *	0,009	0,270 *	-0,012	-0,067	-0,009	-0,046	0,010	-0,098	-0,121 *	-0,172 *	0,017		
27 NYSE	0,244 *	-0,178 *	0,107	0,195 *	0,007	-0,037	0,138 *	0,286 *	0,074 *	0,078	-0,047	0,059	0,201 *	0,221 *	-0,010	-0,251 *	0,021	0,086	0,022	0,067	-0,037	-0,004	0,151 *	0,188 *	-0,008	-0,928 *	

* P<0.1

Panel B: Pearson correlation for variables used in the analysis of European IPO deals

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1 LOG (PROCEEDS)																													
2 LOG (TOBIN'S Q)	0,457 *																												
3 PATENTAPPLIED	0,197 *	0,033																											
4 PATENTOBTAINED	0,199 *	0,025	0,984 *																										
5 PATENTPENDING	0,149 *	0,050	0,843 *	0,732 *																									
6 CITATIONS AT IPO	0,130 *	0,073	0,170 *	0,158 *	0,171 *																								
7 INTERNATIONAL APPL	0,159 *	0,032	0,976 *	0,954 *	0,838 *	0,142 *																							
8 LOG (ASSETS)	0,726 *	-0,280 *	0,187 *	0,196 *	0,122 *	0,084	0,147 *																						
9 LOG (SALES TO ASSETS)	-0,104	-0,010	-0,095	-0,111 *	-0,029	-0,231	-0,090	-0,104																					
10 ROA RATIO	0,097	-0,247 *	-0,032	-0,030	-0,032	-0,053	-0,037	0,295 *	0,237 *																				
11 EQUITY RATIO	0,072	-0,222 *	0,014	0,012	0,018	-0,030	0,012	0,249 *	0,010 *	0,757 *																			
12 VCAP	0,225 *	0,033	0,060	0,085	-0,028	0,120 *	0,041	0,217 *	-0,065 *	0,053	0,077																		
13 CORPVCAP	-0,049	-0,010	0,033	0,050	-0,024	0,094	0,074	-0,045	0,005	-0,097	-0,108 *	0,198 *																	
14 AGE AT IPO	0,043	-0,094	-0,043	-0,047	-0,023	0,058	-0,070	0,119 *	0,164 *	0,168 *	0,096	-0,050	-0,082																
15 SIC(7372) or NACE(58,2)	-0,095	-0,033	0,068	0,068	0,054	-0,004	0,054	-0,077	0,032	0,016	-0,007	-0,076	-0,036	0,025															
16 Y2000	0,354 *	0,445 *	0,029	0,022	0,042	0,132 *	0,036	0,038	-0,140 *	0,036	0,076	-0,104	-0,064	0,057	0,033														
17 Y2001	-0,096	-0,040	-0,044	-0,044	-0,035	-0,042	-0,037	-0,073	-0,076	-0,002	0,035	-0,073	-0,044	0,051	0,060	-0,149 *													
18 Y2002	-0,042	-0,062	-0,026	-0,023	-0,030	-0,036	-0,025	0,002	-0,063	0,038	0,041	-0,024	-0,032	-0,042	-0,021	-0,108 *	-0,041												
19 Y2003	0,026	0,009	0,109 *	0,079	0,175 *	0,061	0,036	0,022	0,003	-0,006	0,053	-0,045	-0,017	0,051	0,030	-0,057	-0,022	-0,016											
20 Y2004	0,040	-0,077	0,029	0,011	0,076	-0,010	0,036	0,103	0,138 *	-0,021	-0,156 *	-0,045	0,155 *	0,010	-0,035	-0,222 *	-0,084	-0,061	-0,032										
21 Y2005	0,009	-0,034	0,085	0,109 *	-0,004	0,047	0,074	0,036	0,147 *	0,006	-0,047	0,246 *	0,125 *	0,009	-0,017	-0,253 *	-0,096	-0,070	-0,037	-0,143 *									
22 Y2006	-0,109 *	-0,131 *	-0,067	-0,068	-0,051	-0,092	-0,059	-0,016	0,038	-0,043	-0,048	0,076	-0,031	-0,095	-0,106	-0,303 *	-0,115 *	-0,084	-0,044	-0,172 *	-0,196 *								
23 Y2007	0,015	-0,125 *	-0,024	-0,018	-0,038	-0,047	-0,032	0,113 *	0,006	0,006	0,042	0,021	-0,066	0,028	0,103	-0,222 *	-0,084	-0,061	-0,032	-0,126 *	-0,143 *	-0,172 *							
24 Y2008	-0,265 *	-0,155 *	-0,040	-0,038	-0,038	-0,032	-0,036	-0,166 *	-0,016 *	-0,013	0,030	-0,109 *	-0,040	-0,061	0,051	-0,136 *	-0,052	-0,038	-0,020	-0,077	-0,088	-0,106	-0,077						
25 Y2009	-0,329 *	-0,135 *	-0,028	-0,026	-0,030	-0,030	-0,021	-0,251 *	-0,106 *	0,003	0,065	-0,086	-0,032	-0,001	-0,073	-0,108 *	-0,041	-0,030	-0,016	-0,061	-0,070	-0,084	-0,061	-0,038					
26 UK	0,104	0,115 *	0,125 *	0,127 *	0,091	0,073	0,124 *	0,023	0,021	-0,147 *	-0,257 *	-0,042	0,054	-0,260 *	0,039	0,008	-0,045	0,131 *	0,095	0,264 *	0,088	-0,085	-0,156 *	-0,130 *	-0,166 *				
27 DE	0,169 *	0,186 *	-0,033	-0,028	-0,039	-0,071	-0,048	0,039	0,035	0,073	0,127 *	0,127 *	0,001	0,050	-0,008	0,128 *	-0,034	-0,065	-0,034	-0,133 *	-0,044	0,105	0,026	-0,082	-0,065	-0,361 *			
28 SE	-0,198 *	0,026	-0,039	-0,038	-0,036	0,039	-0,032	-0,234 *	-0,146 *	-0,094	0,080	-0,074	-0,056	-0,022	0,099	-0,054	-0,072	-0,052	-0,027	-0,106 *	-0,121 *	-0,069	0,084	0,439 *	0,217 *	-0,288 *	-0,113 *		
29 FR	-0,216 *	-0,243 *	-0,079	-0,085	-0,045	-0,045	-0,072	-0,045	-0,019	0,139 *	0,134 *	0,007	-0,006	0,182 *	-0,098	-0,062	0,107 *	-0,048	-0,055	-0,123 *	0,027	0,068	0,055	-0,086	0,120 *	-0,575 *	-0,226 *	-0,180 *	
30 ITES	0,193 *	-0,087	-0,026	-0,029	-0,013	-0,020	-0,027	0,275 *	-0,012	0,065	0,027	-0,018	-0,042	0,180 *	-0,005	-0,016	0,030	-0,039	-0,021	-0,021	-0,038	-0,014	0,100	0,042	-0,039	-0,219 *	-0,086	-0,069	-0,137 *

* P<0.1

Table 3

Dependent Variable: log (PROCEEDS)

Variables	1		2		3		4		5		6	
	Coef.	t-stat	Coef,	t-stat	Coef,	t-stat	Coef,	t-stat	Coef,	t-stat	Coef,	t-stat
PATENTAPPLIED	0,0052	5,16 ***	0,0089	2,54 **								
PATENTOBTAINED					0,0090	7,38 ***	0,0106	2,52 **				
PATENTPENDING									0,0059	3,56 ***	0,0332	1,53
CITATIONS AT IPO	0,0005	0,41	0,0065	0,22	0,0018	1,31	0,0074	0,24	0,0006	0,54	0,0055	0,19
LOG TOTAL ASSETS	0,3673	10,21 ***	0,6770	6,09 ***	0,3843	10,6 ***	0,6773	12,40 ***	0,3845	9,89 ***	0,6804	6,24 ***
LOG SALES TO ASSETS	0,1122	3,27 ***	0,0264	0,32	0,1178	3,39 ***	0,0276	0,33	0,1234	3,35 ***	0,0209	0,25
VCAP	0,1690	1,77 *	0,3955	2,26 **	0,1657	1,70 *	0,3910	2,24 **	0,2371	2,30 **	0,4091	2,34 **
AGE AT IPO	0,0036	0,52	-0,0146	-1,45	0,0031	0,46	-0,0148	-1,47	0,0038	0,55	-0,0144	-1,43
SIC(7372) or NACE(58,2)	0,1020	1,01	-0,3331	-2,03 **	0,0983	0,96	-0,3323	-2,02 **	0,0993	0,97	-0,3284	-2,01 **
y2001	-0,4037	-2,12 **	-1,1953	-2,85 ***	-0,4063	-2,14 **	-1,1971	-2,86 ***	-0,4644	-2,43 **	-1,1940	-2,86 ***
y2002	-0,6371	-3,65 ***	-1,5392	-4,79 ***	-0,6546	-3,69 ***	-1,5414	-4,81 ***	-0,6755	-3,58 ***	-1,5409	-4,77 ***
y2003	-0,6455	-2,70 ***	-0,7827	-2,99 ***	-0,6461	-2,74 ***	-0,7480	-2,94 ***	-0,6933	-2,83 ***	-0,8513	-2,92 ***
y2004	-0,5669	-3,95 ***	-1,2194	-5,20 ***	-0,4880	-3,22 ***	-1,2155	-5,19 ***	-0,6287	-3,81 ***	-1,2315	-5,22 ***
y2005	-0,7298	-4,23 ***	-1,1951	-5,24 ***	-0,7484	-4,36 ***	-1,1996	-5,25 ***	-0,7705	-4,25 ***	-1,1729	-5,17 ***
y2006	-0,5878	-3,86 ***	-1,5192	-7,05 ***	-0,5568	-3,71 ***	-1,5203	-7,06 ***	-0,6497	-3,81 ***	-1,5186	-7,06 ***
y2007	-0,4686	-3,54 ***	-1,3531	-4,18 ***	-0,4635	-3,44 ***	-1,3562	-4,19 ***	-0,5253	-3,49 ***	-1,3466	-4,15 ***
y2008	-0,8589	-3,90 ***	-2,7763	-5,68 ***	-0,8544	-3,92 ***	-2,7798	-5,69 ***	-0,9988	-3,96 ***	-2,7650	-5,65 ***
y2009	-0,4056	-1,62	-2,9544	-5,88 ***	-0,4036	-1,64	-2,9571	-5,89 ***	-0,4695	-1,81 *	-2,9368	-5,83 ***
NYSE	0,2435	1,43			0,1882	1,07			0,3090	1,65 *		
DE			0,4208	1,97 **			0,4216	1,97 **			0,4126	1,93 **
SE			0,4796	1,36			0,4809	1,37			0,4697	1,33
FR			-0,5881	-2,61 ***			-0,5858	-2,60 **			-0,6020	-2,70 ***
ITES			0,2744	0,76			0,2765	0,76			0,2527	0,70
cons	7,5049	19,96 ***	4,5266	8,95 ***	7,3279	19,4 ***	4,5263	8,92 ***	7,3671	18,71 ***	4,4965	8,97 ***
R-square	0,5913		0,7123		0,5803		0,7121		0,5658		0,7123	
observations	234		242		234		242		234		242	

* Significat at 10%

** Significat at 5%

*** Significat at 1%

Table 4 presents the results for models controlling for financial firm performances prior to IPO. The different models (from model 7 to 10), indicates that financial ratios (ROA and EQUITY Ratios) have not statistical significant effect on the amount collected at IPO. The quadratic terms of this ratios are similarly not statistical significant. For the sake of brevity the regressions were not included. Table 4 also presents the results for models considering measures of the "quality of patents" for the US and Europe through the variables SELF-CITE and INTERNATIONAL APPL (PCT). Models 9 and 10 for the US and the European IPO markets respectively, indicate that an additional international application is associated with an additional €1.42 million at IPO in the US and €0.74 million in Europe, holding other factors fixed. As in previous regressions, the value of an additional international application as a signal for investors is higher in Europe; it is related to 0.9% and 1.08% more cash at IPO in US and Europe, respectively. Similarly, an additional self-citation is associated with an additional €0.26 million in the US (model 11) and €0.59 million in Europe (model 12), holding other factors fixed. The value of an additional self-citation as a signal is 0.17% in US and 0.87% in Europe. A higher impact of the power of SELF-CITE and INTERNATIONAL APPL (PCT) in terms of coefficients as "patent quality" metrics signals in Europe is most probably related to the difficulty of European firms to apply for patents which will presumably be important in opening up a particular technological area to exploitation of the firm and will have a worldwide coverage. The number of patents' forward citations and the international applications both over the number of patents applied prior to IPO were also tested but they are not significantly related with additional cash at IPO both in the US and Europe. For the sake of brevity the regressions were not included. We also include interaction variables for the different patent metrics and SMALL SIZE to test whether the retour of patent behavior is the same between small companies and the rest of population in the simple. Regression results show that there is no statistical significant evidence for differences in the retour of patent behavior between software companies related to its size. For the sake of brevity the regressions were not included.

Finally, Models 13 and 14 for US and European IPO markets respectively, confirm the interaction between obtaining of at-least-one patent prior to IPO and the presence of venture capital support as a strong signal for IPO markets, especially for European deals. An innovative US venture backed software IPO with at-least-one patent obtained prior to IPO raise 27.41% more cash than a US non-venture backed software IPO without patents obtained prior to IPO, holding other factors fixed. In contrast, the same comparison in Europe indicates that a European venture backed software IPO with at-least-one patent obtained prior to IPO raise 61.07% more cash at IPO, holding other factors fixed.

Table 4

Dependent Variable: log (PROCEEDS)

Variables	7		8		9		10		11		12		13		14	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
PATENTAPPLIED	0,0051	4,94 ***	0,0085	2,42 **												
INTERNATIONAL APPL (PCT)					0,0090	8,57 ***	0,0108	2,49 **								
SELF-CITE									0,0017	2,52 **	0,0087	1,71 *				
AT-LEAST-ONE-POB * VCAP													0,2741	2,21 **	0,6107	2,34 **
CITATIONS AT IPO	0,0004	0,36	0,0074	0,25	0,0012	1,07	0,0087	0,28	0,0011	0,92	0,0115	0,34	0,0022	1,30	0,0145	0,48
LOG TOTAL ASSETS	0,3912	8,53 ***	0,7221	12,95 ***	0,4015	8,84 ***	0,7255	13,10 ***	0,3902	10,7 ***	0,6757	12,3 ***	0,4200	9,59 ***	0,6958	13,21 ***
LOG SALES TO ASSETS	0,1295	3,33 ***	0,0634	0,72	0,1352	3,50 ***	0,0631	0,72	0,1204	3,38 ***	0,0224	0,27	0,1362	3,40 ***	0,0175	0,20
ROA RATIO	-0,0695	-1,30	-0,0788	-0,94	-0,0736	-1,39	-0,0804	-0,94								
EQUITY RATIO	0,0060	0,10	-0,1923	-1,51	0,0133	0,21	-0,1929	-1,51								
VCAP	0,1729	1,74 *	0,4689	2,61 ***	0,1808	1,78 *	0,4722	2,62 ***	0,2127	2,08 **	0,4390	2,48 **				
CORPVCAP	0,0292	1,18	-0,5714	-1,52	0,0270	1,07	-0,5900	-1,55	0,0361	1,27	-0,4732	-1,52	0,0220	0,90	-0,3370	-1,14
AGEATIPO	0,0037	0,55	-0,0157	-1,56	0,0040	0,59	-0,0156	-1,54	0,0037	0,54	-0,0157	-1,55	0,0028	0,41	-0,0195	-1,97 **
SIC(7372) or NACE(58,2)	0,1085	1,05	-0,3209	-1,98 *	0,1212	1,10	-0,3157	-1,94 *	0,1105	1,05	-0,3264	-1,98 **	0,0925	0,86	-0,3766	-2,25 **
y2001	-0,4133	-2,09 **	-1,1739	-2,83 ***	-0,4197	-2,14 **	-1,1751	-2,83 ***	-0,4391	-2,4 **	-1,2061	-2,88 ***	-0,5307	-2,72 ***	-1,2232	-2,87 ***
y2002	-0,6448	-3,53 ***	-1,4646	-4,72 ***	-0,6413	-3,48 ***	-1,4652	-4,74 ***	-0,6674	-3,78 ***	-1,5526	-4,79 ***	-0,7359	-3,62 ***	-1,5592	-4,93 ***
y2003	-0,6362	-2,67 ***	-0,6716	-2,33 ***	-0,6426	-2,71 ***	-0,5962	-2,27 **	-0,6804	-2,81 ***	-0,6740	-2,88 ***	-0,7479	-3,01 ***	-0,7127	-3,01 ***
y2004	-0,5590	-3,81 ***	-1,2786	-5,58 ***	-0,5057	-3,36 ***	-1,2774	-5,57 ***	-0,5521	-3,65 ***	-1,1693	-5,04 ***	-0,5811	-3,20 ***	-1,1693	-5,11 ***
y2005	-0,7338	-4,03 ***	-1,2394	-5,80 ***	-0,7137	-3,90 ***	-1,2331	-5,78 ***	-0,7475	-4,33 ***	-1,1533	-5,04 ***	-0,8232	-4,37 ***	-1,1932	-4,72 ***
y2006	-0,6029	-3,69 ***	-1,5941	-7,54 ***	-0,5868	-3,58 ***	-1,5948	-7,53 ***	-0,6575	-4,02 ***	-1,5219	-7,01 ***	-0,6579	-3,56 ***	-1,5006	-6,94 ***
y2007	-0,4671	-3,47 ***	-1,4253	-4,36 ***	-0,4505	-3,29 ***	-1,4247	-4,35 ***	-0,5007	-3,52 ***	-1,3561	-4,16 ***	-0,5771	-3,43 ***	-1,4173	-4,20 ***
y2008	-0,9939	-4,42 ***	-2,7528	-5,57 ***	-1,0008	-4,51 ***	-2,7481	-5,55 ***	-1,2246	-4,48 ***	-2,7783	-5,68 ***	-1,2059	-4,75 ***	-2,8133	-5,72 ***
y2009	-0,4099	-1,61	-2,8258	-5,66 ***	-0,3728	-1,48	-2,8171	-5,64 ***	-0,4904	-1,9 *	-2,9572	-5,83 ***	-0,5293	-1,97 **	-3,0084	-5,85 ***
NYSE	0,2174	1,26			0,2057	1,14			0,2867	1,59			0,2906	1,44		
DE			0,5449	2,60 *			0,5473	2,60 **			0,4236	2 **			0,4375	2,10 **
SE			0,6002	1,68			0,5972	1,67 *			0,4651	1,32			0,4867	1,39
FR			-0,4663	-2,08 ***			-0,4683	-2,09 **			-0,5904	-2,62 ***			-0,5358	-2,37 **
ITES			0,2751	0,74			0,2658	0,71			0,2679	0,73			0,1775	0,47
cons	7,2350	15,38 ***	4,1128	8,07 ***	7,1197	15,37 ***	4,0816	8,05 ***	7,2942	19,2 ***	4,5444	8,94 ***	7,0525	16,34 ***	4,4545	8,98 ***
R-square	0,5945		0,7259		0,5857		0,7254		0,5619		0,7126		0,5268		0,7097	
observations	234		242		234		242		234		242		234		242	

* Significat at 10%

** Significat at 5%

*** Significat at 1%

5.1 Alternative and Robustness checks models

Model 15 in Table 5 shows the results of a linear regression analysis interacting dummy variables with other explanatory variables to allow for a different in slopes in order to test the main hypothesis while using the overall simple. In model 15, the estimated return to apply for patents prior to IPO for US software companies is 0.00288, or 0.288 %. For European companies, it is 0.0029 + 0.0135 = 0.0164, or 1.64%. The difference 0.0135 is statistically significant: the t statistic is 0.013236 / 0.003 = 3.47. Thus, we conclude that there is evidence against the hypothesis that the return to apply for patents prior to IPO is the same for U.S and European software companies. Model 15 also introduces four groups related to venture capital support: VCAP*US, VCAP*EU, NONVCAP*US, NONVCAP*EU, for venture and non-venture backed companies for US and Europe, respectively. The estimates on the three dummy variables measure the proportionate difference in IPO valuation relatives to NONVCAP*EU companies. Thus, European venture backed companies are estimated to raise about 55.86% more than NON VB European companies, holding other factors fixed. A venture backed US company raise 98.34% more than a NON VB European company with the same levels of the others variables. Thus, the estimated proportionate difference between US and EU venture backed company is 0.9834 – 0.5586 = 0.425, which means that a US venture backed company raise about 42.5% more that EU venture backed company. Additionally, US venture backed companies raise about 34.69% (0.9834- 0.6332= 0.350) more money that NON US VB companies. That's mean that the value of venture backed support as a signal is significantly higher in Europe than in U.S.

Model 16 performs a regression for the European companies while using interaction variables for the number of patent applications and the country effects. Based on the coefficients of the interaction variables, the analysis infers that the value of patent applications is 7.6% and 9.11% higher for Germany and France, respectively, than for United-kingdom while the difference is not statistically significant for Sweden, Italy and Spain. The number of patent applications prior to IPO is on average 1.66 in United-Kingdom, 0.14 in Germany, 0.17 in France, 0.054 in Sweden and 0.041 in Italy and Spain. Results are consistent with the hypothesis that the value of patents applications as a signal for investors varies between the regions and it is related to the scarcity of the signal while comparing United-Kingdom, Germany and France. However, the difference is not statistically different for United-kingdom, Sweden, Italy and Spain or while comparing Germany, France and Sweden. Robustness checks were also performed including only British, German and French software IPO deals. Result reflects that coefficients are very similar to those of the base

model, in particular the effects of the signal does not change. For the sake of brevity all the regressions were not included.

Models 17 and 18 indicate that a 10% increase in patent intensity (the ratio of the patent obtained stock to assets) is related with an increase by about 0.89% and 2.30% in IPO proceeds in US and in Europe, holding other factors fixed. Thus, an increase in patent application intensity by 10 percentage points is associated with an increase of 1.15% and 2.56% in IPO proceeds in US and in Europe, holding other factors fixed. For the sake of brevity all the regressions were not included.

Table 5 also presents the results for models using an alternative dependent variable a log of Tobin's Q as a function of the knowledge assets intensity. The log of Tobin's Q is used as a firm-level IPO market value equation that is linear and additively separable (following Griliches, 1981; Hall et all., 2005; Hall and MacGarvie, 2010). Models 19 and 20 predict that if the ratio of patent applied related to the assets that produce it increases by 10 percentage points, the Tobin's Q software IPO market value increases by about 0.89% in US and 2.30% in Europe, holding other factors fixed. The effect of VCAP indicates that venture backed support is associated with a 19.44% and 37.08% increase in Tobin's Q software IPO market value in US and Europe, respectively. Each 10% increase in the sales to total assets ratio is associated with a 1.33% increase in US software Tobin's Q IPO market value while is not statistical significant for Europe. Table 5 also compares the impact of the independent variables on different dependent variables: log (PROCEEDS) for models 17 and 18, log of Tobin's Q for models 21 and 22. Those models predict that if the patent intensity ratio increases by 10 percentage points, the Tobin's Q IPO market value and proceeds at IPO increase by about 1.15% in US and 2.56% in Europe. Similarly, venture backed support is associated with a 19.44% and 37.08% increase on the amount collected at IPO (measured by the proceeds at IPO or Tobin's Q IPO market value). Alternative and robustness checks models results are consistent with the hypothesis that the value of a signal for investors (patents applied, obtained and venture capital support, etc.) varies between US and Europe and it is related to the scarcity of the signal.

Table 5

Variables	log (PROCEEDS)								Log of Tobins' Q = ln (PROCEEDS / TOTAL ASSETS)							
	15		16		17		18		19		20		21		22	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
LOG PATENT APPL.INTENSITY RATIO									0,1150	2,66 ***	0,2567	2,83 ***				
LOG PATENT OBT.INTENSITY RATIO					0,0898	2,65 ***	0,2301	2,59 ***					0,0898	2,65 ***	0,2301	2,59 ***
PATENTAPPLIED	0,0029	4,09 ***	0,0063	2,14 **												
PATENTAPPLIED*DE			0,0760	2,24 **												
PATENTAPPLIED*FR			0,0911	4,46 ***												
PATENTAPPLIED*ITES			-0,0440	-0,84												
PATENTAPPLIED*SE			0,0960	0,75												
PATENTAPPLIED*EU	0,0135	3,64 ***														
LOG TOTAL ASSETS	0,5934	15,58 ***	0,6760	12,19 ***	0,4945	8,50 ***	0,9080	9,88 ***	-0,4789	-7,32 ***	-0,0678	-0,74	-0,5055	-8,69 ***	-0,0920	-1,00
LOG SALES TO ASSETS	0,1226	2,57 ***	0,0297	0,36	0,1333	3,39 ***	0,0412	0,52	0,1335	3,48 ***	0,0427	0,54	0,1333	3,39 ***	0,0412	0,52
VCAP			0,4081	2,28 **	0,1944	1,79 *	0,3708	2,16 **	0,1879	1,75 *	0,3736	2,17 **	0,1944	1,79 *	0,3708	2,16 **
NON VCAP*US	0,6332	4,82 ***														
VCAP*US	0,9834	6,54 ***														
VCAP*EU	0,5586	3,29 ***														
AGEATIPO	-0,0013	-0,20	-0,0193	-1,89 *	0,0035	0,50	-0,017	-1,76 *	0,0041	0,59	-0,0173	-1,79 *	0,0035	0,50	-0,0171	-1,76 *
SIC(7372) or NACE(58,2)	-0,0448	-0,47	-0,3640	-2,21 **	0,0938	0,93	-0,356	-2,23 **	0,0999	1,00	-0,3614	-2,26 **	0,0938	0,93	-0,3565	-2,23 **
y2001	-0,9483	-3,25 ***	-1,1623	-2,76 ***	-0,5284	-2,79 ***	-1,184	-2,78 ***	-0,5183	-2,64 ***	-1,1769	-2,79 ***	-0,5284	-2,79 ***	-1,1838	-2,78 ***
y2002	-1,1193	-6,71 ***	-1,5338	-4,79 ***	-0,7226	-3,75 ***	-1,568	-5,08 ***	-0,7432	-3,89 ***	-1,5782	-5,11 ***	-0,7226	-3,75 ***	-1,5683	-5,08 ***
y2003	-0,9143	-3,99 ***	-0,6988	-3,12 ***	-0,6882	-2,89 ***	-1,216	-3,6 ***	-0,6978	-2,96 ***	-1,1635	-3,58 ***	-0,6882	-2,89 ***	-1,2157	-3,60 ***
y2004	-0,9472	-6,18 ***	-1,2026	-5,10 ***	-0,5672	-3,33 ***	-1,249	-5,37 ***	-0,5918	-3,54 ***	-1,2549	-5,39 ***	-0,5672	-3,33 ***	-1,2491	-5,37 ***
y2005	-1,0833	-7,34 ***	-1,1517	-4,92 ***	-0,7699	-4,33 ***	-1,293	-5,52 ***	-0,8092	-4,55 ***	-1,2964	-5,57 ***	-0,7699	-4,33 ***	-1,2926	-5,52 ***
y2006	-1,1222	-6,97 ***	-1,5215	-6,93 ***	-0,6517	-3,75 ***	-1,558	-7,35 ***	-0,6693	-3,85 ***	-1,5529	-7,30 ***	-0,6517	-3,75 ***	-1,5583	-7,35 ***
y2007	-0,9931	-5,92 ***	-1,3968	-4,11 ***	-0,5626	-3,62 ***	-1,424	-4,5 ***	-0,5984	-3,81 ***	-1,4228	-4,50 ***	-0,5626	-3,62 ***	-1,4238	-4,50 ***
y2008	-2,2467	-5,86 ***	-2,7533	-5,31 ***	-1,0787	-4,12 ***	-2,771	-5,78 ***	-1,1251	-4,42 ***	-2,7840	-5,82 ***	-1,0787	-4,12 ***	-2,7708	-5,78 ***
y2009	-1,6611	-4,98 ***	-2,9309	-5,75 ***	-0,4787	-1,89 **	-2,975	-5,98 ***	-0,5265	-2,06 *	-2,9939	-6,01 ***	-0,4787	-1,89 **	-2,9748	-5,98 ***
NYSE	0,2240	1,23			0,2981	1,56			0,2874	1,53			0,2981	1,56		
DE	0,3980	1,81 *	0,3443	1,56			0,4118	2,02 **			0,4121	2,00 **			0,4118	2,02 **
SE	0,0928	0,30	0,4308	1,06			0,4852	1,4			0,4930	1,43			0,4852	1,40
FR	-0,7140	-3,19 **	-0,6390	-2,86 ***			-0,553	-2,46 **			-0,5480	-2,44 **			-0,5532	-2,46 **
ITES	0,3495	1,10	0,3451	0,87			0,2999	0,84			0,3086	0,86			0,2999	0,84
cons	4,8860	13,51 ***	4,5755	8,88 ***	7,0984	17,14 ***	4,5236	9,14 ***	7,1096	17,35 ***	4,5509	9,16 ***	7,0984	17,14 ***	4,5236	9,14 ***
R-square	0,7324		0,7193		0,5448		0,7167		0,7209		0,4479		0,7191		0,4476	
observations	476		234		234		242		234		242		234		242	

*** Significat at 1%

** Significat at 5%

* Significat at 10%

6. Discussion and conclusion

This study provides new insights to the literature in several ways. This study contributes to the innovation literature by analysing the relationship between IPO performance and patent behavior in a comparative perspective that takes geographical differences into account. The study uses an original database that brings together software IPO deals from ZEPHYR database and their patent data extracted from Q-pad patent database, in two different geographical areas. The study consolidates a large sample of 476 completed IPO deals in computer programming based industries (SIC 737) from 1st January 2000 to 31st December 2009. Other studies analysing the relation of IPO performance and firms quality provide much smaller samples as for example Wilbon (1999) and Wilbon (2003) present respectively 31 completed US IPO deals in computer based industries by the of 1996 and 168 completed US IPO deals in high tech industries by the end of 1992. Higgins et al. (2011) bring together a sample of 89 IPO deals in biotech industries in the US with 44 IPOs between 1990 and 1992 and 45 other between 1996 and 2000. LiPuma (2011) constitute a sample of 184 privately held venture capital-backed US technology-based new ventures that executed an IPO in the period of 1997–2003.

This research also suggest that non-homogenous financial markets provide different incentives for growth-up software companies to multiply patent applications before going public. The results of the analysis indicate that patent behavior impacts the amount of cash collected at IPO not only in the US but also in Europe. Results indicate that an additional patent obtained prior to IPO increases the IPO proceeds by about 9.0% in US and 10.6% in Europe. Thus, an additional patent obtained prior to IPO is associated with additional € 1.41 millions in the US and € 0.72 millions in Europe, holding other factors fixed. Furthermore, the estimated return for an additional patent application is 0.52% and 0.89% higher in US and Europe, respectively. An additional patent filed prior to IPO is associated with an additional €0.82 millions of cash at an IPO in the US and €0.61 million in Europe, holding other factors fixed. A higher impact of the power of patents as a signal in Europe is most likely related to the difficulty of European firms to file and obtain patents (2.07 and 1.58 on average, respectively) before going public compared to the US (14.01 and 6.85 on average, respectively). However, even if the impact of an additional patent as a signal is higher in Europe than in the US, a more developed software IPO market (on NASDAQ and NYSE) is related with a larger amount of cash at IPO. Similarly, a higher number of patents applied and obtained prior to an IPO in US and in Europe allows us to suggest that patenting behavior favours principally US software companies at their IPOs.

A higher impact of the power of patents as signals in Europe compared to the US is not the result of a lower level of quality of patents in the US in term of citations at IPO (on average 106.22 in US against 6.86 in Europe). A higher impact of the power of patents as signals in Europe is most likely related to the difficulty of European firms to file and obtain patents before going public. Results reflect that the value of a signal (patents, venture capital support, ect) varies between two regions and it is related to the scarcity of the signal. This means that the power of a signal, in this case patent metrics prior to IPO, is significantly different between the US and Europe. This is probably the result of differences in the conditions of patentability of technologies associated with software industries in two geographical areas. This also suggests that the importance of a signal is consolidated when their conditions of use are spread between the emitters of signals and their receptors. That is to say that an additional patent applied is consolidated as a signal when investors seem to understand the importance of this signal in the evaluation of the firms and when firms understand the importance of this signal for investors. This can also suggests that the importance of a signal can also decrease when it is widely used by most of the players or when getting the signal becomes less expensive. Research findings also indicate that an additional patent pending at the time of IPO is associated with an additional € 0.93 million in the US while it is not significantly important in Europe. This suggests that even if all the applications are related with additional cash at IPO as an R&D reward, companies interested in patenting have an incentive to apply for a patent as early as possible, especially in Europe.

The results also suggest that the increased importance of financial markets in recent years has contributed to growth the number of patents applications before the IPO. This direct monetary incentive through financial markets has helped to increase the number of patents filed by software firms that previously were not necessarily interested in patent protection. However, new questions emerged for future research. For example, is that direct monetary incentive at IPO encouraging speculation through applications of “dubious quality” patents increasing legal uncertainty in software industry? Or, what are the relations between patent behavior and survival of software IPOs?

References

Beresford, K., 2001. European patents for software, E-commerce and business model inventions. World patent Information 23 253-263.

Bergstra, Jan A., and Paul Klint., 2007. About trivial software patents: The IsNot case. Science of Computer Programming 64, 3.

Bessen, James. 2003. Patent Thickets: Strategic Patenting of Complex Technologies. ROI Working Paper.

Bessen J., Hunt R., 2007. An Empirical Look at Software Patents. Journal of Economics and Management Strategy, 16(1), 157–189.

Brau J., Fawcett S., 2006. Initial Public Offerings: An Analysis of Theory and Practice. The journal of Finance, Vol. LXI, No.

Certo, S. Trevis, Michel Holmes Jr, R, Holcomb, Tim. R. 2007. The influence of people on the performance of IPO firms. Executive Digest. Business Horizons, 50(271-276)

Chang S., J, 2004. Venture capital financing, strategic alliances, and the initial public offerings of Internet startups. Journal of Business Venturing;19:721–41.

Chemmanur, T., Fulghieri, P., 1994. Investment bank reputation, information production, and financial intermediation. Journal of Finance 49 (1), 57–79.

Cockburn I., MacGarvie M., 2009. Patents, Thickets and the Financing of Early-Stage Firms: Evidence from the Software Industry. Journal of Economics & Management Strategy, Volume 18, Number 3, 729–773

Freedman, C.,D, 2000. Software and computer-related business-method inventions: must Europe adopt American patent culture?. International Journal of Law and Information Technology 8 (3), 285–309.

Gallini, N., 2002. The economics of patents: Lessons from recent U.S patent reform, Journal of economic perspectives, 16 (2), 131-154.

Gompers P. A., 1995. Optimal investment, monitoring, and the staging of venture capital. J Finance; 50:1461–90.

Graham, S., Hall, B., Harhoff, D., Mowery., D. 2002. Post-Issue Patent Quality Control: A Comparative Study of US Patent Re-Examinations and European Patent Oppositions. NBER Working Paper Series.

Guellec D., B., van Pottelsberghe de la potterie, 2007. The economics of the European patent systems, Oxford University press, Oxford

Hall, B.H., Jaffe, A., Trajtenberg, M., 2005. Market value and patent citations. Rand journal of Economics 36, 16-38.

Hall, B. H., MacGarvie, M., 2010. The private value of software patents. Research Policy. doi:10.1016/j.respol.2010.04.007

Hart, Holmes and Reid., 2000. The Economic Impact of Patentability of Computer Programs. Intellectual Property Institute, London

Hellmann, T., 2002, A theory of strategic venture investing. J. Finan. Econ. 64, 285–314**.**

Higgins M, Stephan P, Thursby, J., 2011. Conveying quality and value in emerging industries: Start scientists and the role of signal in biotechnology. Research Policy 40, 605-617

Higgins, M., Gulati, R., 2003. Getting off to a good start: the effects of upper echelon affiliations on underwriter prestige. Organization Science 14 (3), 244–263.

Hsu, D., Ziedonis, R.H., 2008. Patents as Quality Signals for Entrepreneurial Ventures, Academy of Management Best Papers Proceedings.

Jaffe and Lerner, 2004. Innovation and its discontents. Princeton University Press

Kim, M. and Ritter J., (1999), Valuing IPOs, Journal of financial Economics 409-437

Kim, J., Krinsky, I., Lee, J., 1995. The role of financial variables in the pricing of Korean initial public offerings. Pacific-Basin Finance Journal 3, 449-464.

Krinsky and Rotenberg (1989), "The valuation of initial public offerings", Contemporary Accounting Research Volume 5, Issue 2, pages 501–515.

Lerner, J., 1994. Venture capitalists and the decision to go public. Journal of Financial Economics 35, 293–316.

Levin RC, Cohen WM, Mowery DC. (1985), "R&D appropriability, opportunity, and market structure: new evidence on some Schumpeterian hypotheses". Am Econ Rev 75:20–4.

LiPuma., J. 2011. Internationalization and the IPO performance of new ventures, Journal of Business Research., J Bus Res (2011), doi:10.1016/j.jbusres.2011.05.007

Mann, R. 2005. Do patents facilitate financing in the software Industry? Texas Law Review. Volume 83(4), 961-1030.

Mann, R., Sager T., 2007. Patents, venture capital, and software start-ups. Research Policy 36, 193–208

Masulis and Nahata., 2009. Financial contracting with strategic investors: Evidence from corporate venture capital backed IPOs. J. Finan. Intermediation 18 (2009) 599–631

Merges, Robert P. and Richard R. Nelson. 1990. On the Complex Economics of Patent Scope. Columbia Law Review. 90:4, pp. 839–916.

Olson H, and McQueen, D., 2000. Factors influencing patenting in small computer software producing companies . Technovation 20, 563–576

Peristiani S,and Hong, G., 2004. Pre-IPO Financial Performance and Aftermarket Survival. Current issues in economics and finance. Federal reserve bank of New york. Volume 10, Number 2.

Pisano, G., 2006. Can science be a business? Lessons from biotech. Harvard Business Review (October), 114–125.

Rassenfosse and van Pottelsberghe de la Potterie, 2010, The role of fees in patent systems: Theory and Evidence. ECARES working paper 2010-023

Rentocchini., 2011, Sources and characteristics of software patents in the European Union: some empirical considerations. Information Economics and Policy, doi: 10.1016/j.infoecopol.2010.12.002

Ritter, J.R., 1984. Signaling and the valuation of unseasoned new issues: A comment. Journal of Finance 39, 1231-1237.

Ritter, J.R., Welch I., 2002. A Review of IPO Activity, Pricing, and Allocations, Journal of Finance, 57 (4), 1795–1828.

F.M. Scherer, 1982. Inter-industry technology flows and productivity growth. The Review of Economics and Statistics, 64(4):627-634.

J. Schmookler, 1966. Invention and economic growth. Harvard University Press Cambridge, MA.

Scotchmer, Suzanne. 1991. Standing on the Shoulders of Giants: Cumulative Research and the Patent Law. Journal of Economic Perspectives. Winter, 5:1, pp. 29–41.

Stuart, T., Hoang, H., Hybels, R., 1999. Interorganizational endorsement and the performance of entrepreneurial ventures. Administrative Science Quarterly 44, 315–349.

M. Trajtenberg 1990, A penny for your quotes: patent citations and the value of innovations. The Rand Journal of Economics, pages 172_187, 1990.

van Pottelsberghe de la Potterie B, 2010, The quality factor in patents systems, Ecore discussion paper 42.

A.D. Wilbon 1999, An empirical investigation of technology strategy in computer software initial public offering firms, Journal of Engineering and Technology Management 16, p 147–169

A.D. Wilbon, 2003 Competitive posture and ipo performance in high technology firms. Journal of Engineering and Technology Management, 20 (3) :231-244.

R.H. Ziedonis, 2008. On the apparent failure of patents: A response to Bessen and Meurer. The Academy of Management Perspectives ARCHIVE, 22(4):21-29.