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When academia comes to market: does university affiliation reduce the uncertainty of IPOs?

by

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When academia comes to market: does university affiliation reduce the uncertainty of IPOs?

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Abstract

Companies obtain significant benefits and resources from university affiliations. Building on recent contributions in the fields of organizational theory and signaling theory, we argue that such relationships redresses investors' concerns over the legitimacy of firms and acts as an uncertainty-reducing signal. We study the population of university spin-offs that went public in Europe over the last decade, and find that academic affiliation reduces uncertainty and enhances survivability in the long term. Thus, external stakeholders consider this affiliation a valuable and non-substitutable resource. Our results control for a number of characteristics related to firm quality, including measures of intellectual and relational capital as well as corporate governance mechanisms.

Keywords: *Academic entrepreneurship; Technology transfer; Resource-Based view; Signaling*

Introduction

Many national governments have adopted policies aimed at creating an environment supportive to the creation of new science-based firms. As a result, the number of such firms has increased significantly in recent years (Wright et al., 2006). In particular, universities have shown growing enthusiasm for the practice of forming new companies to exploit in-house technologies (Powers and McDougall, 2005). So far, most studies on academic entrepreneurship have analyzed factors promoting the creation of new ventures (Rothaermel et al., 2007). From a strategic perspective, however, the tasks of starting a company and achieving competitive advantage are very different. Entrepreneurial firms must not only discover and exploit opportunities, but also manage their resources and capabilities in such a way that their venture outperforms others in the marketplace. Academic firms in particular may lack experience with the latter activity. This distinction implies that policy programs aimed at stimulating academic entrepreneurship may not provide enough support for post-entry development (Patzelt and Shepherd, 2009). It is therefore of interest to investigate the implications of university affiliation in the long run. Also, if universities want to maximize the profits of their entrepreneurial initiatives, they should devote attention to their most successful cases.

This paper studies a selection of "successful" university spin-off firms, i.e., those that went public. An investigation of such firms is relevant to both academic entrepreneurs and their supporting universities. For the former, sometimes referred to as "paper millionaires" until their stock market flotation, an IPO is one of the best opportunities to obtain cash from their ventures. The IPO also represents a crowning achievement for the parent university, whether it seeks to advance its reputation as a catalyst for economic development or simply to generate financial returns as a stockholder.

Despite such motivations, the current state of knowledge on IPOs held by university spin-offs (USOs) is fragmented. For example, Shane (2004) observes that university-based firms are 108 times more likely to go public than the average new firm. Zhang (2009), on the other hand, finds no significant difference in IPO rates between the two types. Both studies consider the IPO a final successful outcome, putting aside questions of how these firms are actually perceived by external investors. Hence, there is keen interest in understanding whether university affiliation is a source of legitimacy in the eyes of potential stakeholders.

The present paper contributes by relating academic affiliation to the *perceived* degree of uncertainty associated with investing in USOs. To the best of our knowledge, the only previous paper discussing both academic entrepreneurship and risk perception is that of Wright et al. (2006). Based

on a survey of technology transfer officers, venture capitalists and academic entrepreneurs in the UK, they find that venture capitalists consider USOs riskier than independent firms. We complement their investigation of risk perception by considering the attitude of the public market.

We compare a sample of European USOs to a control sample of independent firms. For the first sample, we identify 131 USOs among the total population of 499 high-tech SMEs that went public in one of the four largest European economies (Germany, the UK, France, and Italy) during the period 1995-2003. Uncertainty is estimated in three ways: the price variation on the first day of trading (underpricing), the volatility of stock prices following the IPO, and long-term survival probability. Because high-tech firms pursuing an IPO typically have few tangible assets and limited track records, affiliation is expected to reassure investors that the firm's stock is a reliable and worthy asset. Naturally, we control for other potential sources of legitimacy such as backing by venture capitalists (Megginson and Weiss, 1991; Gompers, 1996), the intellectual and relational capital of the upper echelon (Dalton et al., 1998), and corporate governance mechanisms (Certo, 2003; Lester et al., 2006). Overall, our results confirm expectations: affiliation with a university reduces the uncertainty associated with investing in IPO firms.

The remainder of the paper is structured as follows. Section 2 relates university entrepreneurship to the resource-based view and to signaling theory. Our research design is presented in Section 3, and Section 4 describes the empirical analysis. Limitations of the model and our conclusions are presented in Section 5.

1. University entrepreneurship

It is notoriously difficult for investors to determine the quality of IPO firms. Much of the uncertainty is due to the lack of publicly available information prior to the offer, when the company is still in private hands. Previous research has relied on signaling theory to guide explorations of how the prospectus might impact potential investors' assessments of the firm (Ritter and Welch, 2002). Our view is that observers perceive university affiliation as a signal that the firm has access to scientific predispositions and resources. We posit that university affiliation thereby eases investors' concerns over legitimacy and improves the attractiveness of the firm.

The resource-based view (Barney, 1991) also applies to our approach. The IPO prospectus provides information on unique resources that could reduce investors' uncertainty over the firm's potential for achieving sustained competitive advantage. The very fact of being a university spin-off could be viewed by investors as a valuable and non-substitutable resource sustaining future performance. Signaling theory and the resource-based view are therefore complementary ways of investigating

the extent to which university affiliations mitigate concerns over legitimacy.

University entrepreneurship and the resource-based view

The resource-based view (RBV) (Barney, 1991) argues that firm-specific resources and capabilities determine the competitive advantage of a firm. In particular, when such resources are neither imitable, substitutable, nor transferable, they may produce a long-lived competitive advantage.[1] Researchers in this tradition typically link the extent to which entrepreneurs can mobilize a diverse set of resources to their probability of overcoming the liability of newness (Clarysse et al., 2007). Firm-specific resources can be knowledge-based or property-based. Property-based resources refer to tangible inputs, whereas knowledge-based resources describe the ways in which firms combine and transform their tangible inputs (Galunic and Rodan, 1998). Knowledge-based resources may be particularly important sources of sustainable competitive advantage, because they are inherently difficult to imitate and thus generate sustainable differentiation (Wiklund and Sheperd, 2003).

Some recent RBV studies have addressed the USO phenomenon (Shane and Stuart, 2002; Wright et al., 2004; Heirman and Clarysse, 2004). The entrepreneurship literature shows that USOs distinguish themselves in terms of their financial, physical, human and organizational resources. Indeed, USOs are known to obtain certain tangible and intangible benefits from their affiliation, such as access to university laboratories and libraries (Quintas et al., 1992). Links with universities can also foster collaboration with other public research institutions (Oliver and Liebeskind, 1998), and consequently lead to information sharing. This is especially true in cases where the knowledge shared is tacit (Cohen and Levinthal, 1990). Moreover, USOs enjoy some insulation from the competition at start-up, while deriving legitimacy from their association with a university-based technology (Markman et al., 2005). All these factors can enhance the confidence of external stakeholders.

Despite the benefits yielded by academic affiliation, the available evidence indicates that USOs are not often gazelles (Ensley and Hmieleski, 2005; Bonardo et al., 2009b). University affiliation may therefore have downsides that hinder the translation of the benefits into substantial gains. For instance, in the context of labour specialization, prestigious research achievements do not necessarily go along with an inclination to do business. Furthermore, the academics involved in creating new ventures may not be motivated solely or primarily by an entrepreneurial vision. For example, they may be attracted by the prospect of enhancing their academic position (Meyer, 2003). In general, university policies on individual rewards and promotions may induce "safer" strategic

[1] Strategic resources should satisfy the VRIO criteria (Value, Rarity, Inimitability, Organization) defined by Barney (1995).

decisions, limiting the firm's performance as it develops. University affiliation may also be destructive because of a culture of secrecy, or may provide the context but not necessarily instigate the capability of development. Developing a technology into a marketable product or service requires prior industry and entrepreneurial experience, not a scientific background (Wright et al. 2004). In short, while universities certainly provide knowledge they may not provide the *right* knowledge for firm continuance (George, 2005).[2] They may also fall short in terms of "knowledge conversion capability" (Zahra et al., 2007).

University entrepreneurship and signaling

The information gap between the founders of a high-tech start-up and external potential investors is likely to be extraordinarily large. For this reason, firms going public face significant challenges gaining the attention of potential investors. Indeed, the information asymmetry between insiders and outsiders can result in market failure, as recognized by Akerlof (1970). While holding an IPO may enhance a young firm's legitimacy, significant uncertainties remain about their capabilities (Fischer and Pollock, 2004). The market partners of an innovative entrepreneur cannot readily observe the quality of the venture, so they will try to approximate that information via reliable signals (Backes-Gellner and Werner, 2007). The challenge of an IPO is to convince a wide variety of potential investors that the firm has long-term potential. To some extent, success is a matter of conveying the right signals.

Research on the organizational level has uncovered a wide variety of characteristics that can serve as signals in markets laden with uncertainty. Extensive research has focused on how specific signals can reduce uncertainty over a firm's quality and future prospects in the eyes of key stakeholders. Such signals include corporate governance characteristics (Certo, 2003; Certo et al., 2003), upper echelon prestige (Pollock and Gulati, 2007), founder presence (Nelson, 2003), celebrity endorsements (Dean and Biswas, 2001), and winning certification contests (Rao, 1994). In the IPO context, affiliations with prominent and legitimate actors of the financial world also seem to play an important role. Prestigious and well-established underwriters (Booth and Smith, 1986; Carter and Manaster, 1990), venture capitalists (Megginson and Weiss, 1991; Gompers, 1996) and auditors (Beatty, 1989) can all lend legitimacy to firms. More recently, this research stream has expanded to consider a wider variety of uncertainty-reducing signals. The future growth of newly public

[2] A useful theoretical background is provided by the concept of resource slack (George 2005). The claim is that resource constraints alter the manner in which resources are expended, forcing managers to allocate them more efficiently. Firms with large resource reserves might be less impelled to undertake initiatives through experimentation, which may decrease performance because new entrepreneurial opportunities are not exploited.

entrepreneurial firms is based not only on the availability of financial capital, but also on intellectual capital related to the creation and management of innovations (Bonardo et al., 2009a). Accordingly, key endorsements are gaining importance as strong signals of *technological legitimacy* (Markman et al., 2005).

Signals of technological legitimacy can take various forms. For instance, Higgins and Gulati (2003) describe the technological partnerships developed by entrepreneurial ventures as signals of legitimacy, and determine which types are predictors of the success of their IPOs. Higgins et al. (2008) show that the proceeds raised by biotech firms holding an IPO are related to the reputations of university scientists affiliated with the firm. In particular, Nobel laureate scientists lent significant rents to the firms that hired them, because their total compensation packages were considerably less than the stock price premium generated by their outstanding scientific reputations. Among biotech IPOs, Higgins and Gulati (2006) find that the presence of employment affiliations with prominent pharmaceutical companies is a signal that attracts new investors. They also find that experience and background of one key board member, the Chief Scientific Officer, is particularly relevant. In another sector, Pollock and Gulati (2007) find that the recognition of technological alliance partners helps IT companies gain access to post-IPO strategic opportunities. Hsu and Ziedonis (2007) find that patents increase the initial valuation of entrepreneurial start-ups. With reference to a sample of software IPOs, Chen et al. (2008) find evidence of a "dressing-up" behaviour where firms hire prestigious executives in the final year prior to IPO.

Thus, several papers have investigated the effects of scientific endorsement on the performance, valuation and overall success of IPOs. We focus on just one signal, affiliation with a university, and how that signal solves or reduces information problems. Specifically, we suggest that the signal provided by university affiliation reduces investor uncertainty. Moreover, we expect that the resources obtained from the affiliation play a long-lasting role, in that university spin-offs are less subject to failure. Our rationale is that this attachment is a valuable indicator of the firm's predispositions and resources, reducing the uncertainty associated with the valuation process at the IPO and enhancing the survival profile. These two hypotheses are formalized below.

Hypothesis 1: Affiliation with a university reduces the valuation uncertainty in a company going public.

Hypothesis 2: Affiliation with a university decreases the probability of failure among companies going public.

2. Research design

Treatment and control samples

The listing requirements established by national exchange commissions stipulate that any firm undertaking an IPO must publish an official prospectus. This document is required to describe the full history of the firm and provide the curricula vitae of the founder(s) and upper management. Potential investors carefully scrutinize it to assess the prospects of taking an equity position in the IPO. The prospectus is indeed the firm's primary means of communicating information to the public at this stage[3]. This paper relies on prospectuses to determine the university affiliations of firms that recently went public in Europe.

The EURIPO database provides prospectuses and other detailed information on all companies that have recently gone public in Europe. We consider the population of all small and medium-sized enterprises (SMEs) operating in four technology industries: electronics and engineering (Electronics & Eng), information technology (IT), pharmaceutical and biotech (Pharma & Bio) and communications (Communications)[4]. Companies in these industries typically have limited tangible assets, so the presence of prestigious affiliates matters greatly to investors. Otherwise, their valuation would carry considerable uncertainty. Based on information reported in the prospectus, this research defines *university spin-offs* (USOs) as companies that were either developed by university faculty members based on their own research, or created specifically to capitalize on academic research. This definition is consistent with similar terms in the literature, and will be used throughout the paper[5]. The final sample of USOs is composed of 131 companies (the treatment sample). They will be compared with an equivalent group of independent firms (the control sample)

[3] The purpose of the prospectus is to sell shares. It is therefore assumed that all relevant information will be included. Since owners and managers can be held legally accountable for errors in the document, it contains the most accurate information available to the firm. As a result, prospectus data are considered reliable and enjoy a longstanding role in strategy research. More recently, these data have also been used in entrepreneurship research (Shrader and Siegel, 2007). Previous research has relied on signaling theory to guide interpretation of the prospectus and capture information that might impact future performance and investor valuations (Ritter and Welch, 2002). Supporting the resource-based view (Wernerfelt, 1984), the prospectus also indicates any unique resources that could sustain competitive advantage.

[4] The EURIPO database is managed by Universoft, a spin-off of the University of Bergamo (www.euripo.eu). It contains data on more than 5,000 companies that went public in Europe since 1985. Following the European Commission, SMEs are defined as firms with annual sales inferior to 50 million € at the time of their IPO. The four high-tech industries considered here are also used in other studies (e.g. Cloodt et al., 2006). The industry classifications are the same as those adopted by European stock exchanges, namely the ICB (Industry Classification Benchmark).

[5] For instance, Ensley and Hmieleski (2005, p. 1097) define university spin-offs as firms that "were developed by students or faculty based on their research, or utilized research from a university's technology transfer area." Druilhe and Garnsey (2004, p. 274) consider those companies "drawing on university-based technological and scientific knowledge, and involving academics or students who were still members or who had just quit the university." Smith and Ho (2006, p. 1560) refer to a "technology-based company founded by a member/former member of a university or one of the seven laboratories, using IP developed in the institution by the founding individual(s)".

selected using the nearest-neighbour propensity score method. Propensity scores are used to select a sample of "control" units (from the EURIPO database) as similar as possible to the "treatment" units, considering several independent characteristics simultaneously (Dehejia and Wahba, 2002). We first estimate a logistic regression to predict whether a company is a USO or independent. The predictive variables are firm size (the natural logarithm of sales at the IPO), age (natural logarithm of the company's age in years at the IPO), industry and country dummies, and a dummy for the IPO year. The propensity scores of firms are the fitted values produced by the logistic regression model. Second, we separate the treatment and control groups and sort the companies in each group from lowest to highest scores. Third, we discard all independent companies with propensity scores outside the range exhibited by the USOs (the "common support" criterion). Fourth, we group the remaining firms into "blocks" with similar propensity scores and perform balancing tests for each predictive variable as well as the propensity scores themselves. These tests are based on the difference in means (*t*-tests) between USOs and independent firms within each block. Finally, we associate each treatment firm with its closest match from the control sample by propensity score ranking[6].

The two samples are described in Table 1, which reports each firm's country, industry, IPO date, and age at first listing. Predictably, the United Kingdom dominates the treatment sample with 62 USOs (47.3%). The UK has the most highly developed stock exchange in Europe[7], and its university system is probably the most entrepreneurial. Most USO firms are found in the biotechnology and IT industries (38.9% and 34.3% of the treatment sample respectively). Prior studies have also found these sectors to be strongly associated with USO activity (Smith and Ho, 2006). Most of the firms went public within 10 years of their foundation. Almost two-thirds of the treatment sample went public between 1998 and 2000, a commonly identified 'hot issue' period in IPO markets for high-tech companies[8].

[TAKE IN TABLE 1]

[6] To verify the success of the matching, it is informative to inspect summary statistics for the treatment and reduced control groups. As shown in Table 1, the two samples are well balanced with respect to all characteristics, with one exception: the Pharma & Bio category represents a significantly larger share of USOs. This industry suffers from a lack of "common support", meaning there are not enough independent companies in the database (with similar characteristics) to construct a comparable sample. To address this problem, we always control for the industry variable in regression models.

[7] At the end of 2006, the ratio between stock market capitalization and GDP was 1.5 in the UK. In contrast, most other countries in Continental Europe were between 0.5 and 1.0 (Paleari et al., 2007).

[8] This period is characterized by a high concentration of IPOs and greater than usual uncertainty surrounding the young firms. This peculiarity, however, allows us to better explore the efficacy of signals that could affect IPO valuations in the face of asymmetric information (Pollock e Gulati, 2007, p. 349). We acknowledge that while this context offers a number of advantages, starting with the large number of observations, it may limit the generality of our results.

We use several measures to compare university-based and independent firms, referring to three main fields: (1) firm and offer characteristics, (2) innovativeness, and (3) upper echelons. The variables in these fields will be used as controls in the regression analysis. Their detailed definitions are provided in Table 2, and Table 3 shows their descriptive statistics. This first step of our empirical analysis is to determine whether USOs show any peculiarities at the time of their IPO which may influence investors' perception of their risk. It is also interesting to find out whether certain features detected by other studies in early stages of the USO life cycle still exist at the time of the IPO.

University spin-offs have a median age of 7 years when going public in Europe, and their average net sales are 14 million € (Table 3, panel A). Their low leverage values suggest that loans are considered unsuitable for early-stage financing of innovative businesses. USOs also exhibit less profitability on average than independent firms at their IPO. This point corroborates and extends in time the results of previous studies (Ensley and Hmieleski, 2005; Zahra et al., 2007). Venture capitalists are backing most of the firms in both samples, but do not appear to prefer one category over the other[9]. Preliminary evidence on the role of university affiliation in reducing risk is provided by the fact that independent companies are characterized by a stronger underpricing effect (29.7% vs. 18.9%).

On average, USOs own more patents (6 vs. 2) and invest more heavily in R&D (15% of sales vs. 10%, Panel B) than independent firms[10]. The characteristics of members in the upper echelons are also considerably different in the two samples (Panel C)[11]. Predictably, USO leaders are characterized by higher educational achievement (Ph.D.s and MBAs), more relational capital (the strength and variety of relationships with public institutions and banks), and more experience (prior and parallel industry experience). Lastly, we find that substantial shareholders[12] and upper echelon

[9] In the regression analysis on the determinants of IPO uncertainty and long-term survival, we control for the presence of venture capitalists, who are expected to decrease the information asymmetry and the moral hazard through active involvement with the enterprise.

[10] Higher levels of innovation input (R&D investments) or output (patents) may also certify the quality of the firm, thereby reducing uncertainty over its prospects. R&D investments and patents are common measures of innovation. However, the number of patents may become problematic as cross-university collaboration increases. We recognize that other, more sophisticated measures have recently been proposed, including newness to market (Dahlqvist, 2007).

[11] The "upper echelon" consists of board members and top managers. The benefits of having prestigious members in both categories at the time of IPO registration are well known. Executives with lustrous credentials and experience may be more capable of leading a company through the IPO transition (Fischer and Pollock, 2004), and prestigious outside directors can reassure markets that the firm will be able to secure scarce resources (Lorsch and MacIver, 1989). In the regression analysis, we therefore control for the relational and educational capital of the upper echelon (advisory role) as well as board independence and corporate governance mechanisms (agency role).

[12] The information required on ownership interests contained in the IPO prospectuses and annual reports is determined by the national securities commissions for each country. In all the jurisdictions evaluated, major shareholders are

members tend to hold a larger stake in independent companies. Given that these companies seem to be largely financed by a small number of shareholders, arguably the circle of 'family and friends', this trend may support the idea that independent firms have greater difficulty acquiring external financial resources. That is, the legitimacy provided by their academic affiliation may help USOs acquire external funding.

[TAKE IN TABLES 2 AND 3]

Methodology

We wish to investigate whether university affiliation reduces the uncertainty associated with IPOs[13]. This uncertainty is measured in three ways. Our first proxy of risk is the absolute value of the IPO underpricing, the difference between the initial listing price of a firm's stock and its closing price on the first day of trading. IPO underpricing is a worldwide phenomenon, and various theories have been developed to explain the anomaly. Most researchers relate it to the existence of information asymmetry between certain parties to the IPO process[14]. A common claim is that underpricing is actually a proxy for the uncertainty surrounding the firm as it goes public, and that it compensates investors for the greater risk of first-day trading. Our first model is therefore an OLS regression (with White robust standard errors) modelling the effects of university affiliation on initial underpricing (expressed as a natural logarithm).

While the market's initial response to the public offering is contemporaneous with the IPO event, we expect the effect of academic affiliation to be more enduring. Accordingly, our second measure of risk is the volatility of stock prices in the post-IPO market. More precisely, we take the standard deviation of monthly market returns over the five years following the IPO (see also Leuz, 2003; Cuijpers and Buijink, 2005). Accordingly, the dependent variable in the second OLS model is an estimate of the price volatility three years after the IPO.

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formally obliged to disclose their holdings in a company. The thresholds triggering this obligation vary from country to country. France (Code de Commerce, article L. 233-7) and Germany (Securities Acquisition and Take-over Act, sections 21 and 22) adopted 5% as a base level, as does the US. Italy (Law No. 58 of 1998) and the UK (Companies Act 1985 sections 198-212) were at 2% and 3%, respectively.

[13] Clearly, our interest is concentrated on university affiliation. However, there are several other factors we need to control. We use the same set of explanatory variables for all models, grouped into three categories: baseline control variables (firms and offer characteristics), innovativeness, and the experience of the upper echelon. The definitions of these variables are reported in Table 2, while descriptive statistics are given in Table 3. We consider firm size, age and leverage at IPO because younger, smaller and more indebted firms are supposed to be more difficult to value and more likely to fail. Finally, year, industry and country dummies are included to control for a variety of factors, including financial market dynamics.

[14] Underpricing is a common occurrence for firms undertaking an IPO. A review of the international literature on IPO underpricing is provided by Ritter and Welch (2002).

Finally, our third model analyzes the survival profile of firms in the years after the IPO. This data set is a matrix with one row for each "subject" (firm) and two columns (variables): (1) the length of time since the IPO that the subject was exposed to the risk of experiencing a "failure", i.e., the survival time; and (2) a censoring dummy variable (equal to 1 if the firm experienced a "failure" at some point during the study period, and 0 otherwise). We use a Cox hazard model where the dependent variable is equal to 1 for failed companies and the time variable measures the time elapsing between the IPO and the failure[15].

3. Empirical results

By mitigating concerns over legitimacy, university affiliation is expected to reduce the level of risk perceived by IPO investors. In agreement with this hypothesis, we find a negative correlation between underpricing and university affiliation (Table 4). However, other control variables play larger roles in reducing underpricing. The experience of the upper echelon (including practical experience gained by working at other companies and academic experience such as MBA degrees) seems to have a particularly strong effect on reducing underpricing.

The role of university affiliation is confirmed by our analysis of the aftermarket volatility. The dummy variable that identifies USOs is negatively correlated with the standard deviation of stock prices, suggesting that investors are less uncertain about the value of these companies. With respect to other variables, the results of the volatility model largely confirm those of the underpricing model. The presence of leaders with strong business experience reduces risk, while a high level of divestment by substantial shareholders at the IPO seems to increase the level of uncertainty. (Incumbent shareholders are assumed to be more informed about the real value of the company, so their divestment may be perceived as a negative signal by external investors.) More profitable and larger firms exhibit less price volatility, probably because they disclose more information to stakeholders (Ashbaugh and Pincus, 2001) and benefit from deeper financial analysis following public exposure (Cuijpers and Buijink, 2005). The bubble period (1998-2000) is also found to be

[15] Among various hazard models, we select the semiparametric Cox proportional hazard regression. The hazard rate is modeled as the product of an arbitrary and unspecified baseline hazard rate $h_0(t)$ and a suitable function of covariates. X_i is a vector of covariates, and β is a vector of regression coefficients to be estimated. Thus, $h_i(t) = h_0(t) \exp(X_i \beta)$. Compared to parametric proportional hazard models, the advantage of this regression is that no assumptions have to be made about the shape of the baseline hazard rate. The method of Breslow (1974) is used to correct the partial likelihood function in order to cope with the existence of ties and obtain unbiased and consistent estimates. The method of Efron (1977) is a reasonable alternative, but leads to almost identical results. Robust variance-covariance matrices are estimated using the method of Lin and Wei (1989). Given that the test for homogeneity of baseline hazards (based on Schoenfeld residuals) does not reject the hypothesis of proportionality (see Table 5), the most basic specification of a proportional hazard model seems suitable.

associated with higher levels of price volatility, suggesting that the prices of IT companies floating during that period were biased by a high level of information asymmetry.

Our final regression analysis focuses on the determinants of failure. We find that university affiliation reduces the failure probability (Table 5). Furthermore, our results show that more indebted companies have a higher probability to fail, while both VC backing and a large portfolio of patents reduce the risk of failure. As with university affiliation, the involvement of VCs at the time of an IPO seems to signal the long-term survivability of the firm. Having patents may indicate that a firm has already overcome the riskiest phase of the innovation process; by realizing some profitable assets from its R&D efforts the firm reduces the probability of financial strain. Table 5 also confirms that the experience of upper echelons and the presence of independent directors reduce the likelihood of financial distress.

[TAKE IN TABLE 4]

4. Conclusions

This research assesses the uncertainty-reducing role that universities provide to affiliated firms. With this aim, we analyze a sample of university spin-offs (USOs) that gained access to European public equity markets in recent years. Of course, only few of these affiliated firms are commercially successful enough to make an IPO. However, by definition, a firm must be successful for gaining attention from stakeholders, being them venture capitalists, industrial partners or the stock market.

Building on recent contributions from organizational theory and signaling theory, we argue that affiliation with a university informs potential stakeholders that the firm is of high scientific quality. Three empirical results prove that academic affiliation reduces the uncertainty associated with valuation at the IPO. Our results run contrary to the research of Wright et al. (2006), who observed that venture capitalists perceive USOs to be riskier than independent companies. Our own work shows that the public market attributes an uncertainty-reducing role to university affiliation. Hence, university affiliation can be viewed as a means of redressing legitimacy concerns in the eyes of investors. The status of USO is considered a valuable and non-substitutable resource by the general investor. Furthermore, the effects of university affiliation are long-lasting; USOs are less volatile in the long run and less subject to failure than independent firms.

Given that university-affiliated firms experience a lower level of underpricing at their IPOs, academic founders have a strong incentive to publicize such links in the offering prospectus. This

signal shapes the process of going public to their advantage. In addition to academic entrepreneurs and managers of technology transfer offices, the results of our study are useful to investors and financial market participants. The models developed here provide useful information on the risk profile of an under-researched asset class. Indeed, this study is one of the first to adopt a market-based perspective on university spin-offs. Our results will be of particular interest to specialized investment entities that take an early equity position in USO firms while envisioning a profitable exit through the IPO.

This study has some limitations that suggest avenues for further research. First, universities are not the only source of legitimacy. As pointed out by other studies aimed at identifying the effects of signals on firm behaviours and outcomes, it is possible that the pattern of results observed in our sample emerges from correlations between valuation uncertainty and unmeasured indicators of firm quality. To account for this possibility, we included a number of firm-quality characteristics as controls in our models: financial variables, measures of the intellectual and relational capital held by upper echelons, and corporate governance mechanisms. However, more sophisticated relationships might be at work. For instance, the composition of the upper echelon in a newly founded firm can vary over time and cannot be considered static (Vanaelst et al. 2006). It would be of interest to collect data on individuals who were part of a firm's upper management but left prior to the IPO, and those who joined afterwards. Once a firm decides to go public, it has indeed a strong incentive to maximize its appeal by hiring prestigious executives and directors (Chen et al., 2008), in some cases Nobel laureates (Higgins et al., 2008). Moreover, it is worth investigating the conflicts that arise during board transitions designed to protect the university's interests while meeting the corporate governance standards of IPOs.

Finally, there remains a paucity of evidence regarding the failure of USOs. The number of spin-offs created is gaining ground as a performance indicator for universities and public research organizations, so Europe has seen the creation of many very small firms with significant public support from national and local governments yet lacking a real business model (Colombo et al., 2009). Naturally, some of these do not achieve substantial success. Their eventual failure would lead to welfare losses, as these resources may have been more effectively invested elsewhere. There is therefore a strong need for research examining the reasons for USO failure at various stages of development.

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Table 1: The treatment and Control Sample.

	University Spin-Offs (%)	Independent (%)	Z-test
Country			
UK	47.32	42.75	-0.74
Germany	35.87	41.23	0.88
France	14.51	12.97	-0.35
Italy	2.29	3.05	0.38
Industry			
Pharma & Bio	38.93	28.24	-1.83*
IT	34.35	36.64	0.39
Electronics & Eng.	18.32	22.90	0.92
Communications	8.39	12.21	0.31
Age at IPO (years)			
Age <=5	33.57	30.54	-0.52
5< Age <=10	24.42	29.01	0.84
10< Age <=15	22.92	21.37	-0.29
Age> 15	19.08	19.08	-0.00
IPO year			
1995-1997	23.66	26.72	0.57
1998-2000	64.12	61.07	-0.51
2001-2003	12.21	12.21	0.00
No. Obs.	131	131	

Table 2: Variable definitions.

Variable [a]	Definition
PANEL A: FIRM AND OFFER CHARACTERISTICS	
Size of the company (€m)	Sales
Age (years)	Age (years since incorporation)
Leverage (%)	Ratio between debt and total assets
Profitability (%)	Return on assets
Size of the offer (%)	Number of shares offered at the IPO over number of shares outstanding after the IPO
Underpricing (%)	Stock return on the first day of trading.
VC-backed (% of firms)	Dummy variable equal to 1 if at least one venture capitalist is present in the ownership structure
PANEL B: INNOVATIVENESS	
Patents (No.)	Number of patents registered at the European Patent Office
R&D investments	Ratio between R&D investments and sales.
PANEL C: THE UPPER ECHELON	
Upper echelon members with Ph.D. (%)	Proportion that are university professors or hold a PhD degree
Upper echelon members with MBA (%)	Proportion with a MBA degree
Prior Industry experience (% of directors)	Proportion with previous experience as board members or top managers in other firms
Parallel Industry experience (% of directors)	Proportion with parallel experience as board members or top managers in other firms
CEO experience (% of directors)	Proportion with CEO experience in other firms
Relationship with Public Inst. (% of directors)	Proportion with experience in public institutions
Relationship with Banks (% of directors)	Proportion with experience on the boards of financial entities
Concentration Change (%)	Divestment by substantial shareholders
Change in ownership of upper echelon (%)	Divestment by upper echelon members
Independent Directors (%)	Proportion of independent board members

[a] Variables measured at the time of the IPO. All data are hand-collected from IPO prospectuses, with the exception of the number of registered patents, which is obtained from the European Patent Office. Accounting data refer to the year prior to the IPO (last annual report available). Substantial shareholders are defined by the thresholds for mandatory disclosure (between 2% and 5%, depending on the legal requirements in each country).

Table 3: Descriptive statistics.

Variable [a]	University Spin-Offs [b]	Independent	T-Mann Whitney or Z test
PANEL A: FIRMS AND OFFER CHARACTERISTICS			
Size of the company (€m)	14.41	16.41	0.85
Age (years, median)	7.00	7.50	0.97
Leverage (%)	26.26	25.79	-0.10
Profitability (%, median)	-1.81	7.54	3.72***
Size of the offer (%)	7.82	12.21	2.69***
Underpricing (%)	18.86	28.53	1.83*
VC-backed (% of firms)	60.31	54.19	-0.74
PANEL B: INNOVATIVENESS			
Patents (No., median)	6	2	-4.68***
R&D investments (%, median)	15.12	10.44	-3.63***
PANEL C: UPPER ECHELONS			
Upper echelon members with Ph.D. (%)	25.42	5.67	-7.32***
Upper echelon members with MBA (%)	16.98	12.62	-1.83*
Prior Industry experience (% of directors)	64.56	65.05	0.53
Parallel Industry experience (% of directors)	53.56	51.09	0.85
CEO experience (% of directors)	13.03	13.62	0.61
Relationship with Public Inst. (% of directors)	4.01	1.06	-3.02***
Relationship with Banks (% of directors)	10.40	6.51	-2.95***
Concentration (%)	66.91	76.85	2.68***
Concentration Change (%)	16.25	20.96	2.31**
Ownership of upper echelon (%)	35.09	41.03	1.74*
Change in ownership of upper echelon (%)	25.77	28.17	0.97
Independent Directors (%)	36.98	38.26	1.23

[a] Averages, when not specified.
[b] The tests compare University Spin-Offs to independent firms. The significance levels are based on *t*-statistics (mean), the Mann-Whitney U-test (median), or the *Z*-test of equal proportions, as required.
Significance levels at 1% (***), 5% (**) and 10% (*).

Table 4: IPO underpricing and aftermarket volatility (OLS regression).

Dependent variable	IPO underpricing			Volatility		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
University Spin-Offs	-0.10**	-0.10**	-0.09*	-0.12**	-0.11**	-0.11*
Control variables						
Size of the company	-0.01	-0.01	-0.01	-0.43**	-0.41**	-0.37**
Age	-0.02	0.02	0.02	-0.11	-0.13	-0.12
Leverage	0.01	0.01	0.01	0.21	0.31	0.27
Profitability	-0.11**	-0.10*	-0.09*	-0.14**	-0.15**	-0.15*
Size of the offer	-0.04	-0.05	-0.06	-0.41**	-0.43**	-0.45**
VC-backed	-0.02	-0.01	-0.01	0.01	0.01	0.02
Electronics	0.03	0.03	0.06	0.85	0.79	0.52
Pharma & Bio	0.04	0.03	0.02	-0.33	-0.32	-0.17
IT	0.11**	0.09*	0.10*	0.19**	0.18**	0.18**
Bubble period	0.17***	0.15***	0.09**	0.35***	0.32***	0.30***
UK	0.10	0.09	0.15	-0.01	-0.01	-0.01
Germany	0.16***	0.15***	0.14***	0.25	0.25	0.23
Innovativeness						
Patents		0.05	0.05		-0.12	-0.09
R&D investments		-0.02	-0.04		0.11	0.05
Upper echelons						
Ph.D.			0.14			-0.15
MBA			-0.57***			0.05
Prior Industry experience			-0.18*			-0.15**
Parallel Industry experience			-0.09			-0.19**
CEO experience			-0.03			-0.13*
Relationship with P. Inst.			-0.11			0.02
Relationship with Banks			-0.05			0.08
Concentration Change			0.12			0.37***
Ownership Change			0.32			0.02
Independent Directors			-0.14			-0.05
Constant	0.07	0.09	0.05	0.08**	0.09**	0.08**
R^2 %	23.12***	23.74***	27.53***	23.14***	23.19***	30.15***
White Test						
H0: homoskedasticity (p value)	0.82	0.95	0.29	0.72	0.65	0.56
Variance Inflation Factors	1.58	1.64	1.98	1.58	1.64	1.95

t-test for significance of the independent variables; F-test for significance of the regression; *** 1% significance level; ** 5% significance level; * 10% significance level.

Table 5: Failure probability (Cox regression).

Failure Probability	Model 1	Model 2	Model 3
University Spin-Offs	-0.67**	-0.65**	-0.66**
Control variables			
Size of the company	-0.06	-0.05	-0.06
Age	-0.12	-0.11	-0.11
Leverage	1.24***	1.21**	1.15**
Profitability	-0.16	-0.25	-0.25
Size of the offer	-1.33	-1.05	-1.14
VC-backed	-0.84**	-0.87**	-0.91**
Electronics	-0.15	-0.19	-0.19
Pharma & Bio	-0.83	-0.74	-0.78
IT	0.01	0.04	0.10
Bubble period	0.37	0.51	0.45
UK	0.75	0.74	0.62
Germany	-0.67	-0.71	-0.74
Innovativeness			
Patents		-0.46*	-0.47*
R&D investments		0.80	0.91
Upper echelons			
Ph.D.			0.61
MBA			-0.45
Prior Industry experience			-0.81*
Parallel Industry experience			-0.60
CEO experience			-0.45
Relationship with P. Inst.			-0.19
Relationship with Banks			-0.95**
Concentration Change			0.17
Ownership Change			0.48*
Independent Directors			-0.78**
Test for homogeneity of baseline hazards	10.88	11.16	15.72
Log-Likelihood	-171.87***	-170.31***	-166.08***

z-test for significance of the independent variables; F-test for significance of the regression; *** 1% significance level; ** 5% significance level; * 10% significance level.