

## **The Effect of University Patent Activity on the Performance of University Spin-Offs. A Path Dependency Perspective<sup>1</sup>**

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### **Abstract**

*The paper aims to study the impact of research activity and its outcomes, incorporated in the patent activity, on the firm success reached by university spin-offs. In detail, following the theoretical arguments related to the path dependency theory, it was stated that the patent activity of university is positively associated with the financial performance of university spin-offs generated, measured in term of ROA index. Using a sample of 692 Italian university spin-offs during the period 2003-2014, the empirical findings confirm the research hypothesis developed. The paper contributes in adding new insights the literature about academic entrepreneurship, particularly regarding the path dependency view of the university spin-off development and performance, which will constitute a fundamental conceptual base for the forthcoming studies on the topic.*

**Keywords:** university spin-offs; university; path dependency theory; patent activity, financial performance; Italy.

### **1. Introduction**

The emerging of knowledge-based economy has considerably highlighted the role of universities in commercializing innovations, in the form of new technologies and knowledge from the research centers (Miller et al., 2018; Breznitz and Etzkowitz, 2017; O'Shea et al., 2004). In this regard, literature recognizes a significant increase in the amount of university spin-offs generated in the European and USA context (Fini et al., 2017; Shane 2004; Wright et al., 2007; Abbate and Cesaroni, 2017). Nevertheless, there are concerns that a large part of these companies reaches limited firm performance (Grimaldi et al., 2011; Mowery, 2011). Particularly in the European context, it emerges that university spin-offs tend to remain small and with a limited growth potential, rather than high-growth firms (Borlaug et al., 2009; Harrison and Leitch, 2010).

Several scholars recognize that universities may have critical role as seedbeds of innovation and consequently transfer this innovation through spin-offs, and the establishment of new ventures on the basis of academic research has turned into a key part of innovation program in different national context (Wright et al., 2007). However, even though high prospects and noteworthy care to the role of universities in generating spin-off ventures, the outcomes in several environments seem unsatisfactory (Harrison and Leitch, 2010; Siegel and Wright, 2015). Debatably, successful universities such as MIT and Stanford are generator of several high-growth firms, even though the majority of universities have limited stories of successful spin-off companies (Mustar et al., 2008). The causes related to these dissimilarities are manifold, calling for a more deep and systematic and understanding about the mechanisms by which universities promote high-performing spin-off firms is desirable in planning programs to stimulate academic start-ups. University spin-offs are usually well-defined as organizations that exploit intellectual property or patented innovation created from the academic research (Di Gregorio and Shane, 2003).

In detail, understandings are missing about how the mixed and multidimensional nature of context impacts the process of spin-off performance and development (Zahra and Wright, 2011).

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<sup>1</sup> Although the research has been carried out jointly, paragraphs 1 and 2.1 have been prepared by Christian Corsi, paragraphs 2.2 and 5 by Manuel De Nicola; paragraphs 3 and 4 by Antonio Prencipe.

Indeed, the multifaceted growth paths and the several capabilities required to convert scientific outcomes into feasible products from the conventionally non-commercial academia provide substantial challenges (Vohora et al., 2004). Literature have pointed out that the influence of the university context upon the performance of university spin-off is chiefly significant and critical (Jong, 2006; Rasmussen and Borch, 2010).

It was stressed that a fundamental clarification about the cause of unobserved heterogeneity of innovation and performance results amongst companies is related to the different past knowledge stocks that exist within them (Blundell et al., 1995). With regard to the universities, literature revealed that familiarity in the commercialization of technology has a positive effect on the number, performance and development of university spin-offs created (Lockett et al., 2005, O'Shea et al., 2005; Powers and McDougall, 2005). Hence, it could be argued that the spin-off activity is a path-dependent process, for which knowledge accumulation from the past research activity produces benefits in the university's prospect capability to foster spin-offs firm' performance. Although the prominence of this argument, the current literature on academic entrepreneurship and firm performance show a not fully understanding of the phenomenon, which call a more comprehensive and methodical analysis, both from a theoretical and practical point of view.

Following this conceptual perspective, the paper aims to address this literature gap by exploring the impact of the tradition and history of university in the research activity and its outcomes, incorporated in the patent activity, on the financial performance reached by university spin-offs. To this end, a panel sample of 692 Italian university spin-offs have been investigated for the period 2003-2014. The paper contributes in adding new insights the literature about academic entrepreneurship, particularly regarding the path dependencies view of the university spin-off development and performance, which will constitute a fundamental conceptual base for the forthcoming studies on the topic.

## ***2. Theoretical background***

### **2.1. University and university spin-off performance: a path dependency perspective**

The exclusivity of historic settings, whereby companies are essentially historic and social units, may be the source for persistent competitive advantage. Following consolidated literature, in the case an organization acquires valued resources in view of its distinctive path through history, it is expected that it will have the capability to exploit those resources in applying value-creating approaches that are hard to be imitated by competitors (Barney, 1991). These path dependencies determine the future activity and outcome of the firm, providing the firm its existing set of competences and a position in the competitive market (Teece et al., 1999).

In the university spin-off literature, it is claim the historically dependent view, supporting that performance of university spin-offs are partially associated with the knowledge spillovers of academic researcher (Golub, 2003). In accordance to this viewpoint, knowledge accumulation intrinsic in the process of creating university spinoffs affects a university's future aptitude to establish high-performing university spinoffs (Shane, 2004). With the purpose to investigate our dependence on history of university spin-off' performance, we take into account the study advanced by Blundell et al. (1995). In detail, their research claim that a fundamental clarification for the basis of unobserved heterogeneity of innovation and performance outcomes amongst companies (in the case of our study, universities) is linked to the different historical knowledge stocks existing within them. In view of this framework, knowledge accumulation coming from the past creates current and forthcoming benefits in the, consequently leading the performance and development of university spinoffs to be a systematic path-dependent process.

It is to note that Blundell et al. (1995) suggest a method to assess a portion of unobservable heterogeneity that comprise the history of university. This is associated to the level of knowledge accumulation activities in previous periods. In this regard, the research activity measure is related to the argument that the average university patent level will be related to the unobservable university idiosyncratic effect. In accordance to the authors, we apply the hypothesis that previous university patent counts make available knowledge for the spinoff process, improving the change for the new venture to reach superior performance.

### **2.2. The role of university patent activity in the development and performance of university spin-offs**

It has been observed that although patent activity not directly assure that the outcome of the university technology transfer will be commercialized or incorporated in a new product, it does embody a key element for protect its latent and future capability.

Additionally, the availability of patents signals to key external players that a university is active in commercialize knowledge/technology and identifies the necessities of for-profit organizations because the academic institution was ready to invest the required effort, time and cost in gaining patents. Consequently, established companies may have a greater interest in obtaining the technology/knowledge developed by the university. Furthermore, and about new ventures, venture capitalists and other institutional investors with advance managerial and organizational capabilities may be interested to the potentials of a patented innovation and look for invest or be part of the technology development (Bell and McNamara, 1991).

Literature points out that patent activity may represent an appreciated organizational resource to sustain the competitive advantage and improve firm performance (Deeds et al., 2000; Zahra and Bogner, 2000). It is to note that an important part of the literature on the topic is dedicated on the changes in prominence of patents instead of merely quantify the number of patents obtained by a firm. Classical and up-to date studies have been analyzed the level to which university patent activity encourages future patent activity and performance (Henderson et al., 1998; Mowery et al., 2002). Similar, scholars have proposed that a dedicated patenting strategy focused on basic technologies with wide-ranging prospective through a variety of applications may result in superior performance with licensing to new ventures (Roberts and Malonet, 1996) and may work as a facilitator for future innovations and firm development (Henderson et al., 1998; Shane, 2001).

Additionally, because patents are quite expensive to obtain, the choice to patent is an economically hazardous for academic institutions and, henceforth, not ever and simply easily achievable. Still, the advanced eminence or more key patents may be particularly appreciated and hard to reproduce. Henceforth, following the arguments of the resource-based view, universities that have more of these types of patents are more expected to outperform universities less well capable with this technological resource. Consequently, university spin-offs may have the possibility to perform better if they are generated by a university with superior and advanced patent activity, relying on the previous path-dependent process and resource advantages.

In view of these arguments, the following research hypothesis is advanced:

Hypothesis: *The patent activity of a university is positive associated with the financial performance of university spin-offs.*

### **3. Method**

#### **3.1. Sample**

With the aim to empirically validate the research hypothesis defined, it was investigated a panel sample of 692 Italian university spin-offs extracted from Netval database at 31 December 2014, which is englobed in the project “Spin-off Italia” in partnership with Netval, Università Politecnicadelle Marche and Scuola Superiore Sant’Anna – Istituto di Management. In detail, the database collects data about the population of research spin-off in Italy. Furthermore, secondary data about university spin-offs was collected through the examination of financial statements and other corporate records from Aida BdV database, an Italian subsection of ORBIS database, enclosing historical financial, biographical and merchandise information of about 700,000 Italian active firms. Specifically, Honyvem who obtains and elaborates all accounts deposited to the Italian Chambers of Commerce provides financial data. Data about the patent activity of universities were collected from PATIRIS database. Finally, information concerning venture capital, business incubators and science parks were collected from institutional websites of local administrations, universities and MIUR (Ministry of Education, University and Research).

#### **3.2. Variables definition**

##### **3.2.1. Dependent variable**

The analyses and measurement of university-spin-offs has a critical role in the literature related to the academic entrepreneurship, as it represents the fundamental element to determine the degree of success and productivity of the spinout process from universities (Bigliardi et al., 2013; Huynh and Patton, 2014). In detail, in this paper we used the return on assets index (ROA) as performance measure of university spin-offs; following the arguments that technology and knowledge based firms tend to be more affected by the asset measures of corporate performance (Delmar et al., 2003).

##### **3.2.2. Independent variables**

To evaluate the effect of university patent activity on the performance of university spin-offs we used four variables that are related to stock of patents held by university in different time period.

This approach is employed to better understand and determine the ability of university to generate patents on different time-frames and improve the validity of our analysis, with a reduction of the potential biases related to the time. In detail, we use the amount of patents held by universities at 5 years (UNIVERSITY PATENT -5), at 10 years (UNIVERSITY PATENT -10), at 20 years (UNIVERSITY PATENT -20), at 60 years (UNIVERSITY PATENT -60).

### 3.2.3. Control variables

A set of control variables were used in the paper. First, we used to the age of the firm (AGE); second, we used the size of the firm by employees (SIZE). Third, we used the number of venture capital in the regional context where is located the university spin-off firm (VENTURE CAPITAL), the number of university business incubator (BUSINESS INCUBATOR) and university science park (SCIENCE PARK). Additionally, we used a dummy variable taking the value “1” if the university spin-off is an innovative firm, “0” otherwise (INNOVATIVE).

### 3.3. Models

An OLS regression method were used to empirically validate the research hypotheses. To this end, we defined 4models to predict the performance of university spin-offs based on the patents stock of their university of origin. The models aim to predict the firm performance measured as the ROA index, taking the following econometric form:

$$ROA_{it} = f(\beta_0 + \beta_1 \text{UNIVERSITY PATENT -5}_i + \beta_1 \text{AGE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{SIZE}_{it} + \beta_4 \text{VENTURE CAPITAL}_i + \beta_5 \text{BUSINESS INCUBATOR}_i + \beta_6 \text{SCIENCE PARK}_i + \beta_7 \text{INNOVATIVE}_i + \varepsilon) \quad (1)$$

$$ROA_{it} = f(\beta_0 + \beta_1 \text{UNIVERSITY PATENT -10}_i + \beta_1 \text{AGE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{SIZE}_{it} + \beta_4 \text{VENTURE CAPITAL}_i + \beta_5 \text{BUSINESS INCUBATOR}_i + \beta_6 \text{SCIENCE PARK}_i + \beta_7 \text{INNOVATIVE}_i + \varepsilon) \quad (2)$$

$$ROA_{it} = f(\beta_0 + \beta_1 \text{UNIVERSITY PATENT -20}_i + \beta_1 \text{AGE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{SIZE}_{it} + \beta_4 \text{VENTURE CAPITAL}_i + \beta_5 \text{BUSINESS INCUBATOR}_i + \beta_6 \text{SCIENCE PARK}_i + \beta_7 \text{INNOVATIVE}_i + \varepsilon) \quad (3)$$

$$ROA_{it} = f(\beta_0 + \beta_1 \text{UNIVERSITY PATENT -60}_i + \beta_1 \text{AGE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{SIZE}_{it} + \beta_4 \text{VENTURE CAPITAL}_i + \beta_5 \text{BUSINESS INCUBATOR}_i + \beta_6 \text{SCIENCE PARK}_i + \beta_7 \text{INNOVATIVE}_i + \varepsilon) \quad (4)$$

where  $i$  indexes university-spinoffs,  $t$  is the time and  $\varepsilon$  is the error term.

## 4. Results

### 4.1. Univariate analysis

Table 1 shows the descriptive statistics of the variables used in the defined models. The results reveal that the sampled university spin-offs have a relatively medium-low firm performance, with a mean value of 2.66 of ROA index and a high dispersion in the sample (S.D. = 109.845). The number of patents held by universities at 5 years shows a sampled mean of about 51, while at 10 years show a sampled mean of about 110. Hence, the stock of university patents shows, predictably, an increasing trend over time, with a relatively low dispersion in the sample (in view of that the S.D. is quite close to the sample mean for the all variables used to measure the university patent activity).

**Table 1.** Descriptive statistics

Variable	Obs	Mean	S. D.	Variance	Min	Max
ROA	2830	2.66	25.455	647.950	-429	88
UNIVERSITY PATENT -5	5580	51.176	55.3831	3067.291	0.0	256.0
UNIVERSITY PATENT -10	5580	78.198	83.1454	6913.150	0.0	375.0
UNIVERSITY PATENT -20	5580	93.766	94.4796	8926.389	0.0	408.0
UNIVERSITY PATENT -60	5580	109.845	106.1860	11275.474	0.0	416.0
AGE	5589	8.594	6.5199	42.510	2.0	78.0
SIZE	2417	5.126	22.1204	489.313	0.0	308.0
VENTURE CAPITAL	5589	0.002	0.0401	0.002	0.0	1.0
BUSINESS INCUBATOR	5589	0.834	0.9221	0.850	0.0	3.0
SCIENCE PARK	5580	0.360	0.4799	0.230	0.0	1.0
INNOVATIVE	5580	0.139	0.3457	0.119	0.0	1.0

Regarding the age of the university spin-offs analyzed, the sample show a mean of 9 years, remarking that the academic entrepreneurship is relatively a young phenomenon in Italy.

In addition, the findings point outs that the sample consists mainly in start-up firms, for which the relation with his parent university is expected to be stronger.

Considering the firm size, the university spin-offs sampled seems to be quite small, with a sampled mean of about 5 employees for each firm. This finding is also consistent with start-up nature previously highlighted. Nevertheless, this result denotes a high-moderate dispersion in sample (S.D. = 22.120), remarking that the firm size of the university sin-offs analyzed is quite heterogeneous.

**Table 2.** Correlations

		1	2	3	4	5	6	7	8	9	10	11
1	ROA	1	0.033	0.030	0.030	0.029	-0.016	0.010	-0.019	0.006	0.057**	0.039*
2	UNIVERSITY PATENT -60	0.033	1	0.984**	0.974**	0.971**	0.118**	0.013	-0.010	0.211**	-0.005	0.075**
3	UNIVERSITY PATENT -20	0.030	0.984**	1	0.996**	0.989**	0.106**	0.003	-0.007	0.267**	-0.030*	0.071**
4	UNIVERSITY PATENT -10	0.030	0.974**	0.996**	1	0.994**	0.102**	-0.002	-0.002	0.283**	-0.029*	0.069**
5	UNIVERSITY PATENT -5	0.029	0.971**	0.989**	0.994**	1	0.109**	0.006	-0.004	0.260**	-0.018	0.070**
6	SIZE	-0.016	0.118**	0.106**	0.102**	0.109**	1	0.008	0.046*	-0.013	-0.016	0.196**
7	VENTURE CAPITAL	0.010	0.013	0.003	-0.002	0.006	0.008	1	-0.016	-0.036**	-0.030*	0.021
8	INNOVATIVE	-0.019	-0.010	-0.007	-0.002	-0.004	0.046*	-0.016	1	0.046**	0.020	-0.233**
9	BUSINESS INCUBATOR	0.006	0.211**	0.267**	0.283**	0.260**	-0.013	-0.036**	0.046**	1	0.221**	-0.033*
10	SCIENCE PARK	0.057**	-0.005	-0.030*	-0.029*	-0.018	-0.016	-0.030*	0.020	0.221**	1	-0.001
11	AGE	0.039*	0.075**	0.071**	0.069**	0.070**	0.196**	0.021	-0.233**	-0.033*	-0.001	1

Notes:

\*\*Significant at 1%.

\*Significant at 5%.

Table 2 shows the bivariate Pearson correlations among all variables used in the study. In view of the absence of sufficient high correlation among the independent variables of the models previously defined, problems of nonsense correlation are not detected (Aldrich, 1995; Cohen et al., 2013). Also, we checked for multicollinearity using VIF statistics. The results show that the VIF scores did not exceed 1.13 for the Model (1), 1.11 for the Model (2), 1.14 for the Model (3) and 1.10 for the Model (4). These findings are not close to the rule of thumb “threshold” value of 10 (Hair et al., 1998), while the “tolerance” level denotes an acceptable value higher than 0.10, proposing that multicollinearity is not a severe issue; hence, multiple regression analysis can be used to validate the defined research hypotheses.

#### 4.2. Multivariate analysis

Table 3 reports the results of the OLS regression estimation about the effect of the university patent activity on the performance of university spin-offs. The regression analyses are performed in a step-wise manner. Model 1, 2, 3 and 4 refer to the four main effects, entered one by one, while Model 5 is the full model. In the Model 1, the estimated coefficient on UNIVERSITY PATENT -5 is positive and statistically significant (coeff. = 0.18,  $p < 0.1$ ). In the Model 2, the estimated coefficient on UNIVERSITY PATENT -10 is, also in this case, positive and statistically significant (coeff. = 0.13,  $p < 0.1$ ). In the Model 3, the estimated coefficient on UNIVERSITY PATENT -20 is positive and statistically significant (coeff. = 0.11,  $p < 0.1$ ). Finally, in the Model 4 the estimated coefficient on UNIVERSITY PATENT -60 is positive and statistically significant too (coeff. = 0.01,  $p < 0.05$ ). Thus, the findings seem to confirm the positive effect provided by the university patent activity of in promoting the performance of university spin-off generated, in accordance with the path-dependence arguments. Henceforth, the empirical analysis supports the research hypothesis defined.

**Table 3.** Estimates of the defined OLS regression models for the effect of the university patent activity on the performance of university spin-offs

<i>Dependentvariable: ROA</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>
	(i)	(ii)	(iii)	(iv)	(v)
UNIVERSITY PATENT -5	0.018* (0.010)				0.029 (0.031)
UNIVERSITY PATENT -10		0.013* (0.007)			-0.058 (0.086)
UNIVERSITY PATENT -20			0.011* (0.006)		0.100 (0.104)
UNIVERSITY PATENT -60				0.010** (0.005)	-0.087 (0.089)
Control variables					
INNOVATIVE	-0.105 (1.961)	-0.085 (1.961)	-0.050 (1.962)	-0.011 (1.962)	-0.005 (1.974)
AGE	0.135* (0.071)	0.134* (0.071)	0.134* (0.071)	0.135* (0.071)	0.135* (0.071)
VENTURE CAPITAL	4.341 (15.099)	4.492 (15.097)	4.399 (15.098)	4.136 (15.098)	4.774 (15.142)
SIZE	-0.033 (0.025)	-0.033 (0.025)	-0.033 (0.025)	-0.034 (0.025)	-0.033 (0.025)
BUSINESS INCUBATOR	-1.013 (0.622)	-1.071* (0.627)	-1.041* (0.623)	-0.969 (0.613)	-1.081 (0.692)
SCIENCE PARK	3.235*** (1.137)	3.277*** (1.138)	3.257*** (1.137)	3.151*** (1.136)	3.196*** (1.187)
R	0.081	0.082	0.082	0.083	0.086
R-Squared	0.007	0.007	0.007	0.007	0.007
AdjustedR-Squared	0.004	0.004	0.004	0.004	0.003
DF	7	7	7	7	10
F	2.286**	2.344**	2.339**	2.391**	1.798*

Notes: Standard errors in parenthesis.

\*  $p < 0.1$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

### 5. Result discussion and conclusion

The paper aimed to study the impact of the tradition and history of university in the research activity and its outcomes, incorporated in the patent activity, on the success reached by the university spin-off. In detail, following the theoretical arguments related to the path dependency theory, it was stated that the university patent activity is positive associated with the financial performance of university spin-offs generated. To test the developed hypotheses, a sample of 692 Italian university spin-offs was examined during the period 2003-2014. The empirical findings confirm the positive effect of tradition and importance in university patent activity on the consequent financial performance of university spin-offs, measured in term of ROA index. This finding is in line with the arguments related to the path dependency literature, remarking that historical knowledge accumulation related to the research activity generates positive externalities in the university's future ability to effectively improve the spin-offs firm's successes and future growth. In view of the above path-dependent process, university is likely to increase the ability to exploit innovative resources related to the patent activities, which constitutes the fundamental base to create value-added effect on spin-off firms.

The study has some interesting practical and policy implications. Our findings suggest that the university history and tradition in patent activity create an evolutive environment where the university spin-off process is influenced and seems to considerably affect the growth and financial performance path of academic start-ups. Consequently, to improve the effective creation and development of university spin-offs, more attention upon innovative activities and patent protection at the department level within universities is needed.

Additionally, in the above emerging setting become central the role of policy makers, at local and national level, as facilitators of the knowledge and technology transfer. This may be effectively achieved also by designing and implementing project and programs aimed to recognize and spur innovative activities at university level, with the synergic, complementary and proactive involvement of the local industry too. The fostering approach above delineated will constitute one of the key prerequisites to improve the university patent activity, by which the path-dependent process will transform that in an increase of growth and development opportunities for university spin-offs.

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