

The Role of the Entrepreneurial University to Improve Innovation in Region¹

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Abstract

The paper aims to explore the impact of patenting activity, university spin-offs (USOs), business incubators and Science Parks on regional innovation. Based on a panel sample of 53 Italian universities, 621 Italian USOs, 543 business incubators and 233 Science Parks for the period 2004-2012, the results show that university patenting activity does not seem to promote the innovation capacity of a region. Similar consideration for university business incubators and Science Parks. However, a more effective role is provided by USOs. Indeed, the scale of the spin-out process is pivotal in the exchanging of innovative output/input from academia to industry. Local governments should act as facilitators in the interchange of knowledge/technology, by planning policy and network towards a more innovative ecosystem.

Keywords: Entrepreneurial university; regional innovation; patent activity; university spin-offs; business incubator; Science Park.

1. Introduction

In the contemporary university model of Triple Helix, university is called to assume an active role in the promotion and dissemination of innovativeness, enclosing itself among the processes of innovation diffusion in the up-to-date knowledge-based economy (Cesaroni and Piccaluga [1]; Etzkowitz [2]). The progressive enrichment of the university identity as generating opportunities for innovative forms of entrepreneurship - a phenomenon called entrepreneurial university - has altered the socio-economic role of universities in many countries (Lazzeroni and Piccaluga [3]; Kalar and Antoncic [4]). Indeed, the improved prominence of the impact of university on the economic system is perceived within the entrepreneurial context (Aldrich [5]). In view of this, universities are becoming more entrepreneurial with the aim to remain competitive, productive and innovative in the connection between academia and industry (Kirby et al. [6]).

Furthermore, an entrepreneurial university makes available new choices to the university context, which usually recognizes entrepreneurial opportunities (Guerrero et al. [7]). According to this, the commercialization and dissemination of technology-knowledge, developed by universities, have gained the consideration of the policy makers as strategic and crucial elements able to let emerge and support the regional socio-economic growth (Iacobucci and Micozzi [8]). Governments, throughout the world, agree that universities should be more entrepreneurial and should contribute directly to the economic development through business activities such as the formation of spin-off companies, the patenting and licensing of technology (O'Shea et al. [9]; Martinelli et al. [10]).

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Taking into account the endogenous growth theory (Braunerhjelm et al. [11]), for which innovation is considered as the key element for accomplishing long-term economic growth, the universities are become prominent actors not only as generators of new knowledge but also for the transfer of these knowledge to the economic sector through entrepreneurial and commercial activities (Iacobucci and Micozzi [8]). The current Knowledge-based economies are fundamentally innovation driven. Indeed, several scholars agree that the three fundamental processes, namely the generation of new knowledge (1), the transfer of knowledge to technological innovation (2) and the business competitiveness (3), are narrowly interconnected in high-tech environment (Caiazza et al. [12]). In this context, the universities are becoming a vital and strategic resource for high-tech entrepreneurship, mainly in the early stages of its development.

Additionally, the geographical proximity and the agglomeration activities have a main part in the R&D partnership and the innovation dissemination. Therefore, it becomes pivotal understanding the role of universities on technology transfer and innovation promotion within the regional context where they are located (Mowery and Ziedonis [13]). Although the theoretical and practical relevance of the above arguments, the dynamic relationship, between the indirect and direct impact of entrepreneurial university on the contextual innovation performance, is not fully understood and explored in literature; though, recently, we observe a more pronounced scholars' interest in these aspects, especially in terms of economic impact (Iacobucci and Micozzi [8]; Guerrero et al. [8]; Mowery and Ziedonis [13]).

Hence, this paper aims to fill the knowledge gap on the "University and innovation" literature by exploring and focusing on the three main channels of knowledge-technological transfer of the entrepreneurial university, namely the patenting activity, the university spin-off activity and the entrepreneurial facilities of business incubators and science parks, in order to evaluate their impact on regional innovation. In details, the study aims to investigate if the three above mentioned university channels are active tools able to promote regional innovation, jointly with a comparison among them about their effectiveness. To this purpose, the study analyzed a panel sample of 53 Italian universities from 2004 to 2012. In line with the European context, Italy has rapidly increased the technological transfer activities from universities in the last decade, with a quick expansion of the academic entrepreneurship (Iacobucci et al. [14]). The paper aims to provide a contribution to the knowledge – in both term of academic and practical/policy perspective - about the mechanisms of the universities which foster innovation in the regional context, with reference to the emerging entrepreneurial opportunity and dissemination of knowledge-technology, evaluating their effectiveness and value for the best assessment and planning of policies and of managerial actions.

Theoretical framework

The impact of university patenting activities on regional innovation

The university knowledge and the technology output had been indicated as key sources of the innovation input for the industry (Abramo et al. [15]). An important theme of debate is the prominence of the commercialization of university research. Indeed, following the consolidated emphasis of academic entrepreneurship within the new socio-economic knowledge-based context, the research activity is one of the most valid university purposes (Wright et al. [16]). This purpose has allowed recognizing the creation, transfer, and commercialization of new knowledge as fundamental mechanisms by which the universities commercialize the knowledge developed in academia, which includes copyrights, licenses, trademarks and, particularly, patents (Wu et al. [17]; Mowery and Ziedonis [13]).

Therefore, the socio-economic impact of entrepreneurial universities may be well related with the promotion of the innovation and knowledge transfer embodied in patenting activity, facilitating the degree of spatial spillover between university research and high technology innovations in the regional context, as argued by the Knowledge Spillover Theory of Entrepreneurship (Audretsch and Keilbach [18]; Acs et al. [19]). Indeed, the scientific results generated by universities could be relocated into applied science, and then employed by the industry (Bstieler et al. [20]). The industrial context has moved from mainly exploiting in-house resources to exploring new idea and creative outputs by the external innovative environment. The theoretical arguments of absorptive capacities remark the capability of the companies to efficiently use the scientific knowledge and technology from outside firm boundaries (Lau & Lo [21]).

Additionally, following the relational view of the firm, companies aim to establish relational links with other enterprises and universities, or come into an alliance network to increase the access to the external scientific knowledge and other inventive input resources in order to better perform their innovative activities (Martín-de Castro [22]). Thus, in view of the above considerations, it can be stated the following:

H₁: The patenting activity of university positively affects the regional innovative performance.

The impact of university spin-offs on regional innovation

The university spin-offs (USOs) are an entrepreneurial phenomenon that is considerably grown in the USA but also in Europe in the last decade, conferring, at the same, the rating of one of the better promoting university initiatives, which offers an effective and profitable mechanism for the dissemination of new technologies and knowledge (Palumbo [23]; Calcagnini and Favaretto [24]). Additionally, USOs are now incorporated among the more proactive fostering tools to endorse the creation and development of knowledge-based economies (Sternberg [25]). Consequently, the development elements and entrepreneurial configurations of these types of firms, jointly with their socio-economic effects, have been permanently integrated in the political agenda relating to the sustaining actions of the dissemination and promotion of innovation in definite environmental contexts (Lockett et al. [26]). Indeed, USOs provide direct and prominent support to the development of the socio-economic context wherein are located, mainly in terms of innovative contribution (O'Shea et al. [9]; Martinelli et al. [10]).

Thus, scholars and practitioners have recognized to USOs a bridging role between university and industry, acting as intermediaries in the dissemination of knowledge/technologies developed in academia to potential users, such as businesses and institutions (Cardamone et al. [27]). Additionally, USOs are promoters of the renovation of the industrial sectors from traditional or low intensity technology to high-tech sectors (Iacobucci and Micozzi [28]). The pivotal function of promoting innovation by USOs is underlined also by the Knowledge Spillover Theory of Entrepreneurship, which stressed the need to create new entrepreneurial opportunities to better conduct the economic knowledge / technologies developed by the university research to the regional industry sector (Audretsch and Lehmann [29]). It is to note that compared with other technology transfer tools, USOs require an intensive resource allocation from the universities and they prospect a low or absent future economic return, though they have actually got the highest effect on the local context (Iacobucci, and Micozzi [8]). The reasons are related to the fact that USOs are inclined to stay close to the parent university, with an effective beneficial impact on the local community that receives most of the direct and indirect knowledge spillover effects (Audretsch and Lehmann [29]), building the innovative capabilities and infrastructure of a region (Berggren and Lindholm Dahlstrand [30]). Thus, it can be stated the following:

H₂: The activity of university spin-offs positively affects the regional innovative performance.

The impact of university business incubators and university science parks on regional innovation

The university business incubators and the university science parks are property-based organizations with recognizable executive centers that have the goal of business acceleration, through knowledge cluster and resource sharing, between the partner and incubated actors (Minguillo et al. [31]). These university infrastructural support mechanisms are instinctively considered as accomplisher of such an environment-creating function and they are essential components of the regional innovation system (Gunasekara [32]). Thus, they are assumed to be generators of a supportive milieu for the diffusion of innovation, inventiveness, and entrepreneurship (Felsenstein [33]).

Indeed, Science Parks and business incubators are entrepreneurial infrastructures where knowledge spillovers may arise more easily between the academia and the companies, supporting the formation and interchange of technological knowledge between them (Montoro-Sánchez et al. [34]). Consequently, the organizations inside parks can increase their innovative capability via combining their inside know-how with the knowledge provided by the academic institutions and the other sited companies (Giarretta [35]; Díez-Vial and Montoro-Sánchez [36]). Taking into account the Network theory (Hansen et al. [37]), the dissemination, and commercialization of knowledge/technology typically occur inside an innovation cluster rather than a lone organization (Lynn et al. [38]). Indeed, the key value-added element of networked incubators is the establishment of institutionalized practices that build and transfer the knowledge through the incubator network with the aim of generating environments that assist the growth of incubators and the dissemination of their innovations in the socio-economic context (Hackett and Dilts [39]).

The ability of an entrepreneurial context to generate innovation is affected by the degree to which a company has access to the external knowledge sources, both tacit and explicit knowledge (Díez-Vial and Montoro-Sánchez [36]). University business incubators and university science parks improve the chance, for the firms therein located and situated in their proximity, to have access to different external knowledge sources and detect new methods of combining these knowledge sources (Löfsten and Lindelöf [40]; Zeng et al. [41]). Hence, according to the above arguments, it can be stated the following:

H₃: The activity of university business incubators and science parks positively affects the regional innovative performance.

Method

Sample

In order to test the research hypothesis above, it was analyzed a panel sample of 53 Italian universities extracted from Netval database at 31 December 2014, while data cover a period from 2004 to 2012. In detail, it was further collected information about 621 Italian USOs, jointly with data of about 543 business incubators and 233 Science Parks. The collection of secondary data about USOs was performed by the analysis of financial statements and other corporate files extracted from Infocamere database and Aida BdV database (containing financial, biographical and merchandise data of about 700,000 Italian active companies). Information regarding the innovative performance of the regional context was collected by extracting data from the records stored by the Italian National Institute of Statistics (ISTAT) and the Statistical Office of the European Communities (EUROSTAT), while data concerning the patent activity of universities were extracted from PATIRIS database. Lastly, data regarding business incubators and Science Parks were collected from institutional websites of universities, MIUR (Ministry of Education, University, and Research) and regional authorities.

Variable definition and measurements

Dependent variable

The dependent variable applied in this study, the regional innovative performance, was measured by the number of patents applied to the European Patent Office (*Regional innovation*), following Ejermeo [42] and Acs et al. [43]. Indeed, patent data represent one of the major indicators of regional innovativeness and spillover.

Independent variables

With the aim to predict the potential effects of the selected entrepreneurial university mechanisms on the regional innovative performance, three independent key variables were used in the multivariate analysis. First, following Fini et al. [44], in order to measure the patenting activity of university it was used the stock of university patents generated in the last ten years (*Uni Patents*). Secondly, with the aim to evaluate the impact of the infrastructural support to innovation by university incubators and Science Parks, it was used the number of university-affiliated business incubators and Science Parks (*Uni incubators Science Park*). Finally, in order to assess the beneficial effects of the spin-out activities from university, it was used the number of university spin-offs generated by each academic institution (*USO*).

Analytical approach

In order to test the research hypothesis it was used a log-linear Poisson model that is very useful for counting variables such as response variables (Cameron and Trivedi [45]). A goodness of fit test rejected the Poisson distribution assumption (the equality of mean and variance of the exogenous variable), which is indicative of an over-dispersion in the data. Hence, negative binomial regression was selected to analyze the data and overcome this problem of over-dispersion (Greene [46], pp. 740–752). Additionally, this statistical method is designed for a maximum-likelihood estimation of the number of rates of non-negative counts. Finally, the developed empirical model takes the following form:

$$\text{Regional innovation}_{it} = f(\beta_0 + \beta_1 \text{Uni Patents}_i + \beta_2 \text{Uni incubators Science Park}_i + \beta_3 \text{USO}_i + \delta_t + \epsilon_{it})(1)$$

Where indexes universities and t indexes years. In addition, δ_t is the time effect and ϵ_{it} is the error term.

Results

Univariate analysis

Table 1 shows the descriptive statistics and correlation of the key variables used in the empirical model. The results indicate that the average of patent stock, generated in the regional contexts wherein the sampled universities are located, is 39.44; although this value is highly dispersed in the sample (S. D.= 42.48), remarking as the innovative performance is noteworthy heterogeneous in different contexts. With regards to the patenting activity of the university sample, it has been noted a sample mean of patent stock in the last ten years of 78.18. Also in this case, the prominence of universities, which disseminate knowledge/technology through the patents, is highly mixed in the sample (S.D. = 83.15). As regard to the number of spin-offs generated by the sampled universities, results show an average of about 19 firms, with a low-moderate dispersion in the sample (S. D. = 8.95). This evidence highlights as the spin-off phenomenon is quite diffuse among the Italian universities. Finally, the number of university-affiliated business incubators and Science Parks show a sample mean of about 1, with a relative low dispersion in the sample (S.D. = 0.98), remarking the low attitude of the Italian universities to provide infrastructural support of entrepreneurship. Finally, the absence of high significant correlations among the main explicative variables (Table 2) reveals that multicollinearity is not a major issue in this analysis.

Table 1: Descriptive statistics

	N	Min.	Max.	Mean Statistics	S. E.	Std. Deviation	Variance
Regional innovation	5466	0.17	172.80	39.4417	0.57454	42.47736	1804.326
Uni Patents	5580	0.0	375.0	78.198	1.1131	83.1454	6913.150
USO	5589	1.0	36.0	18.643	0.1198	8.9525	80.147
Uni incubators Science Park	5589	0.0	3.0	1.403	0.0131	0.9776	0.956

Table 2: Correlations.

	1	2	3	4
1 Regional innovation	1			
2 Uni Patents	0.331**	1		
3 Uni incubators Science Park	0.010	0.150**	1	
4 USO	0.050**	0.308	0.214	1

*** p < 0.01; ** p < 0.05; * p < 0.10 (all two-tailed tests).

Multivariate analysis

Table 3 shows the results of the log-linear Poisson model estimating the impact of entrepreneurial university mechanisms on regional innovation. H_1 states a positive relationship between the patenting activity of the university and the regional innovative performance. The coefficient on patenting activity is positive but not statistically significant, thus rejecting the H_1 . H_2 states a positive relationship between the activity of university spin-offs and the regional innovative performance. The coefficient on university spin-offs is positive and statistically significant (coeff. = 0.020; $p < 0.001$), thus providing support to H_2 . H_3 states a positive relationship between the activity of university business incubators and Science Park and the regional innovative performance. The coefficient on university business incubators and Science Park is negative and not statistically significant, hence rejecting the H_3 .

Table 3: Estimation of log-linear Poisson model regression with regional innovation as the dependent variable

Variables	Model	
	B	S. E.
Hypothesized effects	0.001	(0.0007)
Uni Patents	-0.050	(0.0444)
Uni incubators Science Park	0.020***	(0.0046)
USO		
Akaike's information criterion (AIC)	980.677	
Hurvich and Tsai's criterion (AICC)	981.162	
Bozdogan's criterion (CAIC)	1012.013	
Bayesian information criterion (BIC)	1005.013	

*** p < 0.01; ** p < 0.05; * p < 0.10 (all two-tailed tests).

Result discussion and Conclusion

The paper aimed to study the impact of some key mechanisms of the entrepreneurial university on the regional innovative performance. In detail, and based on existing literature, it was stated that university patenting activity, university spin-offs, as well as university business incubators and Science Parks, positively influence the degree of innovativeness of the regional context wherein universities are located. In order to test the developed hypothesis, a sample of 53 Italian universities was investigated during an exploration period of nine years, from 2004 to 2012. The results show that the impact of the university knowledge and technology output incorporated in patenting activity does not seem to promote, in an effective and substantial manner, the innovation capacity of the local context wherein academic institutions are inserted.

This evidence remarks how the spillover effect of research externalities, embodied in patenting activity, is very small in the regional context (Bottazzi and Peri [47]). However, the same findings are in contrast to the spatially localization arguments regarding the potentially spillover of new knowledge and technology from research institutions as stated by the Knowledge Spillover Theory of Entrepreneurship (Audretsch and Keilbach [18]; Acs et al. [19]). Additionally, also the infrastructural support of entrepreneurship, provided by university business incubators and Science Parks, does not seem to have a promoting role in building the innovative capability of a region. This evidence diverges from the arguments related to the benefits, in term of knowledge and other innovative input resources, for those firms localized in the proximity of business incubators and Science Parks (Löfsten and Lindelöf [40]; Zeng et al. [41]).

More likely, the latter consideration it may be true only for business herein localized. In this case, the potentially innovative impact of university business incubators and Science Parks may be limited to the firms incubated. A more effective role in promoting innovative performance of the regional context is provided by the USOs. Indeed, the scale of the spin-out practices, sponsored by each university, is pivotal in guaranteeing a continuum interchange of innovative output/input from academia to industry. The finding is consistent with the idea of spin-offs as an elective business model for the dissemination of technologies and knowledge (Sternberg [25]; O'Shea et al. [9]).

In consideration of the main findings of this study, the only effective mechanism of entrepreneurial university, among those selected, is the USOs, highlighting as the academic entrepreneurship takes an active part in building the innovative capability of the region. The study has some interesting practical and policy implications. In order to exploit all the potentials of the technology/knowledge diffusion from university to industry and strengthen their impact on regional innovative performance, it is necessary a more convinced and shared collaboration among all the actors involved in the spillover processes, both public and private. In this case, it is crucial the role of the local governments that should act more as facilitators and brokers in the exchange of knowledge and technology, by planning policy actions that recognize the importance of network and relations in the efforts towards a more innovative ecosystem. However, the study is not free of limitations.

The empirical study has been based only on an index of regional innovation and only on some potential impacts of entrepreneurial university. Therefore, the developed model can be considered as a basic starting point with the aim to develop more extensive studies that are able to intercept, in a comprehensive and systemic way, the impact of university on regional innovation. In this line, future studies could expand the regional innovation measures at indicators related to the activity of the start-up of the high-tech and new technology-based firm (Motohashi [48]), the innovation output (Acs et al. [43]), as well as to the multidimensional measures (Siller et al. [49]; Fini et al. [44]).

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