

University Technology Transfer and the Contribution of University Spin-offs in Stimulating the Socio-economic Development of Regions

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Abstract

The commercialization and dissemination of knowledge technologies developed in academia have increased the attention of policy makers as strategic components to support regional socio-economic and innovative development. The emerging models of the third and fourth university missions underline the critical function of commercializing the results of academic research, innovation and entrepreneurship for the growth and competitiveness of regional areas. This study aims to investigate, both from a theoretical and empirical point of view, the role of university spin-offs as a contribution to the socio-economic and innovative development of the regions in which they are located. To this end, the contributor analyzes a longitudinal sample of 952 university spin-offs located in 20 Italian administrative regions. The results from the empirical analysis show that the knowledge and technological production of the university spin-out process generate an affective and active role in the regional context, stimulating its innovative capacities and supporting their socio-economic development.

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Keywords: University technology transfer, University spin-offs, Regional economic development, Regional innovation.

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1. Introduction

The interest and the diffusion of the university technology transfer model in the so-called knowledge society have grown considerably in recent years, although there is still a relative divergence regarding the contribution of technology and knowledge in adding value for the creation of an extensive competitive advantage (Iqbal, 2021; Cunningham et al., 2019). The generally recognized function of technology transfer in the knowledge economy is related to a model of knowledge capital accumulation for socio-economic development (Huggins and Johnston, 2009; Prokop, 2021), through increasing returns to scale and the generation of knowledge clustering (Scuotto et al., 2020; Ryan and Daly, 2019). These elements are critical as new technologies have generated innovative market opportunities, as well as the creation, acquisition, absorption, imitation and dissemination of knowledge and technology are perceived as the central feature of entrepreneurial development at local, regional and national level (Amry et al., 2021; Audretsch et al., 2021). From this point of view, it emerges that some localization skills strengthen the economic performance of university technology transfer mainly in the promotion of innovative entrepreneurial initiatives and projects (Audretsch and Belitski, 2020), since the creation of knowledge and technology at the regional level is the dominant economic explanation in regional socio-economic development (Audretsch et al., 2021).

The emerging models of the third and fourth university missions underline the critical function of commercializing the results of academic research, innovation and entrepreneurship for the growth and competitiveness of regional areas (Rodríguez-Gulías et al., 2016; Lopes et al., 2018). Indeed, the interaction between entrepreneurship and economic geography is receiving a growing interest from the academic and professional-managerial world, highlighting the importance of spreading the endogenous perspective of universities in the regions, which constitute significant spillovers of knowledge / technology that they influence the degree of regional competitiveness in the national and international economy (Álvarez-García et al., 2018).

In this context, the university function becomes more effective in the development and enhancement of innovation in the current knowledge-based economy. The continuous improvement of the university as a creator of opportunities for new forms of entrepreneurship -the so-called entrepreneurial university- has transformed the socio-economic functions of universities (De Falco, 2015). Undoubtedly, the increased importance of the university's influence on the socio-economic system is observed within the regional business context (Aldrich, 2012). In this line, universities are called to be more entrepreneurial with the aim of remaining competitive and innovative in the connection between the academic world and industry (Guerrero et al., 2016; Schmitz et al., 2017).

Therefore, the commercialization and dissemination of knowledge technologies developed in academia have increased the attention of policy makers as strategic components to support regional socio-economic and innovative development

(Meoli and Vismara, 2016).

This paper analyzes this issue with reference to one of the most significant university technology transfer mechanisms, namely university spin-offs that are new companies created with the aim of commercially exploiting the knowledge and technology developed within a university (Criaco et al., 2014). University spin-offs are a critical way to stimulate the growth of knowledge economies in different national and regional contexts (Ramaciotti and Rizzo, 2015; Kruger and Steyn, 2020). Furthermore, spin-offs represent a strategic lever for universities committed to ensuring that the latter adopt a more proactive involvement in the socio-economic and innovative growth of the regions. In this situational context, the research work investigates the role of university technology transfer through spin-offs in contributing to the socio-economic and innovative development of the local context at the regional level.

To this end, the contributor analyzes a longitudinal sample of 952 university spin-offs located in 20 Italian administrative regions. Italy is one of the main European countries that is experiencing a rapid growth in the phenomenon of university spin-offs. According to the latest Netval report (Netval 2021), in Italy there are 1,830 research spin-offs, of which about 64% have been established in the last 10 years

2. Theoretical background

2.1 Technology transfer and the role of university spin-offs in the regional growth' dynamics

Universities, as "knowledge factories" (Ankrah et al., 2013), play a major role in development at local and regional level (Guerrero et al., 2016). In terms of the third and fourth university missions, the university, industry and government constitute the key institutional framework of knowledge-based post-industrial societies (Etzkowitz and Zhou, 2017). Spatial proximity to knowledge and technology transfer sources can confer a significant competitive advantage and co-location close to knowledge and technology-producing universities has been found to positively correlate with innovative outcomes at corporate and regional level (Batabyal and Nijkamp, 2012).

Unsurprisingly, professionals and political actors engaged in the development and management of innovation at the contextual level are interested in universities, considering the range of roles they assume in regional social and economic development (Huggins and Kitagawa, 2012; Pugh, 2017). Third mission activities, such as licensing, patents, technology transfer and the creation of spin-offs, have received considerable attention from academics and policy makers due to their significant economic impacts.

In detail, university spin-offs are an entrepreneurial phenomenon that has developed significantly in the United States and the EU over the last 20 years, representing one of the most effective initiatives of the so-called entrepreneurial university, which provides a proactive mechanism for the commercialization of knowledge and the technology generated in university (Compagnucci and Spigarelli, 2020; Agasisti et

al., 2019). In addition, university spin-offs are one of the most influential tools in fostering the establishment and growth of knowledge-based economies (Kruger and Steyn, 2020; Carayannis et al., 2022). It follows that the growth characteristics and business models of these business cases, together with their socio-economic externalities, have been incorporated into political actions aimed at exploiting and promoting innovation, as well as socio-economic development in defined regional areas.

The scientific literature has revealed that university spin-offs are important technological drivers and spillovers, essentially incorporated in externalities with added value in economic and innovative terms. Similarly, it was noted how university spin-offs encourage the development of the regional context, stimulating the creation of heterogeneous entrepreneurial networks in which various actors are active at the private and institutional level, as well as at local, national and international levels (Theodoraki et al., 2022).

However, the effective contribution of university spin-offs to regional economic and innovative development also depends on the technology transfer policy of the parent-universities (the universities from which they originated), which lead to different regional externalities. It was noted that universities can mainly undertake three types of university spin-off promotion processes (Clarysse et al. 2005):

- unselective approaches;
- support actions;
- business incubation.

Each of these processes influences the spin-off activity and its growth trajectories, drawing on the prevailing regional contexts in different ways and, therefore, heterogeneously influencing regional innovative and socio-economic development. In this regard, Clarysse et al. note that technology transfer requires adequate relationships with local professionals, entrepreneurs and experts with the aim of supporting the spin-out process and effectively contributing to the creation of innovation and added value in the regions through the commercialization of technology and university knowledge (Davies et al., 2021).

Nonetheless, the fundamental role assumed by university spin-offs in the context of regional development is also highlighted by the Knowledge Spillover Theory of Entrepreneurship. In fact, this theory supports the need to generate new entrepreneurial opportunities to improve the effectiveness of the dissemination of knowledge and technologies, developed in the university environment, to the regional socio-economic context. It should be noted that unlike other technology transfer mechanisms, university spin-offs require an intensive allocation of resources from their parent universities, with a generally medium-low economic return, although the externalities of the spin-offs on the regional context are among the most effective (Meoli and Vismara, 2016). The explanations of this process are linked to the circumstance of how university spin-offs usually remain close -in terms of geographical location- to their parent universities, providing an effective

contribution to the regional community which obtains most of the spillover effects of knowledge and direct and indirect technology (Stam & Van de Ven, 2021). These elements contribute to building and improving the capacity to generate innovation, as well as to improve socio-economic development capacities (Åstebro and Bazzazian, 2011).

It is therefore possible to note that university spin-offs can have a significant impact on the innovative capacity and the creation of socio-economic value of the regions, and this impact may differ from regional area to another, both for the effectiveness of the spin-out activity, both for the diffusion of spin-offs in the local context; these elements are linked to the promotion actions of parent universities.

2.2 The contribution of university spin-offs as drivers of innovation in the region

University spin-offs -as companies generated with the aim of commercializing knowledge and technology developed in the university environment- offer their main contribution to the knowledge economy in the regional context in which they are inserted through their attitude to generate innovation (Memon et al., 2020). It should be noted that, on the other hand, the role of innovation as a key and strategic component of growth at the firm and contextual level has been well recognized among scholars, both in theoretical and empirical terms (Andreeva and Kianto, 2012). The literature observes that university spin-offs typically have a better innovative performance than non-university entrepreneurial initiatives, mainly in terms of patent activities, highlighting how the distinctiveness of the university-context setting significantly affects innovative performance and the underlying forces of the company spillover (Rodríguez-Gulías et al., 2016; Criaco et al., 2014). Basically, this type of entrepreneurial initiative is necessary for a resilient development of innovative capacities in the local context (Sánchez-Barrioluengo and Benneworth, 2019). This argument is justified by the circumstance that a greater innovative orientation of university spin-offs could considerably favor the absorption of knowledge and technologies by companies at the regional level, thus improving the creation of new value for the region (De Wit-de Vries et al., 2019). However, the effect generated by technology transfer and deep innovation from university spin-offs seems to be strongly correlated with the need for geographical proximity between the university and the business context. In this emerging context, the region represents precisely this type of proximity and it should be observed how the Italian regional context is affected by limitations that devalue the value of knowledge and technology that is transferred from the university to industry (Miranda et al., 2018). These limits are mostly linked to a cultural aversion to collaboration between researchers and entrepreneurial / institutional actors at the regional level (Mason et al., 2022). The connection function performed by university initiatives is therefore fundamental, which, as mediators in the dissemination of knowledge and technologies from the academic world, create a pool of innovation opportunities for the socio-economic and innovative

development of the regions (Hossinger et al., 2020), supporting the renewal of the entrepreneurial context towards high-tech sectors. It should be noted that the Knowledge Spillover Theory of Entrepreneurship also underlines the positive and effective contribution of university spin-offs in promoting innovation in the regions they operate (Scuotto et al., 2020).

Therefore, considering the significant and potential innovative impact that university spin-offs spread in the regional context, it is possible to state that these university companies, with their technology transfer activities and their innovative results, can generate an effective and strategic impact in improving the socio-economic development of local regional contexts.

3. Method

3.1 Sample and Data

Concerning the empirical analysis, the study relies on the data collected from the Netval database at 31 December 2020, which is incorporated into the Spin-off Italy project and established in collaboration with Netval, Polytechnic University of Marche and Scuola Superiore Sant'Anna - Institute of Management. The Netval database contains updated data on the entire population of spin-off companies active in Italy (1,830 active companies). From the Netval dataset, only university spin-offs were selected, i.e., 1,275 companies. Furthermore, governance and economic-financial information on the selected companies was collected from the Aida BdV database, an Italian subset of the ORBIS database, which collects financial, biographical and historical-commodity information of approximately 700,000 active Italian companies. From the 1,275 university spin-offs, companies for which data were not available in the Aida BdV database for the period under investigation were excluded. Therefore, the final panel sample consists of 952 Italian university spin-offs, while the data cover a period from 2010 to 2019.

With reference to the information on the regional socio-economic development of the 20 Italian administrative regions, this was collected by extrapolating the data from the database by the Organization for Economic Cooperation and Development (OECD).

3.2 Variables

3.2.1 Dependent variables

In this study, two variables were used to measure the degree of regional socio-economic and innovative development. First, the gross domestic product per capita of the sampled regions (REGIONAL GDP) was used. Indeed, per capita GDP is considered as one of the key measures of regional socio-economic performance. In detail, GDP measures the ability of the local economy to create wealth and GDP per capita has a positive link with the average level of economic return achieved by the population.

Secondly, with the aim to measure the innovative activity of the regions, the number of patents present in the sampled regions (REGIONAL PATENTS) was used.

Indeed, several studies claim that patents provide a reliable measure of the innovative spillover of technology transfer, representing a fundamental proxy for regional knowledge and technology production.

3.2.2 Independent variables

With the purpose to predict the potential effects of university spin-offs on the degree of socio-economic and innovative development of the regions, the number of spin-offs established in each university was used (NUMBER SPIN-OFF). It should be noted that the number of spin-offs constitutes a suitable measure to evaluate the influence of the spillover effect on the regional context, especially in terms of local development. In addition, a dichotomous variable with a value of 1 was used if the spin-off company owns patent assets in each annuity and 0 in the other cases (SPIN-OFF PATENTS).

3.2.3 Control variables

Three control variables were used reflecting the socio-economic characteristics of the region and the possible economic advantages in terms of innovativeness. First, a variable related to urbanization economies was used, measured in terms of population density, defined as the number of inhabitants per square kilometer in the region (REGION DENSITY). Secondly, a variable linked to the main inputs in the development of regional innovation and socio-economic development was used, i.e., the number of R&D employees in the region compared to the total number of employees (REGION R&D EMPLOYEES).

Thirdly, since the socio-economic development of the regions is also linked to the knowledge and skills of the population living in them, a variable measuring the percentage of adult population (age 16+) with higher education in each region was used (HIGHER EDUCATION REGION).

Fourth, a variable was used to measure the size of the Venture Capital/Private Equity sector using the total number of investment transactions in the sector by region in the reference time period of the survey (VENTURE CAPITAL REGION). In addition, a variable measuring the natural logarithm of the number of innovative enterprises in the region was used (COMPANIES INNOVATIVE REGION).

4. Main Results

4.1 Descriptive statistics

Table 1 shows the descriptive statistics of the variables used in the study. The results indicate that the sample shows an average degree of regional socio-economic development in terms of GDP per capita equal to € 27,754.39, with a moderate dispersion in the sample (S.D. = 5739,795). This result highlights how the sampled regions differ significantly in terms of economic value generated. As regards the second measure of regional socio-economic development used, namely the number of patents, the sample detects an average of about 413 patents. The sampled regions show a high heterogeneity (S.D. = 407,349). This evidence reveals a good potential

for generating innovative outputs in the Italian context, although this intensity differs significantly between regions.

In general, the descriptive statistics show the existence of a significant heterogeneity in the Italian regions sampled in terms of socio-economic development achieved, suggesting that the regional contexts are relatively heterogeneous in Italy.

With reference to the first key explanatory variable of the study, namely the number of university spin-offs, the sample shows an average of about 28 spin-offs per university. However, the number of spin-offs is affected by a high dispersion in the sample (D.S. = 16.07513). This evidence points out that university spin-offs are a widespread phenomenon in Italy, with a potentially high expected effect on the regional context, although the diffusion of this typological class of business differs significantly between regions. This may also have consequences in part in terms of the impact of the positive regional externalities of spin-offs, accentuating the divergences and socio-economic and innovative performances between regions.

Furthermore, as regards the second key explanatory variable, namely the patent activity of university spin-offs, the sample shows an average of about 4% of the spin-offs with patents in the time period analyzed. This evidence highlights the limited tendency towards innovation on the part of the university start-ups sampled, although this result could only highlight a low orientation towards the protection of the innovation generated rather than a limited innovative capacity.

Table 1: Descriptive statistics

| | No. observations | Min. | Max. | Mean | S.D. |
|-----------------------------|-------------------------|-------------|-------------|-------------|-------------|
| REGIONAL GDP | 9,480 | 15800 | 37250 | 27754.39 | 5739.795 |
| REGIONAL PATENTS | 7,592 | 0.35 | 1509.05 | 413.0975 | 407.349 |
| NUMBER SPIN-OFF | 9,490 | 1 | 70 | 27.76396 | 16.07513 |
| SPIN-OFF PATENTS | 9,490 | 0 | 1 | 0.0415174 | 0.1994941 |
| REGION DENSITY | 7,575 | 0.54 | 112.24 | 6.083564 | 15.67485 |
| HIGHER EDUCATION REGION | 9,490 | 11.1 | 36.1 | 17.06889 | 2.961109 |
| REGION R&D EMPLOYEES | 9,190 | 38.1 | 430.6 | 223.8266 | 103.2297 |
| VENTURE CAPITAL REGION | 9,490 | 0 | 464 | 115.4659 | 137.957 |
| COMPANIES INNOVATIVE REGION | 9,490 | 4.682131 | 9.95123 | 8.479181 | 0.9366398 |

4.2 Estimation of linear mixed models

Table 2 shows the results of the Model (1), Model (2) and Model (3) in order to evaluate the impact of university spin-offs on regional competitiveness.

In Model (2), which predicts the effect of the number of university spin-offs on regional GDP per capita, the coefficient estimated on the variable NUMBER SPIN-OFF is positive and statistically significant (column ii, coeff. = 50.40646, $p < 0.001$). Instead, in Model (3), which predicts the effect of the innovative degree of university spin-offs in terms of patenting on regional GDP per capita, the coefficient estimated on the SPIN-OFF PATENT variable is negative and not statically significant.

In all models (Model (1), Model (2) and Model (3)), the estimated control variables used (DENSITY REGION, HIGHER EDUCATION REGION, R&D EMPLOYEES REGION, VENTURE CAPITAL REGION, INNOVATIVE COMPANIES REGION) show a high statistical significance.

The results of the estimated models suggest that the presence of university spin-offs partly contributes to determining the competitive advantage of the regions in which they are located. However, the innovative degree of university spin-offs does not contribute to determining the competitive advantage in terms of per capita GDP of the regions in which they are located. This evidence highlights some concerns about the effectiveness of the innovative potential of university spin-offs to improve the level of socio-economic performance at the regional level.

Table 2 shows the results of the Model (4), Model (5) and Model (6) to evaluate the impact of university spin-offs on the innovative degree of the regions measured in terms of patenting activities. In Model (5), which predicts the effect of the number of university spin-offs on the number of patent applications at regional level, the coefficient estimated on the variable NUMBER SPIN-OFF is positive and statistically significant (column ii, coeff. = 1.122843, $p < 0.001$).

In Model (6), which notes the effect of the innovative degree achieved by university spin-offs on the number of patent applications at regional level, the coefficient estimated on the SPIN-OFF PATENT variable is positive and statistically significant (column iii, coeff. = 5.568895, $p < 0.1$).

It should be noted that this evidence reveal that the presence of university spin-offs and their degree of innovation contribute to determining the innovative performance of the regions in which they are located. This highlights a higher contribution of the spin-offs on the innovation of the regional context rather than on its competitiveness in terms of socio-economic performance.

Table 2: Estimation of the linear regression model of regional GDP

| | Model 1 | Model 2 | Model 3 |
|--------------------------------|----------------------------|-----------------------------|-----------------------------|
| | (i) | (ii) | (ii) |
| NUMBER SPIN-OFF | | 50.40646*** (2.811904) | |
| SPIN-OFF PATENTS | | | -532.907 (171.7702) |
| Control variables | | | |
| REGION DENSITY | -16.87817*** (0.607554) | -14.39137*** (0.5770554) | -16.88463*** (0.6064762) |
| HIGHER EDUCATION REGION | 985.7484*** (14.05979) | 1025.904*** (13.66245) | 986.0205*** (14.04593) |
| REGION R&D EMPLOYEES | 23.61073*** (2.066761) | 23.90057*** (1.982426) | 23.31029*** (2.067936) |
| VENTURE CAPITAL REGION | 20.69531*** (0.5682783) | 21.35191*** (0.5511905) | 20.73522*** (0.5678107) |
| COMPANIES INNOVATIVE REGION | 2885.246*** (100.7263) | 2516.847*** (104.5308) | 2887.612*** (100.6318) |
| N. observations | 7,426 | 7,426 | 7,426 |
| F | 4476.85*** | 3944.86*** | 3728.18*** |
| R ² | 0.6965 | 0.7136 | 0.6968 |
| Root MSE | 3200.8 | 3109.4 | 3199.2 |

Table 3. Estimation of the linear regression model of the regional patenting activity

| | Model 4 | Model 5 | Model 6 |
|--------------------------------|-----------------------------|------------------------------|-----------------------------|
| | (i) | (ii) | (ii) |
| NUMBER SPIN-OFF | | 1.122843*** (.0624514) | |
| SPIN-OFF PATENTS | | | 5.568895* (4.855806) |
| Control variables | | | |
| REGION DENSITY | -.5191761*** (0.0106035) | -0.4647525*** (0.0108275) | -0.5189626*** (.0105974) |
| HIGHER EDUCATION REGION | -8.460468*** (0.2814388) | -7.45948*** (0.2790006) | -8.464117*** (0.2813778) |
| REGION R&D EMPLOYEES | 0.7117253*** (0.0744497) | 0.7192622*** (0.0715925) | 0.714676*** (0.0745647) |
| VENTURE CAPITAL REGION | 2.4804*** (0.0166571) | 2.495109*** (0.0165633) | 2.479967*** (0.016691) |
| COMPANIES INNOVATIVE REGION | 100.2985*** (1.904135) | 92.14016*** (1.887247) | 100.277*** (1.90384) |
| N. observations | 6,480 | 6,480 | 6,480 |
| F | 16040.49*** | 15218.55*** | 13442.52*** |
| R ² | 0.9560 | 0.9578 | 0.9560 |
| Root MSE | 83.627 | 81.9 | 83.626 |

5. Conclusions

This study aimed to investigate, both from a theoretical and empirical point of view, the role of university spin-offs as a contribution to the socio-economic and innovative development of the regions in which they are located. In this perspective, the study aimed to assist the emerging literature gap in our understanding of the elements that stimulate competitiveness and socio-economic growth at the regional level.

The analysis of the role of university technology transfer through spin-off companies in actively contributing to the generation of renewed socio-economic and innovative value of the regions assumes a central role for the definition of policies and targeted actions to support technology processes and knowledge transfer from the university to the local context.

The results emerging from the empirical analysis of a longitudinal sample of 952 university spin-offs located in 20 Italian administrative regions reveal that the

knowledge and technological production of the university spin-out process can have an affective and active role in the regional context, stimulating its innovative capacities and supporting their socio-economic development, acting as fundamental intermediaries in the generation of territorial competitive advantage. However, it should be noted that the greater added value produced by spin-off companies is linked to the effect they have on the dynamics of innovative development of the regions in which they are located. This evidence is in line with the proactive role of university spin-offs as a key link between universities and industry in the transfer of innovations fundamental to the development of the so-called knowledge economy, the results of which certainly pass through the region in which the spin-off company operates and maintains major inter-organizational relationships with heterogeneous actors in the process of technology transfer, both in the public and private sectors.

Based on the evidence emerging from this research work, the study aims to provide a potential contribution to the knowledge, both theoretical and practical, about the role of the entrepreneurial university in stimulating and assisting the generation of socio-economic value by supporting the competitiveness and innovation of local contexts, with specific regard to the proactive role of university spin-offs. Furthermore, the study aims to encourage suitable strategic planning together with policies and actions targeted at increasing regional development, encouraging the economic exploitation of innovation, the role of the university and its spin-off companies as agents systematically integrated in the development models of regional competitiveness.

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