

The Emerging Effect of Meso and Macro Contexts in Partially Determining the Development of Academic Spin-Offs

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Abstract

In view of the widespread expansion that the academic spin-offs (ASOs) phenomenon in Europe, the literature has shown considerable interest in the determinants regarding growth of this new form of business. In particular, several studies have highlighted how universities can play a key role in the development of ASOs. Furthermore, other research points out that factors deriving from the local context can also encourage the spread of ASOs. The paper aims to explore the joint effect of meso and macro context determinants on the ASOs success, both in terms of financial performance and quantity, on a regional level. Analyzing a sample of 405 ASOs extracted from Netval database in 2013, the research results show how the two entities observed have an impact on fostering ASOs success only in terms of companies generated, while their financial performance seems to be only marginally influenced by the mechanisms facilitating entrepreneurship, both within university and local context. This is likely due to the issues related to the high-tech start-up nature of ASOs and to the policies beyond their creation and development.

Keywords: Academic spin-offs; ASO; meso factors; macro factors; university technology transfer; academic entrepreneurship; regional context.

1. Introduction

The emerging of university as an opportunity for entrepreneurship, has changed its socio-economic role in many countries (Etzkowitz, 2004), and the creation of spin-off companies represent an important instrument for the commercialization of research generated therein (Shane, 2004; Wright et al., 2007). Academic Spin-Offs (ASOs) are indeed considered one of the most qualified entrepreneurial initiatives in offering effective and profitable ways for the diffusion of new technologies and knowledge (Mathisen and Rasmussen, 2019; Miranda, et al., 2018; Fini et al., 2017; Lazzeri and Piccaluga, 2012); as well as they are commonly included among the most active and recommended tools to stimulate the creation and development of knowledge-based economies (Benneworth and Charles, 2005; Sternberg, 2014). As a result of the numerical and dimensional development of these types of businesses, the interest shown by literature in the success determinants of this phenomenon has increased. First of all, it has been noted that the diffusion and growth of the academic entrepreneurship may differ significantly in different contexts (Baldini, 2010; Lockett et al., 2005; Autio et al., 2014). The organizational (Walter, Auer, Ritter, 2006) and institutional factors (Wright, 2014), together with the cultural ones (OECD, 1999) can indeed create environments more conducive to the development of this innovative high-tech phenomenon, such as those generated in Silicon Valley and the greater Boston area in the U.S. (Lee et al., 2000; Kenney, 2000; Carayannis et al., 1998; Degroof, Roberts, 2004); but even more specifically in Europe, particularly in some areas of the UK (Lockett, Wright, Franklin, 2003; Shane, 2004) and of Sweden (Stankiewicz, 1994).

However, several studies reveal that academic spin-off ventures in regions outside established high tech clusters tend to stay small (European Commission 1998, 2000; Degroof, Roberts, 2004). The underlying reasons of these localization differences can be usefully explained using the resource-based view theory (Penrose 1959, Fleisher, Bensoussan, 2003; Sirmon et al., 2007), focused on the resource combination of a company to gain a competitive advantage (Conner, 1991; Fleisher, Bensoussan, 2003); in conjunction with the dynamic capability perspective (Teece, Pisano, Suen, 1997; Eisenhardt, Martin, 2000; Teece, 2009), which argues that in a dynamic environment the key source of existence and development of a firm is its ability to build, integrate and adapt its tangible and intangible resources – together with its relations – in order to achieve a dynamic coherence with the external environment (Eisenhardt, Martin, 2000); especially regarding small high tech companies (Zahra et al., 2006). Several studies have effectively applied the resource-based view and the dynamic capabilities concepts to the creation and development of spin-offs' phenomenon (Pazos et al., 2012; Lockett et al., 2003; Lockett, Wright, 2005; O'Shea et al., 2005; Vinig, Van Rijsbergen, 2010). According to the theoretical framework used by these studies, the spin-offs may differ significantly on the basis of the resources and capabilities possessed, closely related to the context of university affiliation that can facilitate their development through various support mechanisms (Rasmussen, Borch, 2010; Lockett, Wright 2005; Rasmussen, Mosey, Wright, 2014)

And the features, the composition and the interactions with the geographical area (Baldini, 2011; Fini, Grimaldi, Sobrero, 2009; Sternberg, 2014; Kolympiris, Kalaitzandonakes, Miller, 2014).

Reviewing various studies available in literature, this paper wants to give a contribution to the research of university and local context determinants that affect the development of the academic spin-off, by highlighting to what extent these factors influence the performance of this new form of academic entrepreneurship in the Italian business scenery.

2. Development determinants of academic spin-offs

The development of the spin-offs phenomenon can be analyzed from different points of view. In this regard, the literature distinguishes development factors at the macro and meso levels.

2.1. Meso factors

The university environment is one of the main contextual factors, variously linked to the development of spin-offs (Fini et al., 2011; Fini, Grimaldi, Sobrero, 2009; Di Gregorio, Shane, 2003; O'Shea et al., 2005; Rasmussen, Borch, 2010). According to the various studies in the literature, the main development factors of ASOs, deriving from the academic environment, are the following.

First of all, an important role is played by university policies relating to technology transfer models. In particular, it is highlighted that the establishment of technology transfer offices (TTO) have a significant impact on the existence and the development of ASOs (Siegel et al., 2007). Their role could be described as "facilitating technological diffusion from university research to industry; managing and enhancing the value of the university's intellectual property and assisting researchers in disseminating research results for the public good" (O'Shea, Chugh, Allen, 2008, p. 657). TTOs perform a support function for ASOs very similar to that performed by university incubators, which represent an essential support tool for the development of start-ups, especially in their initial phase (Rothaermel, Thursby, 2005; Vinig, Van Rijsbergen, 2010). In this regard, it should be noted that several universities have introduced technological incubators (Link, Scott, 2005; Mian, 1997), science parks and other entrepreneurship promoting programs (Shane, 2004) for the development of ASOs. The university initiatives mentioned before produce various benefits, aimed at favoring a faster growth of spin-offs. In particular, they foster relation with the industry and provide technical and managerial support, helping spin-offs to overcome the various technical and market barriers (Jensen, Thursby, 2001; Montáñez, 2006.). In addition, university can have a more direct involvement in spin-off companies by promoting them through equity participation (Smilor, Gibson, Dietrich, 1990), so drawing financial benefits and prestige in case of success, through the commercialization of technology and ideas generated and developed within (Bray, Lee, 2000). At the same time, the active participation of university in the shareholding structure of the USOs is a valuable support mechanism reducing their capital needs and improving their liquidity (Di Gregorio, Shane, 2003).

Secondly, a determining factor in the development of academic entrepreneurship is the amount of R&D funding obtained by university, as evidenced by several studies. For example, Lockett and Wright (2005) in a study involving 122 UK universities, observed that the large number of spin-offs generated were statically significant and positively associated with R&D spending of the university; similar results were noted by Powers and McDougall (2005).

Similarly, the availability of the staff employed in research and development activities - and in the commercialization of their results - is an important source of support for the effective launch of the spin-out processes (Lockett et al., 2003; Clarysse et al., 2005; Vinig, Van Rijsbergen, 2010), since human capital represents a key resource in the development of new technologies (Power, McDougall, 2005) and access to expert knowledge surely determines the degree of success of the ASOs (Zucker et al., 1998).

Finally, an important role is played by the inventions patented by the university (Colyvas et al., 2002; Shane, 2004). Indeed, it has been pointed out that the technology eminence and scientific results achieved by universities can stimulate the activation of spin-off processes, creating a source of business opportunities by encoding the knowledge produced (Van Looy et al. 2011). In particular, several studies (Di Gregorio, Shane, 2003; O'Shea et al., 2005) suggest that the patents supply of a university is positively associated with the activity of ASOs, as this may generate benefits, such as protecting competitive advantage, which arises from the need of universities to protect their intellectual property and, at the same time, to enhance it economically (De Coster, Butler, 2005).

2.2. Macro factors

The local context in which an ASO is located can be defined as a set of skills and resources, both physical and intangible (Niosi, Bas, 2001; Saxenian, 1996), which affects its activity (Fini, Grimaldi, Sobrero, 2009). Several scholars (Chiesa, Piccaluga, 2000; Bramwell, Wolfe, 2008; Moray, Clarysse, 2005; Kolympiris, Kalaitzandonakes,

Miller, 2014) have shown how the features of the local context can create a support network, which is likely to produce positive effects on the spin-offs development.

First of all, it should be noted that ASOs could find a significant infrastructural support in institutions other than those deriving from the university environment mentioned before. In this regard, a development factor of the ASOs can be found in the economic interventions of national and local Governments. Indeed, the public institutions, have introduced incubators on their own initiative and in their economic, employment and technological development programs, as a tool to reduce the probability of failure and to speed up the process of business creation (Klofsten, Autio, 1998; Mian, 1997), as well as decreasing the costs of doing business (Grimaldi, Grandi, 2005). Considering that one of the largest issues of high-tech companies is the lack of financial resources, which limits their own development (Perez-Ruiz, Carballido, Agüera Vega, 2013; Vohora et al., 2004), the joint effort operated by incubators and venture capital acquires significance (Chen, 2009). However, in contexts - such as in parts of Europe, especially Italy - in which the venture capital has not yet established itself as an entrepreneurial support mechanism (Salvador, 2006; Pennacchio, 2014; Bertoni, Colombo, Grilli, 2011), an important role is played by the relationships established with local business angels and banking institutions in order to gain access to funding needed (Grimaldi, Grandi, 2005).

Secondly, the composition of the entrepreneurial context plays a decisive role in the development process of ASOs (Klepper, 2007). In fact, it is highlighted that the presence of regional entrepreneurial networks encourages the spontaneous exchange of ideas, personnel and other mutual support mechanisms, through formal and informal networks (Deeds et al., 1998; Fini, Grimaldi, Sobrero, 2009; Fini, Grimaldi, Santoni, Sobrero, 2011). In particular, the concentration of technology clusters in the university area that is in the localization context of the spin-off facilitates their creation, their growth and the related processes as well (Friedman, Silberman, 2003; O'Shea et al., 2007). In addition, the local industrial fabric can stimulate the spin-out phenomenon by actively engaging in several kinds of partnership with the universities, such as research and development projects, as well as advice and contract research aimed at the development of new technologies (Motohashi, 2005; O'Shea et al., 2005).

To these facilitator factors of academic entrepreneurship is added the level of innovation generated in a geographical area (Smith et al., 2014; Sternberg, 2014), primarily measured by the regional spending on research and development (Fini et al., 2011; Bramwell, Wolfe, 2008). The results obtained from this type of investment are considered by several authors (Acs, Audretsch, Lehmann, 2013; Audretsch, Lehmann, 2005) to be a positive indirect effect of mid-term impacting on new technology ventures. In addition, literature usually employs the patenting activity as an indicator of technical knowledge of a region (Jaffe, Trajtenberg, Henderson, 1993; Audretsch, Bönte, Keilbach, 2008), as the location of a spin-off in an active region, in this sense, may bring benefits to the entrepreneurial development of intellectual property generated therein and thereby contribute to the entrepreneurship and innovation effort (Griliches, 1990).

The factors previously shown, following the various studies mentioned above, represent the main success determinants of academic spin-offs. Therefore, it's possible to draft different research hypothesis:

H1a - The mechanisms facilitating entrepreneurship within the university are positively correlated with the number of ASOs in a region.

H1b - The mechanisms facilitating entrepreneurship within the university are positively correlated with the performance of ASOs in a region.

H2a - The local context features and the mechanisms fostering high-tech entrepreneurship are positively correlated with the number of ASOs in a region.

H2b - The local context features and the mechanisms fostering high-tech entrepreneurship are positively correlated with the performance of ASOs in a region.

3. Methodology

In order to validate the aforementioned hypothesis, has been proposed a regional analysis in order to investigate how meso and macro factors have a concrete impact on the development of ASOs in the Italian entrepreneurial context. The survey is based on the study on a sample of 405 Italian academic spin-offs extracted from the Netval database and university websites as at 31st December 2013, and divided into 18 administrative Italian regions. Initially, 747 companies were identified, but inactive spin-offs (34), those liquidated and canceled (193) and those for which it was not possible to obtain comparable financial statements or data (115) were excluded. Information regarding the impact of university and local context factors in the success of academic spin-offs was collected by extracting data from the records stored in the Italian National Institute of Statistics (ISTAT), the Statistical Office of the European Communities (EUROSTAT) and PATIRIS database. Lastly, further data concerning 167 national business incubators were collected from institutional websites of universities, MIUR (Ministry of Education, University and Research) and business incubators and regional authorities.

Table I shows the geographical distribution of the ASO sampled and analyzed.

Descriptive statistics of ASOs by geographical macro-area and administrative regions per frequency distribution and ROE

Geographic distribution	Number of ASOs		ROE of ASOs	
	<i>Absolute frequencies</i>	<i>Relative frequencies</i>	<i>Mean</i>	<i>Stand. Dev.</i>
Centre	137	33.83%	7.71	24.39
Emilia Romagna	48	11.76%	7.84	23.08
Lazio	14	3.55%	6.04	15.48
Marche	26	6.35%	7.91	23.63
Tuscany	35	8.67%	6.52	25.02
Umbria	14	3.50%	11.15	33.30
North	176	43.46%	12.10	31.58
Friuli Venezia Giulia	37	9.10%	3.09	36.51
Liguria	13	3.25%	5.58	30.52
Lombardy	56	13.83%	16.93	25.93
Piedmont	39	9.59%	6.03	31.88
Trentino-South Tyrol	3	0.78%	15.73	3.82
Veneto	28	6.91%	24.81	30.07
South	92	22.72%	-0.11	23.85
Abruzzo	9	2.25%	-0.19	20.55
Basilicata	1	0.20%	14.50	0.00
Calabria	9	2.27%	2.32	7.27
Campania	14	3.40%	0.32	20.83
Apulia	37	9.14%	-1.78	27.82
Sardinia	17	4.25%	1.41	24.23
Sicily	5	1.21%	-1.13	24.00
	405	100%	7.77	27.97

The study was conducted through the analysis of three variables:

- Through the first set of variables, called university determinants, the importance of research and development was first assessed and, following Link and Scott (2005), Degroof and Roberts (2004), Powers and McDougall (2005), Lockett and Wright (2005), the annual R&D expenditure at the university level (Uni_R&Dexp) and the university staff in R&D in the observed regions (Uni_R&Dstaff) were used. Secondly, following O'Shea et al. (2005), the university patent activity was measured by the number of patents relating to all the institutes in each region (Uni_Npatent). Third, according to Pazos et al. (2012), Fini et al. (2011) and O'Shea et al. (2005) the infrastructural business support of universities was assessed based on the number of university-affiliated incubators established in each region (NUnincub). Furthermore, following Fini et al. (2009), the direct involvement of the university in the share capital of the ASOs was measured by means of a variable that expresses the rate of participation in the university's capital in spin-off companies (% Uni_equity).

- As regards the second set of variables, called determinants of the local context, these were first employed to measure, like the university variables, the impact of incubation services on the spin-offs success by the number of public funding incubators (NPublic_incub) and, with a particular focus on the financial support offered by these entities, the number of incubators participated by the banking institutions was used (NBank_incub). Secondly, to measure the high-tech industry level and knowledge-intensive services in a region, a variable expressing the level of employment in the technology and knowledge-intensive sectors was used (NTechknow_Staff) along with a variable indicating Human Resources in Science and Technology (NHR_S & T) for the number of people with tertiary education and / or employed in science and technology at the regional level. Thirdly, the local business structure was assessed by a variable of business demography based on the presence of high-growth firms in each region (NBusdem_hg). Finally, three sets of variables were used to assess the innovation capacity of a region: the first, in line with Fini et al. (2011) was measured by public R&D expenditures expressed as the total regional intramural R&D expenditure (Public_R&Dexp); the second one, in line with Audretsch, and Keilbach (2004) measures the R&D staff involved in a region by the totality of R&D personnel and researchers (R & D_staff); and third, the technological excellence of a region was measured and, in accordance with Baldini (2010), EPO's high-tech patent applications in each region (N_patentEPO) were used.

- The last set of variables, named academic spin-off variables, are divided into two groups and aimed at evaluating the success of academic spin-offs: the first one consists of an estimate of the economic-financial performance achieved by spin-offs, by means of the mean return on equity (Mean_ROE) at regional base; while the second one, in line with Pazos et al. (2012) and Fini et al. (2011), concerns the number of academic spin-offs generated in each region (N_spinoff).

Through Person's bivariate correlation analysis on the above variables, relevant data have been found and will be reported hereafter.

4. Results

As for meso factors, it should be noted that the correlation analysis between the aggregate values assumed by return on equity (ROE) of ASOs at regional level and university determinants (Table II) shows positive but not significant statistical relations with the variables related to the degree of research and development (Uni_R&Dexp), university staff employed (Uni_R&Dstaff) and patent activity (Uni_Npatent). Furthermore the number of university-affiliated incubators and the rate of equity participation in the ASO of university are negative and not statistically significant. In light of the correlations observed, the H1a cannot be accepted.

Correlation matrix between university determinants and ASOs success variables

	Mean_ROE	N_spinoff
NUnincub	-0.074 (0.386)	0.282 (0.128)
Uni_R&Dstaff	0.291 (0.128)	0.607** (0.005)
Uni_R&Dexp	0.184 (0.240)	0.488* (0.023)
Uni_Npatent	0.269 (0.140)	0.722** (0.000)
%Uni_equity	-0.146 (0.282)	0.166 (0.255)

*Significance at 5% level (1-tailed).

** Significance at 1% level (1-tailed).

On the contrary, the correlations between the number of academic spin-offs in a region and the same variables show positive and significant statistical relations with the annual university-wide R&D expenditure (48.8%) as well as with the university R&D staff (60.7%). These results are consistent with the findings of Lockett and Wright (2005) and Link and Scott (2005), and point out how these types of university resources encourage the development and diffusion of ASOs; this assumption is confirmed by the positive and significant statistical correlation with the number of university patents (72.2%), results which are consistent with those obtained by Di Gregorio and Shane (2003) and O'Shea et al. (2005). Furthermore, in contrast with the results obtained by Fini et al. (2009), the correlation with the equity participation of university in the spin-off shows positive, but low and not statistically significant, results, pointing out how the involvement of university as a shareholder of the spin-off does not affect the spin-out processes in terms of more companies generated. Similar considerations regard the correlation with the university-affiliated incubator, which is positive but also in this case not statistically significant, in contrast with the results found by Link and Scott (2005), Pazos et al. (2011), but as pointed out by the results of several studies (Di Gregorio, Shane, 2003; Phan, Siegel, Wright, 2005) there is no definite conclusion yet as to the effective contribution of university business incubators and science parks to fostering ASOs development and success. However, on the basis of the global results obtained, the H1b can be accepted.

Instead, for what concerns the macro factors, the correlation analysis between the aggregate values assumed by return on equity (ROE) of ASOs at regional level and local context determinants (Table III) show positive and significant relations with the total intramural R&D expenditure (40%) of regions as well as with the regional R&D personnel and researchers (56.4%), which note the actual contribution of this type of resources on the financial performance of ASOs. The importance of financial resources in the improvement of ASOs is also emphasized by the positive and significant correlation with the number of business incubators participated by banking institutions in a region (51.4%), confirming the joint support of an entrepreneurial facilitator and an investor, similar to a venture capital and a business angel. The rest of local context variables show positive correlations with the ROE (only the correlation with the number of public-mixed incubators is slightly negative) but are not statistically significant, so the H2a can be only partially accepted.

Correlation matrix between local context determinants and ASOs success variables

	Mean_ROE	N_spinoff
NTechknow_Staff	0.311 (0.104)	0.663** (0.001)
N_patentEPO	0.364 (0.083)	0.504* (0.023)
NHR_S&T	0.281 (0.130)	0.635** (0.002)
NBussem hg	0.249 (0.160)	0.675** (0.001)
Public_R&Dexp	0.400* (0.050)	0.247 (0.161)
R&D_staff	0.564** (0.009)	0.111 (0.336)
NPublic_incub	-0.011 (0.483)	0.449* (0.031)
NBank_incub	0.514* (0.015)	0.508* (0.016)

*Significance at 5% level (1-tailed).

** Significance at 1% level (1-tailed).

Concerning the correlation analysis between the number of academic spin-offs in a region and the same context variables, first of all it must be noted that, in contrast with the ROE results, the correlation with the total intramural R&D expenditure of regions and with the R&D personnel and researchers in the region are positive but not statistically significant. Therefore, these factors impact more on the development of the ASOs than on their foundation.

On the contrary, positive and significant relations are shown with the level of employment in technology and knowledge-intensive sectors (66.3%) and with the human resources in science and technology (63.5%), highlighting how the availability of human resources plays a fundamental role in the development and diffusion process of the ASOs. This result is closely linked to the importance of technology in a region, as highlighted by the positive and significant correlation with the high-tech patent applications of the EPO (50.4%). The importance of the context is confirmed by the positive and significant correlation with the local entrepreneurial structure (67.5%), which shows the significant impact of the local industrial fabric in the growth of the spin-off phenomenon. Furthermore, positive and significant correlations exist with the number of public-mixed incubators (44.9%) as well as with the number of business incubators participated by banking institutions (50.8%), which reveals the effective contribution of the local government programs to supporting and developing the activity of local innovative start-ups by means of incubation services. Finally, like in the correlation with ROE, the financial support offered by incubators involving banks affiliate to the establishment of ASOs acquires significance. Taking into account the results obtained, the H2b can be accepted.

5. Results discussion and conclusion

Through the aforementioned study, it has been possible to assess the joint effect of university and local context determinants on the academic spin-off success, both in terms of financial performance and quantity, on a regional level. In the light of the results shown in the previous paragraph concluding remarks can be drawn.

First of all, it should be noted that the direct involvement of the university in the share capital of the spin-offs does not seem to improve the business success, especially in terms of financial performance, and it has some but very low effects in terms of ASOs generated. In the same way, the incubation services provided by the universities seem to have no effect on the spin-off success.

Therefore, a major participation of the university, both financially-wise and through promotional programs in the spin-offs phenomenon does not result in a better development of it, but seems to play a passive role that may find a better explanation in the institutional policies of the university. Conversely, research and development programs of a university and the related resources play an essential role in stimulating the start of spin-out activities in the university. Therefore, university policy decisions based on investment choices in research and innovation have a significant impact on the development of academic entrepreneurship; university that wants to be more "entrepreneurial" must invest in the key resources for innovation (Powers, 2004). Secondly, with regard to macro factors, in coherence with the findings of some previous studies (Baldini, 2011; Fini, Grimaldi, Sobrero, 2009; Sternberg, 2014; Kolympiris, Kalaitzandonakes, Miller, 2014; Feldman, 2001), the analysis shows how the local context can have an effective role in the creation of a basic environment for the academic spin-off development and success. More specifically, the results reveal that the innovation and technological level of a region, in terms both of tangible and intangible resources, provide the necessary conditions for the creation of academic spin-off. In fact, a specific geographical area, where there are companies with highly specialized human capital and a significant level of innovative capacity, represents a favorable environment for the start of academic spin-offs. On the other hand, the financial performance of academic spin-offs is sensitive to the research and development resources of a region, both in financial terms (relating to the public government funds) and in personnel employed. This evidence raises two concerns: first, as for university determinants, the research can affect significantly the process of development of ASO; second, the major presence of R&D personnel in the local area can create a support network

for the development of the ASOs, favoring the establishment of stronger ties with industry resulting in R&D projects and contract research projects (Audretsch, Keilbach, 2004), which increase the licenses income and relative profits. Additionally the relevance of public support is confirmed by the actual action played by public-funded business incubators, giving a significant infrastructural and entrepreneurial assistance to the new ventures (Abetti, 2004). In particular, pivotal incubation services are those offered by business incubators involving banks, because they can support spin-outs by providing loans and other financial facilities, but can also invest in early stage technologies, acting as venture capitalists.

Therefore, against the university incubators, this last form of business incubator is the most useful because it is the only one that positively affects both the number and the performance of ASOs in a region.

This study, through an empirical analysis of the theories indicated, highlights which factors, at the macro and meso level, have a significant impact on the development and performance of ASOs, contributing to the current debate about the success determinants of academic spin-offs.

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