Regional Dynamics of Triple Helix Spaces of Innovation, Knowledge and Consensus and the Creation of Firms in Coimbra (Portugal)

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ABSTRACT

The purpose was to understand how the university-industry-government interaction has been applied at regional level to create a strong environment to generate new firms and encourage entrepreneurship. Based on the literature, the conceptual framework of Etzkowitz was used to aid in understanding the innovation, knowledge and consensus spaces, seeking to evaluate the regional dynamics of the triple helix. The results show that the innovation and knowledge spaces influence entrepreneurship in the Coimbra region. On the one hand, the incubator and Tecnopólo, as indicators of innovation space, influence the birth of new firms from outside the University and, on the other, the social networks for learning and programs encouraging entrepreneurship, belonging to the knowledge space, prompt the birth of new firms with less than 10 employees.

1. Introduction

Neither the rate of technological change in any country nor the effectiveness of companies in the competitive world of international trade in goods and services, depends simply on the scale of R&D carried on in a particular country, they also depend on how resources are managed and organized, at both firm and country level (Etzkowitz, 2008). In this regard the literature mentions the concept of a national innovation system (Lundvall, 1992; Nelson, 1993) to show the importance of the combination and interconnection of a number of networks related to innovation in increasing the ability of an economy to innovate. Other authors, such as Etzkowitz and Leydesdorff (1996, 1997, 2000) proposed the model of the triple helix, conceptually different from the previous one in that it states there is a spiral pattern of relationships and linkages between three institutional actors: university, industry and government, where the university tends to play a decisive role in the context of a knowledge-based economy.

Thus, the country that stimulates interactions between universities, business and government gains a competitive edge through a faster diffusion of knowledge (Etzkowitz, 2008). In other words, the performance of an innovation system depends now, more than ever, on the intensity and effectiveness of interactions between the key players involved in the generation and dissemination of knowledge. This dynamic has motivated discussion of the importance of entrepreneurship (Baumol, 1993; Ardichivili, Cardozo & Ray, 2003; Aviram, 2010), leading to wider recognition of the growing role of entrepreneurial initiative and innovation as crucial factors of economic growth. Other studies (Rothwell & Dodgson, 1991; Jenssen & Aasheim, 2010) have pointed out the vital importance of creating micro and small businesses to industrial revitalization. There is, however, still a lack of literature on the relationship of the conceptual spaces of innovation, knowledge and consensus, with the encouragement of entrepreneurship and in the creation of firms.

The purpose of this study is to examine this topic more thoroughly in the context of a small country in the European Union, Portugal, and to analyze the university-industry-government interaction in the context of the Coimbra region. It will try to find out how the triple helix spaces have been used to create a favorable regional environment in which to generate new firms and foster entrepreneurship. What characteristics of incubation firms based in the University incubator are associated with indicators of innovation, knowledge and consensus spaces?

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For this, section 1 gives a brief analysis of the regional dynamics of the triple helix, viewing spaces of innovation, knowledge and consensus, as elements capable of increasing the creation of businesses and fostering innovation and entrepreneurship. Section 2 sets out the approach taken, and section 3 gives the results and discusses them. Finally, the findings confirm the relevance of the triple helix dynamics in Coimbra region and highlight some indicators of the areas that most influence the generation of new businesses. The paper concludes suggesting some implications for management and future studies.

2. The regional dynamics of the triple helix

The Triple Helix model of Etzkowitz and Leydesdorff (1996) is a model through which we interpret the recent changes in a society and knowledge-based economy and the new roles that are opening up for the modern university. A triple helix relationship between university, industry and government means the evolution of institutional relations, be they the more liberal (laissez-faire) ones or the socialist ones, with the economy / market predominating in the first and the policy and behavior of governments predominating in the second, where the knowledge sector has a secondary role.

The triple helix model justifies a new configuration of the institutional forces emerging within innovation systems, whether through the overall decline of the current state or the opening up of companies traditionally closed to the external environment. Until now, industrial policies have focused on the relationship between government and business, either by improving the "business climate" with lower taxes or by influencing location decisions through grants.

Because knowledge has become an ever more important and crucial part of innovation, the university, as an institution for the production and dissemination of scientific and technological knowledge, has a more important role in industrial innovation, both as a provider of human capital, facilitating technology transfer and as an incubator of new ventures. The three institutional spheres, public, private and academic, that previously worked in laissez-faire environments, are increasingly involved in a spiral pattern of linkages emerging at various stages of the innovation process, and the drafting of policies by governments (Etzkowitz, 1998).

In fact, encouraged by technology transfer offices and government regulations relating to funding programs to support research, scientists are increasingly examining the results of their research for their technological and economic potential. A cognitive dual-mode thus emerged in academic science with researchers focusing on getting key advantages in knowledge and inventions that can be patented and marketed (Etzkowitz et al., 2000; Etzkowitz, 2008).

The current configuration of the relationship between the three institutional agents is creating a triple helix of knowledge infrastructures in terms of overlapping institutional circles, each having the role of the other and with hybrid organizations emerging from the interfaces.

Etzkowitz (2008) says that the dynamics of the triple helix also emerges at regional level, from the interaction of "innovation", "knowledge" and "consensus" spaces (Table 1). An "innovation space" denotes an organizational invention or adaptation carried out to fill a gap in the regional development process, so often detected during the consensus phases. The organizational effort to create a new hybrid entity resembles a social movement in that it assembles resources, people and networks through the triple helix.
A "knowledge space" supplies the building blocks for regional growth in the form of a critical mass of researchers, which signifies a concentration of research resources on a specific area, based on which technological ideas can be generated. When these resources reach a certain level they can play a significant part in regional development.

A "consensus space" denotes the process of obtaining relevant actors to work together (brainstorming, problem analysis and formulation of plans). When these actors devise a strategy and assemble the resources to implement it the regional development process can receive a strong impetus.

Most regions and countries are currently trying to achieve some form of triple helix (Etzkowitz, 2008), with the common goal of building innovative and dynamic environments in their regions to create jobs and wealth. The result may consist of cultivating conditions for entrepreneurship, for example by creating: 1 - academic spin-off companies (Carayannis et al, 1998); 2 - tri-lateral initiatives for economic development

based on knowledge, as is the case of science and technology parks and business incubators (Marques et al., 2006); 3 - strategic alliances between firms (Tether, 2002); 4 - hybrid institutions, with non-profit interface functions (Marques & Caraça, 1998); and, 5 – R&D contracts with government laboratories and academic research groups (Benner & Sandström, 2000).

These different combinations of relationships between university, industry and government are producing a momentum that promotes and creates a balance between the different systems (Etzkowitz, 2008). The example of the Coimbra region in Portugal raised some scientific curiosity in me about understanding how the concepts of the triple helix spaces have been implemented to create a strong regional environment fostering entrepreneurship and generating new firms.

Table 1 – Indicators of the degree of triple helix interaction: innovation, knowledge and consensus spaces

Innovation Space	
1 – University technology transfer	Develops an effective technology transfer unit to commercialize university R&D and create a series of spin-off companies that produce sustainable economic growth.
2 – Investors, "business angels"	Seed funding is available for newly emerging enterprises. There are capital investor groups - "business angels" – who are seeking investment opportunities.
3 – Science park	Builds a physical infrastructure to accommodate emerging companies or R&D units of large companies.
4 – Entrepreneurship training program	Creates a training program at a university designed to turn students into entrepreneurs.
5 – Attracting artists	Encourage, attract and facilitate local artists using underutilized spaces to revitalize urban enterprises or old factories that were not viable.
6 – Business incubator	Sponsorship of new firms in a physical space with shared facilities that promote their growth. Can be developed by a university, a firm or government.
Knowledge Space	
1 – University-industry research partnership	Includes the forging of academic-corporate partnerships for the use of knowledge, skills and financial assets of the partners in order to obtain better results that benefit the community.
2 - Open academia	It includes a large university that puts content online to promote learning.
3 – Trust based entrepreneurship	Implementation of measures leading to the creation of entrepreneurship based on trust where they forge new business relationships that result in a high economic impact for the new businesses.
4 – Student internships	Development of internships for students, giving them the opportunity to have training based on highly relevant skills. It also requires the establishment of a mechanism to develop the demand for student interns and give them the opportunities available.
5 –Social learning network	The social network is leveraged to promote the exchange of knowledge, skills transfer, and to develop relationships and speed up learning.
Consensus Space	
1 – Central government intervention	The process is led by a central government agency.
2 – Industry intervention	The solution is backed by a reputable company, industry association or influential business leader.
3 – Regional government intervention	The solution is promoted by a regional government agency, and triple helix agents are also appointed to participate in local / regional development.
4 – University support	The university facilitates R&D to promote or structure an innovation strategy for local or regional development and partnerships with the triple helix agents.
5 – Community intervention	Communities (including NGOs, business associations, employers associations, etc.) head the formation of the coalition needed to fill the gap in existing leadership structures that are dysfunctional or ineffective.

Source: Based on Etzkowitz (2008)

3. Methodology

In order to answer the research question about how the spaces of triple helix have been applied to create a strong regional environment to encourage entrepreneurship and generate new businesses, I started from the conceptual model of university - industry - government interactions and the innovation, knowledge and consensus spaces of Etzkowitz (2008). This makes it possible to understand the interactions between the actors of the regional triple helix, using the case study method to analyze the Coimbra region in Portugal.

The methodology used for data collection involved face-to-face interviews conducted with officers from the University of Coimbra, managers of the firms in incubation in the university's incubator, and the representative of the local government about the structure of incubator. Previously constructed interview scripts were used for this. A pilot interview was conducted in May 2011 with a technology based firm and the final interviews took place between June and September 2011. Each interview lasted about 1 hour.

The script for the academics aimed to find out about the degree of interaction between the triple helix agents from academia's viewpoint, so an interview was held with the University of Coimbra officer involved in the incubator. The responses from the university to the variables of each of the spaces specified in Table 1 (6 innovation indicators, 5 knowledge indicators and 5 consensus indicators), taken as the analytical domains, were rated between 0 and 1, assigning the value 0 for a negative response and 1 for an affirmative response. The aim was to measure the degree of involvement of the university in creating new businesses and fostering local entrepreneurship.

The industry viewpoint was assessed by means of interviews conducted with the 18 firms in incubation, on 31 December 2010. Twelve of the firms were in the information and communications technology (ICT) sector and 6 were in 'Other Sectors'. None was in the biotechnology sector. All the firms in the sample were less than 3 years old. The first part of the interview script had four questions framed so as to characterize the firms (1 – origin, 2 – business sector, 3 – size, and 4 – R&D activities). The second, third and fourth parts respectively asked companies about the 6 innovation space indicators, the 5 knowledge space indicators and the 5 consensus space indicators, specified in Table 1 and treated as analytical areas. The value 0 was assigned for a negative response and 1 for an affirmative response. The purpose was to measure the perception of the firms within the local dynamics of the triple helix.

The assessment of the government perspective was obtained via an interview with the Coimbra local authority official, and dealt with the indicators of the innovation, knowledge and consensus spaces presented in Table 1. The purpose was to measure the level of government involvement in the local entrepreneurship dynamics.

In addition to knowledge about the presence or absence of any of the indicators of the triple helix spaces, the study was designed to measure the relationship between indicators of those spaces and four characteristics of companies in incubation. The first is the firm's origin, to see if it was a spin-off from a university, a spin-off from another company, a new firm established on individual initiative, an already-existing firm, a subsidiary of another already-existing company, or some other situation. The second, economic sector, denotes the activity in accordance with its technological character. The first and second groups included mostly high-tech sectors, e.g.: 1- ICT (communications, computer and electronic hardware and software), 2- biotechnology and health (medical and health products and services and genetic engineering). The third group contains mostly low-tech sectors, designated 3- Other sectors (energy, consumer products, industrial products and other goods and services). The third variable concerns the size of the company measured in terms of employees (up to 3, from 4 to 10, and 11 and over). The last variable measured R&D activities: 1– none; 2 full-time R&D, and 3– part-time R&D.

SPSS was used to process the results. In order to find associations between variables, and since they are categorical variables, we applied the chi-square or Fisher's exact test in cases of a small number of companies, for a confidence level of 90 %. Whenever possible the association was measured using Cramer's V coefficient.

4. Results and discussion

The empirical analysis is divided into five parts: first, a summary of general findings; second, the characteristics of the firms in the study are presented; third, discussion of responses of the University and the Government to the indicators of the innovation, knowledge and consensus spaces; fourth, discussion of the responses of the firms to the same indicators. Finally, we also discussed the significant associations between the characteristics of the firms and the responses found in the innovation, knowledge and consensus spaces.

4.1 General results

The overall results highlight the regional dynamics of the triple helix for fostering entrepreneurship and firm creation through the combination of the innovation, knowledge and consensus spaces in the Coimbra region. All of the 18 firms in incubation stated they had a true perception of the importance of combining innovation efforts, creating knowledge and the need for consensus for solving society's problems and for regional development, confirming Etzkowitz's (2008) argument. The University of Coimbra has attracted and developed a critical mass of highly specialized human resources, which has led to the creation of numerous firms. As a consequence, the relevance of the University's business incubator and its Tecnopólo is emphasized for the reception of new start-ups, for the encouragement of innovation and for locally-based entrepreneurship.

4.2 Characteristics of the firms

The 18 firms used in the study were based in the university's incubator. In terms of the origin of the firms, 22.2% were university spin-offs and 55.6% were new firms from outside the university. The predominant economic sector is ICT, accounting for 66.7%, with the other sectors comprising 33.3%. Naturally, most of the firms in incubation were micro-enterprises, with 15 (83.3%) of them having 10 or fewer employees. In terms of R&D, 55.6% engage in R&D on a part-time basis and 7 (38.9%) do none at all (Table 2).

Table 2 – Characteristics of firms in incubation (N=18)

Firm origin	Economic sector	Size	R&D activities
22.2% (4) university spin-off	66.7% (12) Information Communication and Technologies	27.8% (5) up to 3 employees	38.9% (7) no R&D
11.1% (2) spin-off from other company	0% biotechnology and health	55.6% (10) 4 to 10 employees	5.6% (1) full-time R&D
55.6% (10) new firm	33.3% (6) other sectors	16.8% (3) more than 11 employees	55.6% (10) part-time R&D
5.6% (1) existing firm			
5.6% (1) subsidiary of existing firm			

Source: Interviews conducted in the study.

4.3 University and government in triple helix spaces

The distribution of the answers of the University of Coimbra and local government in relation to indicators of innovation, knowledge and consensus were quite homogeneous with respect to "yes" responses. There are two exceptions. Indicator 5 - Attracting artists (innovation space), does nothing to improve the environment for innovation in the Coimbra region, and indicator 1 - Central government intervention (consensus space) has no impact on the establishment of consensus solutions and commitment at regional level. But the relevance of the Tecnopólo, the incubator, the activity of "business angels", the training in entrepreneurship, transfers between academia and society was unanimous.

Furthermore, all respondents highlighted the importance of cooperation between university and industry, social learning network, a trust-based entrepreneurship and the organization of internships. The active cooperation at regional level between the University, local government and various community organizations, were also mentioned by all respondents.

4.4 Firms and responses to the indicators of the triple helix spaces

The 18 companies in the study also gave their views about the impact of the indicators of innovation, knowledge and consensus. It appears that the central government (indicator 1, consensus space) is not involved in innovative efforts and the creation of companies regionally, and 17 companies feel that, variable 5 - Attracting artists (innovation space) is not at all relevant to stimulating an innovation environment and encouraging entrepreneurship, and only one company said it is (Table 3).

Table 3 – Industry: No. of "yes" responses to the innovation, knowledge and consensus indicators (N=18)

Innovation	Knowledge	Consensus
77.8% (14) university technology transfer	50% (9) university-industry research partnership	0% (1) – central government intervention
33.3% (6) investors, "business angels"	33.3% (6) open academia	88.9% (16) (industry)
83.3% (15) science park	83.3% (15) trust based entrepreneurship	100% (18) regional / local government
94.4% (17) entrepreneurship training program	72.2% (13) student internships	100% (18) university support
5.6% (1) attracting artists	61.1% (11) social learning network	0% (5) community intervention
100% (18) business incubator		

Source: Interviews conducted in the study.

4.5 Associations between firms' characteristics and the indicators of the triple helix spaces

The chi-square test was used to identify associations between the characteristics of the firms (Table 2) and indicators of the innovation, knowledge and consensus spaces on the answers given by start-ups in incubation (Table 3). It was found that only the origin of the company and its size had statistically significant values (Table 4). The origin of the company in the variable "new company" is associated with the indicator "Science Park" ($p = 0.069$). This variable expresses the clear perception by new firms originated outside the university that a physical infrastructure to accommodate emerging firms has been constructed and this is a structuring factor in boosting innovation and entrepreneurship at regional level. Origin, in the variable "new company", is also associated with the indicator "trust-based entrepreneurship" belonging to the knowledge space ($p=0.069$). This result can be explained by the implementation of programs that lead to the promotion of entrepreneurship based on trust and where new business connections are established that result in high economic impact for new firms. An example is programs encouraging entrepreneurship implemented regionally in recent years – ARRISCA and INOV-C, which have been particularly effective. It is undeniable that the greater the effort the greater the number of start-ups.

Firm size variables "up to 3 employees" and "4-10 employees" are associated with the indicator "social learning network" belonging to the knowledge space ($p = 0.101$ and $p = 0.066$ respectively), meaning that micro-enterprises in incubation with fewer employees benefit greatly from the social network that promotes the exchange of knowledge and skills transfer, develops relationships and accelerates learning. The programs implemented in the Coimbra region and intended to promote entrepreneurship, involving the University, local government and other regional organizations have had a strong impact on the generation of start-ups that have less than 10 employees.

Table 4 – Statistically significant associations between the firms' characteristics and the innovation, knowledge and consensus spaces

			Innovation Space *Science park (n=15)*		**Knowledge Space** *Trust based entrepreneurship (n=15)*		**Knowledge Space** *Social network based on learning (n=11)*	
			n	%	n	%	n	%
Origin	New firm (n=10)		10	100,0	10	100,0		
		p-value	*.069*		*.069*			
		V-Cramer	*.500*		*.500*			
Size	Up to 3 employees (n=5)						5	100.0
		p-value					*.101*	
		V-Cram					*.495*	
	4 to 10 employees (n=10)						4	40.0
		p-value					*.066*	
		V-Cramer					*.484*	

Note: The *p*-values relate to Fisher's exact test because of the small number of observations.
Source: Interviews conducted in the study.

5. Conclusions

This paper examines the influence of innovation, knowledge and consensus spaces in the scope of the triple helix dynamics in the Coimbra region, with respect to increasing entrepreneurship and creating micro-enterprises. A database of 18 start-ups based in the University of Coimbra incubator was used. Interviews were conducted with the university, the 18 firms and local government officials. The results show the importance of university-industry-government interaction at region level. All the firms in incubation stated they had a true perception of the importance of combining innovation efforts, creating knowledge and the need for consensus for solving society's problems and for regional development, thus confirming Etzkowitz's (2008) argument.

The University of Coimbra has attracted and developed a critical mass of highly qualified human resources, which has given rise to the creation of numerous firms. As a consequence, the relevance of the University's business incubator and its Tecnopólo is emphasized for the reception of new start-ups, for the encouragement of innovation and for locally-based entrepreneurship.

The responses of the University of Coimbra, the firms and local government coincide for the indicators of innovation, knowledge and consensus spaces. The Tecnopólo, the incubator, the activity of "business angels", training in entrepreneurship and transfers between academia and society are especially emphasized. Furthermore, the respondents drew attention to the importance of cooperation between university and industry, the social learning network, a trust-based entrepreneurship and the organization of internships for students. Cooperation between the University, local government and various community organizations was also mentioned by the respondents, but no central government influence on regional entrepreneurial dynamics was found.

The study shows that the origin of the firms and their size influence the triple helix regional dynamics through the innovation and knowledge spaces. Regarding the firms' origins, the new firms from outside the University rely heavily on the innovation space indicator "Science Park", signifying that the construction of a physical infrastructure to accommodate emerging firms, has forged ahead and is a structural factor in boosting innovation and entrepreneurship at regional level. The origin of the firms is still associated with the knowledge space indicator "trust-based entrepreneurship". This finding allows us to conclude that the

implementation of programs that lead to the promotion of entrepreneurship based on trust and where new business connections are established, result in high impact for new firms.

Firm size variables "up to 3 employees" and "4-10 employees" is associated with the indicator "social learning network" belonging to the knowledge space, meaning that micro-enterprises in incubation with fewer employees benefit greatly from the social network that promotes the exchange of knowledge and skills transfer, develops relationships and accelerates learning. The programs implemented in the Coimbra region, involving the University, local government and other regional organizations are instrumental in supporting the results found.

5.1 Practical implications for management

There is little literature on the application of the innovation, knowledge and consensus spaces to explain the regional dynamics of the triple helix. University, business and local government are organized through various initiatives to promote regional entrepreneurship and to stimulate business creation and innovation. The practical implications for management are twofold.

First, incubators and science parks, considered as instruments that facilitate entrepreneurship and innovation, are appropriate incentive for the innovative activity of start-ups. This research showed that firms in incubation with fewer than 10 employees access knowledge through the university network, benefiting from regional programs and initiatives that promote entrepreneurship. Paying greater attention to these aspects could help to increase the rate by which firms are engendered, jobs created and the economy grows.

Second, from an economic perspective, encouraging innovation in business incubators can be regarded as a strategy to stimulate sustainable regional and national growth and development and encourage the transfer of knowledge / technology from the academic environment to the corporate world.

5.2 Future research

This work contains only information on firms based in the University of Coimbra incubator. It would be interesting to extend the analysis to firms headquartered in the Tecnopólo, and carry out a more detailed study on the extent of responses in each indicator of the innovation, knowledge and consensus spaces. An analysis of this nature could also allow conclusions to be drawn about national entrepreneurship policy.

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