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RESEARCH

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Expanding the vision of entrepreneurial universities: a case study of UNIRIO in Brazil

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Abstract

This paper aims to study a set of entrepreneurial activities at a public university and the interaction with other universities, the business sector and government at Federal University of the State of Rio de Janeiro (UNIRIO), Brazil. The study sought an understanding of the dynamics and results of the research activities, the interaction with various organizations and the establishing of commercial, social, cultural and civic entrepreneurship developed by UNIRIO's research groups. Analysis of the activities related to entrepreneurship, in a broad sense, offers the possibility of shedding light on less appreciated but equally important aspects of the activities performed by universities, representing an initiative focused on social and humanistic activities. It is this set of endeavors, aimed at the commercialization of technology and appropriation of knowledge, along with others aimed at creating social value, that comprise the entrepreneurial university.

Keywords: Research groups, Triple helix, University-industry-government interaction, Innovation policy, Entrepreneurial university

Resumen

Este trabajo tiene como objetivo estudiar un conjunto de actividades empresariales en una universidad pública y la interacción con otras universidades, el sector empresarial y el gobierno de la Universidad Federal del Estado de Río de Janeiro (UNIRIO), Brasil. El estudio buscó una comprensión de la dinámica y los resultados de las actividades de investigación, la interacción con diversas organizaciones y el establecimiento de la iniciativa empresarial comercial, social, cultural y cívica desarrollada por los grupos de investigación de UNIRIO. Análisis de las actividades relacionadas con el espíritu empresarial, en un sentido amplio, ofrece la posibilidad de iluminar aspectos menos apreciados pero igualmente importantes de las actividades realizadas por las universidades: iniciativas centradas en las actividades sociales y humanísticas. Es este conjunto de esfuerzos, destinado a la comercialización de tecnología y apropiación del conocimiento, junto con otras destinadas a la creación de valor social, que comprenden la universidad empresarial.

Résumé

Cet article vise à étudier un ensemble d'activités entrepreneuriales dans une université publique, ainsi que l'interaction avec d'autres universités, le secteur des entreprises et les pouvoirs publics à l'Université d'Etat de Rio de Janeiro (UNIRIO) au Brésil. L'étude a cherché à comprendre la dynamique et les résultats des activités de recherche, l'interaction avec diverses organisations et l'enracinement de l'esprit entrepreneurial développé dans les domaines commercial, social, culturel et civil par les groupes de recherche de l'UNIRIO. L'analyse des activités liées à l'esprit entrepreneurial, au sens large, offre la possibilité de faire la lumière sur des aspects moins appréciés mais tout aussi importants des activités menées par les universités, ce qui représente une initiative centrée sur des activités sociales et humanistes. Il s'agit des expériences visant la commercialisation de la technologie et l'appropriation de la connaissance ainsi que celles relatives à la création de valeurs sociales dont l'université entrepreneuriale.

摘要

本文旨在研究公立大学的创业活动,并以巴西里约热内卢联邦大学(UNIRIO)为主要案例,研究它与其他高校、产业部门、政府之间的互动。这项研究寻求对科研活动的动力和结果、对与各种组织机构的互动和对由UNIRIO研究小组发展建立的商业、社会、文化和公民创业的理解。对创业相关活动的分析,在广泛的意义上,为在大学里进行的缺少悦人光华但同样重要的活动提供了可能性,代表着聚焦在社会和人文活动方面的努力。正是这些以技术商业化和追求知识实用性为目的的一系列努力,同其他旨在创造社会价值的努力一起,构成创业型大学。

Аннотация

Настоящая статья посвящена изучению предпринимательских инициатив в государственном университете и взаимодействию его с другими университетами, представителями бизнеса и правительством на примере Федерального Университета Штата Рио-де-Жанейро (UNIRIO) в Бразилии. Исследование направлено на изучение закономерностей проведения исследовательской деятельности, взаимодействия университета с различными организациями и осуществления предпринимательской деятельности коммерческого, социального, культурного и гражданского характера, выполняемых исследовательскими группами UNIRIO. Анализ активности, связанной с предпринимательством в широком смысле, дает возможность пролить свет на недооцененные, но не менее значимые виды деятельности, осуществляемые университетами в социальной и гуманитарной сферах. Такие проекты, нацеленные на коммерциализацию технологий и внедрение знаний, наряду с прочим ориентированные на создание социальной ценности, осуществляются предпринимательскими университетами.

Resumo

Este artigo tem como objetivo estudar o conjunto de atividades empreendedoras em uma universidade pública, bem como a interação com outras universidades, o setor empresarial e o governo na Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Brasil. O estudo buscou compreender a dinâmica e os resultados das atividades de pesquisa, a interação com várias organizações e o estabelecimento do empreendedorismo comercial, social, cultural e cívico desenvolvido pelos grupos de pesquisa da Unirio. A análise das atividades relacionadas ao empreendedorismo, em um sentido amplo, oferece a possibilidade de lançar a luz sobre aspectos menos abordados, mas igualmente importantes das atividades realizadas por universidades, que representam iniciativas voltadas para atividades sociais e humanísticas. É esse conjunto de esforços com a finalidade da comercialização de tecnologias e da apropriação de conhecimento, juntamente com outros visando a criação de valor social, que compõem a universidade empreendedora.

Multilingual abstract

Please see Additional file 1 for translation of the abstract into Arabic.

Introduction

There is a growing trend at the universities, transforming them into what the literature describes as “entrepreneurial universities”, and examples can be seen in different cultures and regions, in developed countries and in developing countries (Etzkowitz 2014). The development of these activities was spurred by changes that took place in the USA following approval of the Bayh-Dole Act, in 1980, which encouraged universities to commercialize their research results (Grimaldi et al. 2011).

The transition to an entrepreneurial university has been occurring through different processes and time durations as a consequence of specific national and organizational contexts. According to Etzkowitz (2015), there are three stages to the university entrepreneurial transformation process: (1) the university starts to define its priorities and diversify its income sources; (2) the institution starts commercializing the intellectual property that arises from its research activities; and (3) the university takes an active role in participating in its regional innovation environment.

A variety of complementary activities are also important to this process, such as an emphasis on establishing new businesses to commercialize intellectual property, patenting and licensing, setting up incubators, science parks, and university spin-outs, and investing equity in start-ups, among other indicators (Mowery and Sampat 2004). The introduction of entrepreneurial activities at a university requires time, a favorable institutional culture and a balance in the entrepreneurial spectrum in line with existing university capabilities, in order to avoid tensions within the internal environment as a consequence of differing opinions about the entrepreneurial path (Philpott et al. 2011).

The entrepreneurial activities in Brazilian universities have been introduced following two combined tendencies: top-down and bottom-up. From the middle of the 1980s, there was a predominance of bottom-up initiatives, for various different reasons. For example, at PUC-RJ, a private not-for-profit institution, it was a consequence of government cuts in resources, while at UNIFEI, a federal public university, it was the decision of the new rector, and at the UFMG, it was the decision of some professors in the Computer Science Department that led to the introduction of the discipline of

entrepreneurship and also to an incubator (Almeida 2008), the development of support capability for entrepreneurial activities, technology transfer and interaction with external bodies at the Federal University of Rio de Janeiro (Renault and Mello 2013); and the implementation and consolidation of the Campinas State University Science and Technology Park as a new hub for ST&I in this part of the state of São Paulo, aimed at promoting regional progress (Baldoni 2015). The national diffusion of this process could be considered as an action of Brazilian university professors, concerned about a lack of innovation in the country, that started to develop incubators and entrepreneurship training in the universities, at a time of legal restrictions (Etzkowitz et al. 2005).

With regard to the institutional and political contexts, approval of the Innovation Law, in 2004, introduced the regulatory framework that was necessary to stimulate innovation, covering three different areas: (1) creating an environment that is conducive to establishing strategic partnerships between universities, technological institutes, and companies; (2) encouraging the participation of scientific and technological institutions in the innovation process; and (3) fostering innovation in companies, based in incubators and technological parks.

In the Innovation Law, there is a provision that establishes two years for a university to implement adaptation of its internal regulations to the objectives of the new law, including the creation of a TTO (Technology Transfer Office). According to the latest survey conducted by the CNPq, in 2014, to evaluate the implementation of institutions' internal mechanisms to stimulate innovation, a total of 264 institutions had introduced TTOs, including 59 federal universities, and only 14 federal universities had not completed their implementation. So, there is still much to be learned with regard to the implementation of this policy in Brazil, considering the positive aspects and difficulties.

The top down policy was a consequence of the pressure for some universities in the country to play a more active role and to show more flexibility in developing entrepreneurial activities and partnerships with industry. However, it was and continues to be a source of tension derived from the controversy over the role of the university in society and how knowledge can be appropriated. The aim of this paper is to study a set of entrepreneurial activities at a public university — Federal University of the State of Rio de Janeiro (UNIRIO), Brazil — and the interaction with other universities, the business sector and government and to examine the university internal resistance to adopting the changes in the national policy. The study's goal was an understanding of the dynamics and results of the research activities, the interaction with various organizations and the establishing of commercial, social, cultural and civic entrepreneurship developed by UNIRIO's research groups.

The following section presents a brief review of theoretical concepts, empirical studies, and policy aspects related with entrepreneurial university. Section Data and methodology describes the data sets and methodology used for the statistical analyses, and Section UNIRIO background shows an analysis of the academic entrepreneurship activities developed by academic research groups with the aggregate level of knowledge fields. Finally, Section Entrepreneurial activities at UNIRIO concludes the main findings, discussion of the implications, relevance, and limitations of the research.

Literature review

For this analysis, we used the theoretical model of the triple helix, which considers that the key to social and technological innovation is university-industry-government interaction. The model adopts the premise that the university plays an entrepreneurial role,

seeking to contribute to economic and social development both at the local and regional level (Etzkowitz and Leydesdorff 2000), whether by transition from research-based university to entrepreneurial university (Etzkowitz et al. 2000) or by transformation from education-focused universities to entrepreneurial universities (Etzkowitz 2015).

The literature covering this topic is extensive and includes a variety of elements, regions, and contexts, such as the interaction between universities and other organizations (Boardman and Corley 2008); growth in the relationship between academia and business research networks and its influence on the organization of modern science (Jong 2008; Haeussler and Colyvas 2011); the institutionalization of technology transfer in a given field of knowledge (Colyvas 2007); social and individual factors affecting the decision of researchers to take part in entrepreneurial activities (Clarysse et al. 2011); parent organization characteristics and the availability of resources for technology-based companies (Moray and Clarysse 2005); and university departments and their influence on the development of entrepreneurial skills within spin-offs (Rasmussen et al. 2014).

The concept of entrepreneurship has been expanded to include activities that are not related exclusively to the creation of new technology-based businesses. Besides the aforementioned approaches, others have been incorporated from the literature, relating to social entrepreneurship (Dees 1998), civic entrepreneurship (Perkmann 2007), eco-entrepreneurship (Schaltegger 2002), sustainable entrepreneurship (Schaltegger and Wagner 2011), and arts and culture.

Based on various definitions of entrepreneurship, the concept of the entrepreneurial university could be understood as a series of concentric circles, moving from broad engagement with society to a specific focus on enhancing economic development through research, educational, and entrepreneurial initiatives. This broader concept allows for expansion of academic entrepreneurship, which would be achieved only through research, to include universities that are focused on teaching or initial research as another source of new economic activities (Etzkowitz 2014). The entrepreneurial university has been considered by organizations such as the World Bank to be one of the important public policy tools for speeding up the creation of innovations and the process of economic development (Vonortas et al. 2014).

Knorr-Cetina (1999) points out the collective dimension (team/group) in modern science, whether it be mono-, multi-, or trans-disciplinary, local or global, composed of researchers or non-specialists, or small or large. They affect the communication process and publicity in science. In their organizational procedures, scientific “facts” are constructed inside laboratories, where they examine reality and register the results, which are then evaluated and published in the form of papers and other scientific writing (Latour and Woolgar 1979; Latour 1987). The “inner logic” of academic development has pushed the university into expanding the focus from teaching to research and entrepreneurial activities, turning research groups into quasi-firms (Etzkowitz 2003). The specific characteristics of individual universities, such as the history, culture, internal values, and organizational identity contribute to the performance of the in-house research groups (Clarysse et al. 2005).

As a result of reflection on the experience of commercial entrepreneurship at entrepreneurial universities, certain internal aspects of these institutions emerge as indicative

for policymakers, such as determining specific support policies for the spin-offs from different areas of knowledge, including mechanisms to cover financial gaps during their development; the technology transfer office (TTO) is a driver of the marketing/licensing process; incentives for researchers to engage in entrepreneurial activities, taking care over the impact of entrepreneurial activities on various areas of knowledge, since the setting up of some companies may take up more working time (Siegel et al. 2007).

The ideas, reasoning and tools of innovation policy come about as a result of the ongoing interaction of the agents involved in innovation practice, innovation-related public intervention strategies and innovation research and theory (Kuhlmann et al., 2010). The authors recognize the importance of these learning processes, including policy learning, which documents the close interaction between analytical work on innovation and the planning and implementation of innovation policy.

This process involves a number of administrative layers. Some empirical studies have shown that certain segments of university administration discourage collaboration between universities and business. Even when the upper management levels are committed to such a partnership, intermediate and lower levels of the hierarchy may act to undermine that objective (Audretsch et al., 2002). For the universities, incorporating all the features of entrepreneurship requires a modification of internal structures and practices including adoption of the technology transfer office (TTO) as a new career field for their professionals (Mosey et al., 2006). The transformation in an entrepreneurial university takes time and depends on the internal and external environment at the micro level, related to internal changes aimed at flexibility and diversity in addressing a particular organization, and the external context that includes policy vision and specific actions for implementation (Jacob et al., 2003).

At the regional level many European, Asian and Latin American countries have introduced reforms and public policy initiatives to encourage and improve entrepreneurial activities and technology and knowledge transfer. The transformation of Latin American universities has been conducted based on two different theoretical approaches: the entrepreneurial university, as presented previously (Etzkowitz, 1998; Clark, 2004), and the developmental university that, to face the problem of inequalities and economic development, should seek the democratization of knowledge, in order to achieve inclusive development. The case study of the Universidad de la República, the only public university in Uruguay, has been analyzed as an example of this perspective for initiatives to expand the university to other regions of the country, fighting early drop out from the university through a “peer tutorial” system, including academic research into problems concerning the quality of life of the most deprived sectors, among other programs (Arocena et al., 2015). The entrepreneurial university model places economic and social development side by side as part of their mission (Etzkowitz, 1998) and points out that entrepreneurial activities should not be considered as synonymous with commercialization (Clark, 2004).

The trend towards entrepreneurial activities adopts various approaches in other Latin American universities and numerous examples along these lines can be mentioned. For example, in the case of the Catholic University of Chile, devoted to deep change, the research groups have been operating as quasi-firms, but don't launch start-up firms developing products, instead looking to obtain and manage the resources made available for science on a competitive basis, diversifying financial sources as a consequence of government cuts in the 80s (Bernasconi, 2005). Then there are the numerous Brazilian

universities, such as PUC-Rio, USP, UNICAP, UFRJ and others, that pursue entrepreneurial activities and academic excellence, organizing business incubators to nurture start-ups and spin-off companies and cooperative incubators to support the organization of cooperatives to generate jobs and educational and economic opportunities for excluded social sectors (Gonçalo, 1998; Almeida and Etzkowitz, 2012). The national educational policy implemented by the federal government created 17 more federal universities in various regions of the country and also established a progressive quota system in federal universities, as an affirmative action mechanism for Afro-Brazilians, indigenous peoples and students from poor families to study in those institutions, which in the past had been a traditional space for white and the rich/middle classes. In Argentina, the Buenos Aires University has been increasing its entrepreneurial activities and interacting with industry, as well as advancing the research and teaching activities (Fanelli and Estébanez, 2008).

Brazilian universities have created a platform for civic and social entrepreneurship through projects and action aimed at helping to improving the quality of life for socially excluded groups, in projects aimed at economic and social development, known in the country's laws as "outreach projects". As a whole, they cover a range of projects aimed at the fields of education, health, the environment, and others. The activities may be top-down or bottom-up. While the Ministry of Education has for several years been issuing calls to tender in support of these activities, there are also internal structures to encourage them, especially when there is an existing vocation among the university faculty and students.

However, with regard to technology-based academic entrepreneurship, this began from the bottom up at the universities, with the establishing of business incubators, as from 1987, and these were only included in a national program in 1998, when there were already more than 60 incubators spread around the country. Support for these activities came from the Ministry of Science, Technology, and Innovation and only recently has the Ministry of Education begun to tentatively support the setting up of incubators in the creative industries and cooperatives/social area. Within this institutional tangle, the programs to encourage innovation, including those arising from the university's internal organization, according to the instructions of the Innovation Law, can be said to be involved in an ongoing learning process.

Data and methodology

The methodology adopted covered qualitative and quantitative research. The data was based on semi-structured interviews with the leaders of a representative sample of the existing university research groups that were registered with the CNPq's Research Group Directory, conducted in the second half of 2014.

The size of the sample was randomly determined, considering three levels: field of knowledge, academic center and department, in order to balance and represent the research group diversity, using an equation suggested by Castro et al. (2011) for this purpose, as shown below:

$$n = \frac{(1.96)^2 (0.5)^2 N}{(1.96)^2 (0.5)^2 + N e^2}$$

where n = sample size (percentage of the sampled population); N = size of the population sampled; $e = 0.05$, assuming a level of reliability with a safety margin of 5 %;

1.96 = the value of the normal distribution, assuring accuracy of 95 %; and 0.5 = the significance level expected for the calculation of the sample size.

The calculation of the representative sample involved interviews with 71.5 % of the research groups, by means of three samples: by department, by academic center, and by field of knowledge. The largest sample was then chosen, representing 119 groups, classified by department. Excel was used for the random selection of the groups. A total of 135 interviews were conducted, from a total of 162 research groups.

The questionnaire used in the interviews with the academic research groups included basic questions about the nature of their activities and their impacts on and benefits to society, as well as the types and number of organizations with which the groups interacted, such as Brazilian and foreign universities, companies, civil society, incubators, and spin-offs. The researchers were also asked whether they were familiar with the Innovation Law and how they would classify the university-business relationship at their university. Section 6 outlines the researchers' point of view regarding these questions.

The total number of research groups, classified according to the CNPq's fields of knowledge, the sample size, and the number of interviews are presented in Table 1.

UNIRIO background

UNIRIO is located in the southeast of Brazil, in the state of Rio de Janeiro, which accounted for 11.44 % of the total Brazilian GDP in 2014. While the state economy is mainly based on oil and gas production, in the city of Rio de Janeiro, where the university is situated, the main economic activity is services.

The university was founded in 1979. It came about as a progression from the FEFIEG (Federation of Independent Higher Education Institutions in the State of Guanabara), which was set up in 1969. With the exception of the medical school, which was established in 1912 by a group of doctors who wanted to teach homeopathic medicine, started to receive government funding in 1954 and was finally incorporated by the Ministry of Education in 1957,¹ all the other courses had their origin in technical schools linked to a variety of government agencies: Ministry of Labor, Commerce and Industry - Central School of Nutrition; Ministry of Health - Alfredo Pinto Nursing College; Ministry of Education and Culture - National Theater Conservatory; Villa-Lobos Institute; the National Library's Librarianship course; the National Archive's Archive Studies course; and the National History Museum's Museum Studies course (UNIRIO 2006). These schools were incorporated within the FEFIEG in order to offer graduate courses in their respective fields (Ventura 2005).

This process of bringing together different schools in order to create a university was a common feature in the creation of the country's first universities in the early part of the twentieth century. They were referred to as *universidades sucedidas*, since their institutional roots stemmed from the unification of separate existing colleges (Cunha 1980).

The courses were set up for the purpose of training professionals to meet the social and technical requirements for carrying out specific functions at those institutions that were in need of skilled staff. The process was linked to the analysis of Burgos (1999), whereby the Brazilian educational structure was not, in the period when UNIRIO was established, directly devoted to science or research, but to the training of qualified professionals who would sustain the country's bureaucratic and urban infrastructure.

UNIRIO is a public university that receives financial support from the federal government. As a public university, the rector is chosen by the Ministry of

Education, through a public consultation process that includes the three professors most voted for by students, professors and other university staff, considering the relative proportion of each group. Subordinate to the rector are the vice-rector and six deans, representing undergraduate studies, research and graduate studies, outreach and culture, planning, financial administration, and human resources. There are five colleges: Technology, Humanities, Law and Public Policy, Literature and the Arts, Biological and Health Sciences. Within these colleges, in 2014, there were 25 master's (13 academic and 12 professional) and 10 doctoral courses,² 47 undergraduate courses, including 4 that were geared to distance learning.³ The number of students enrolled on graduate courses was 1451 and on undergraduate courses was 14,668. The university has 914 professors, of whom 90.85% are full-time. The faculty at UNIRIO includes 69.54% with a PhD degree, while 23.43% have a Master's degree, 5.13% a specialization degree and 1.9% a graduate degree.

Graduate courses in Brazil are accredited by the Coordination for the Development of People in Higher Education (CAPES), which is part of the Ministry of Education. These courses are given a status of "3", "4", "5", "6", or "7". The "7" level courses have the highest ranking and also qualify for additional funding from various federal and state agencies. The research capacity at UNIRIO can be evaluated by the course ranking by CAPES, shown in the Table 2. The research capacity differs by knowledge area and is considered higher in the Drama School and Music School, where the courses received a level "5" CAPES assessment.

From teaching university to research university

At the time that UNIRIO was established, three important features of the Brazilian context influencing the universities should be mentioned: (1) the introduction of research at universities during the 1970s (Botelho and Schwartzman 1996); (2) the deepening economic difficulties and macroeconomic imbalance, brought about by the oil crises and growing indebtedness, led to a lack of resources to fund technology projects and indeed the education field in general; and (3) the beginning of discussions about S&T policy and the university-business relationship (Medeiros et al. 1987). As a result, new public policies were introduced, as well as new mechanisms to encourage the transfer of knowledge from universities to business.

When UNIRIO was newly established, there was a prevalence of education over research, due to the specific characteristics of the courses that had been assembled to form the university, in which research was not incorporated within the culture. The introduction of research and the ensuing development of master's and doctoral courses was reflected in the organization of research groups in various fields of knowledge. Figure 1 illustrates the setting up of the research groups in the different fields of knowledge, showing the creation of new groups over time, as new courses were set up and professors were engaged by the university.

We investigated the relationship between setting up research groups and establishing new master's and doctoral courses at the university, because it can reflect the internal competence within a new field. The results are shown in Fig. 2.

It can be seen that UNIRIO initiated a process of internal transformation in 1982, when research was introduced to supplement the existing undergraduate courses at the university and spilled over into the setting up of the graduate school, where the first master's course was offered in Nursing (1982), followed by Collective Memory (1987),

Theater (1991) and Music (1993). The first doctoral course, in 1998, was in Music, followed by Performing Arts in 2000. Making a correlation between the number of research groups established in each year and the number of master's and doctoral courses set up over the same period yields the value of $\rho = 0.3864$, which signifies a positive correlation. There is a direct linear relationship between the increase in the number of research groups and the introduction of master's and doctoral courses, as portrayed in Fig. 2, which shows the scatter plot and straight-line correlation.

Entrepreneurial activities at UNIRIO

There is a gap at UNIRIO between the discussions and the activities carried out, in relation to the university-industry relationship. As a result, the institution has not followed the footsteps of the majority of the federal universities, which quickly institutionalized research and subsequently decided to set up business incubators and technology parks, thereby adopting a process of transformation leading in the direction of commercial entrepreneurship. In the Innovation Law, there is a provision that establishes 2 years for a university to implement adaption of its internal regulations to the objective of the new law, including the creation of a technology transfer office (TTO). Delays could be due to a governance problem rather than the position of research group leaders.

At the time that the Innovation Law was approved, the university adopted the opposite course, with the former rector declaring that, as a public university, all business activities needed to be suspended. At that time, as at other public institutions, undergraduate, masters, and PhD students did not pay any tuition fees for their studies, although there were fees for specialization courses. The prohibition by the rector of paid specialization created an internal environment that was antagonistic towards entrepreneurial activities. As one research group leader said, “there seems to be a myth that in the university one cannot have any partnership with business”, while another said “the university-business partnership is very much frowned upon at UNIRIO, although that is not my position. The ideological political position of the left is that the university doesn't have a relationship with industry”.

The organizational dimension is an important aspect to allow universities to implement changes along the entrepreneurial path, because this can stimulate proactive behavior among its groups and researchers (Clark, 2004), but the internal

Table 1 UNIRIO research groups by CNPq's fields of knowledge

CNPq field of knowledge	Number of groups	Representative sample	Done	Denied	Retired	Deceased	On leave	Total
Agrarian Sciences	2	1	2	0	0	0	0	2
Biological Sciences	23	16	19	1	0	0	0	20
Health Sciences	34	24	23	3	0	0	0	26
Physical and Earth Sciences	12	9	10	1	0	0	0	11
Humanities	30	21	21	1	1	0	1	24
Social Applied Sciences	31	22	22	2	1	1	0	26
Engineering	3	2	3	0	0	0	0	3
Linguistics, Literature and the Arts	27	19	19	0	2	1	1	23
Total	162	115	119	8	4	2	2	135

Source: the authors

environment at UNIRIO has been unfavorable for changes in this direction. This university has not been taking advantage of the opportunities created in the modification of the external context following approval of the Innovation Law. The concern over the influence of industry on the production and diffusion of knowledge has been placing the university on an opposite trajectory to similar institutions. The present path, although stimulating research, does not create an internal dynamic to seek out external sources of resources. The majority of university financial sources are from the federal government, with the exception of the University Hospital, which also receives funding from the Ministry of Health. In the university budget provided by the federal government, 1% is devoted to research activities. This amount is augmented by government agencies at the federal and government levels. There was no official data about the number of projects and total amount approved by those agencies, but considering the answers from 54.37% of the professors who participated in the 2014 university evaluation survey, it was revealed that 7.24% of the respondents had received grants from one of those institutions (UNIRIO/CPA, 2015). The current rector sent to the legal department, for analysis, a proposal to set up a TTO in 2013, but it was approved only in August 2015. According to the Dean of Research and Graduate Studies, the proposal includes the creation of a new Sector of Technological and Cultural Innovation and needs to be submitted to the university council in 2016.⁴

In realizing the creation and subsequent implementation of the TTO new challenges will be added to this university as a result of necessity to create synergies with new actors dealing with the discussion about the character of entrepreneurial university clarifying the differences between entrepreneurial action and commercialization of knowledge. In the view of 43 % of the research group leaders, the institution's internal environment in relation to university involvement with business and government in university projects for the transfer of knowledge to society was considered to be poor or only in the initial stage, while only 14 % considered it to be good (usually because they were involved in developing partnerships with government institutions) and the rest stated they had insufficient information about the university to provide an overall assessment. However, 84 % considered partnerships with both business and government to be very important and only 10 % of the respondents, most of them in Humanities, were against any partnership with business. It was also found that the majority of research group leaders lack knowledge about the Innovation Law, as shown in Table 3.

The lack of understanding differs among the different fields of knowledge and is most accentuated in the Humanities and in Linguistics, Literature and the Arts. In the majority of Brazilian universities, the university management assumes the responsibility for providing legislative updates by publicizing the Innovation Law. In this particular case, the opposition to that proposal created an internal barrier to entrepreneurial activity. Taking a different line, Philpott et al. (2011) suggested that, for university management to stimulate entrepreneurship, it would be more effective to concentrate on removing the existing barriers within their institutional system.

From the point of view of another researcher who was interviewed, "UNIRIO is not an innovative institution; traditionally its reaction is to avoid modifications, is to avoid innovation". That point of view could reinforce the hesitation of management.

Table 2 UNIRIO course ranking by CAPES

Status	Number of PhD courses	Number of academic master's	Number of professional master's
Level "3"	1	5	7
Level "4"	7	6	4
Level "5"	2	2	1
Level "6"	–	–	–
Level "7"	–	–	–

Source: The authors, based on Capes evaluation

The effect of this lack of partnership with government and business has caused “a problem for the university, because it creates isolation from society” and means that higher education administration has been ignoring the opinion of a significant proportion of the professors, who are precisely the ones who are the most active in research.

The data show that within the knowledge field represented by the research groups (Etzkowitz 2003), there is a view that it is important to move towards the internal formalization of innovation mechanisms within the institution, not least for the development of the research being carried out, since the results may have consequences other than publications. However, consensus still needs to be built, through clarification of the need for national legislation that covers all public universities.

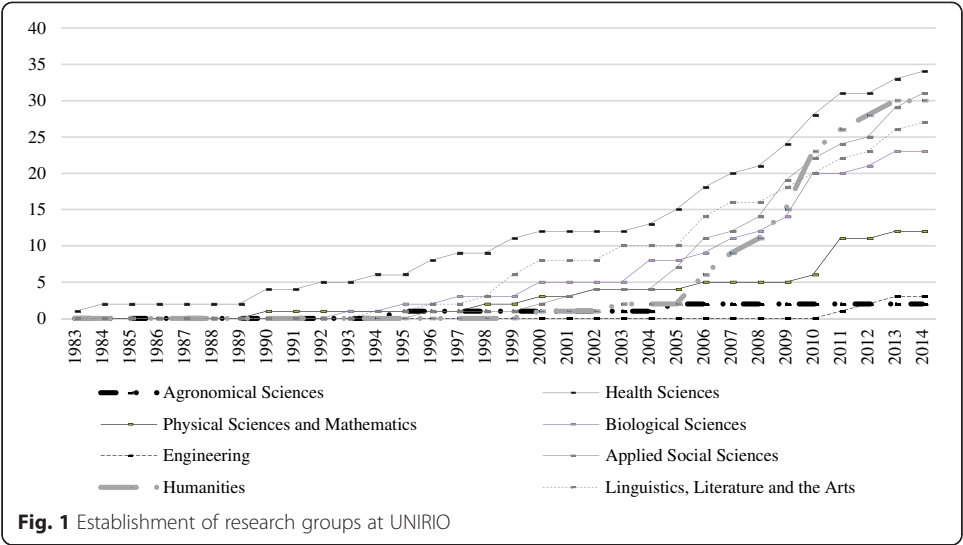
While practical steps to establish such partnerships—highlighted as positive under the Innovation Law—are not taken, one sees in the activities related to entrepreneurship that are developed by the research groups that two different approaches have evolved that are not mutually exclusive, according to the concept of the entrepreneurial university proposed by Etzkowitz (2014): commercial and non-commercial entrepreneurship, with a predominance among the latter of social and civic entrepreneurship. Some examples of the entrepreneurial activities of the research groups are spotlighted.

Commercial entrepreneurship

For activities relating to commercial entrepreneurship, a knowledge exchange typology was used, based on Landry et al. (2002), which had previously been used by Martinelli et al. (2008) in a study on the entrepreneurial activities of Sussex University, in the UK. To this end, new questions were included in the questionnaire, as follows:

“What kinds of relationship with business has your group had?” And questions were inserted about six kinds of knowledge exchange.

- *Transmission*: has the group ever sent research results to a private company, the government, an agency, or other entity outside the academic sphere?
- *Presentation*: has the group ever been invited to present its research results to any group or organization that could make direct use of them?
- *Effort*: has the group ever been invited to join a round table discussion where company representatives were present?
- *Consultation*: has the group ever provided consultancy services (specialist advice or analysis)?
- *Business activities*: has the group ever participated in business activities with a company?



Three other questions were added to the above, asking whether any group members had participated in a spin-off company, whether they were aware of any student having set up a spin-off company as a result of the knowledge acquired in the group's field of research and had applied for a patent or whether there were any research results that could be patented. The information is shown in Fig. 3.

According to Landry et al. (2002), the technology transfer process can be divided into stages, beginning with the transmission and culminating in the sale, and researchers generally tend to be more involved in the early stages.

The UNIRIO results show greater numbers for transmission and presentation and generally lower numbers for Effort and Consultation. The other indicators generally used to assess the entrepreneurial activity of a university are registered patents and number of spin-offs, but those are as low as its commercialization. Taken as a whole, the results indicate that the research results are transmitted, but that this knowledge is not capitalized.

To this must be added the high number of research results that are not protected by suitable intellectual property mechanisms. It shows that the organizational mechanism devoted to fostering commercial entrepreneurship has not yet been established,

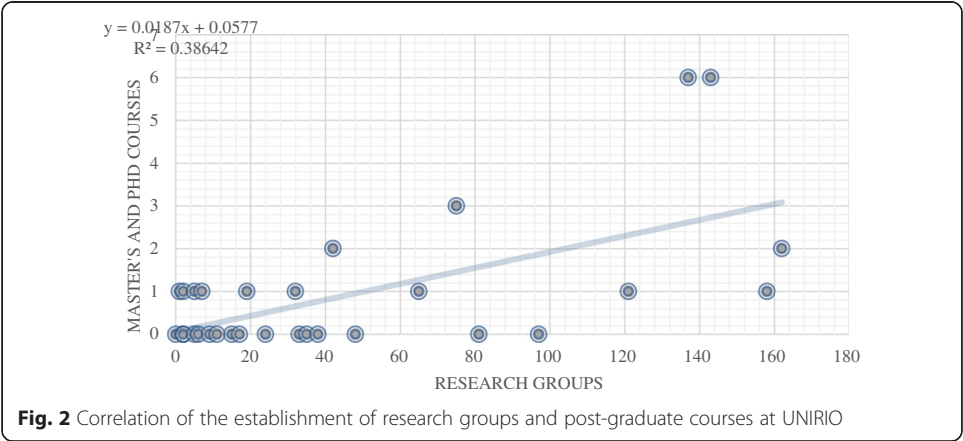


Table 3 Level of knowledge about the Innovation Law

Field of knowledge	Yes	No	Refused	Retired	Deceased	On leave	Total
Agrarian Sciences	1	1	0	0	0	0	2
	50 %	50 %					
Biological Sciences	9	10	1	0	0	0	20
	45 %	50 %	5 %				
Health Sciences	7	16	3	0	0	0	26
	27 %	62 %	11 %				
Physics and Earth Sciences	3	7	1	0	0	0	11
	27 %	64 %	9				
Humanities	4	17	1	1	0	1	24
	17 %	71 %	4 %	4 %		4 %	
Applied Social Sciences	6	16	2	1	1	0	26
	23 %	61 %	8 %	4 %	4 %		
Engineering	3	0	0	0	0	0	3
	100 %						
Linguistics, Literature and the Arts	1	18	0	2	1	1	23
	4 %	80 %		8 %	4 %	4 %	
Total							135

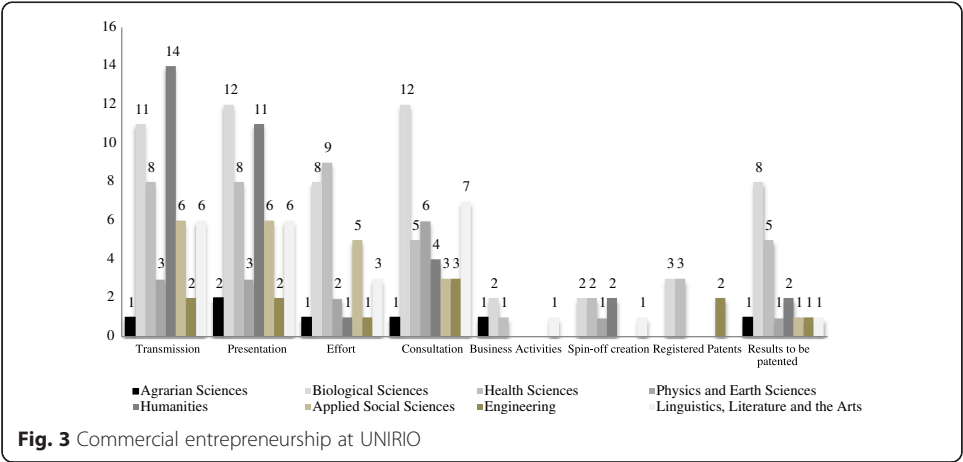
Source: the authors

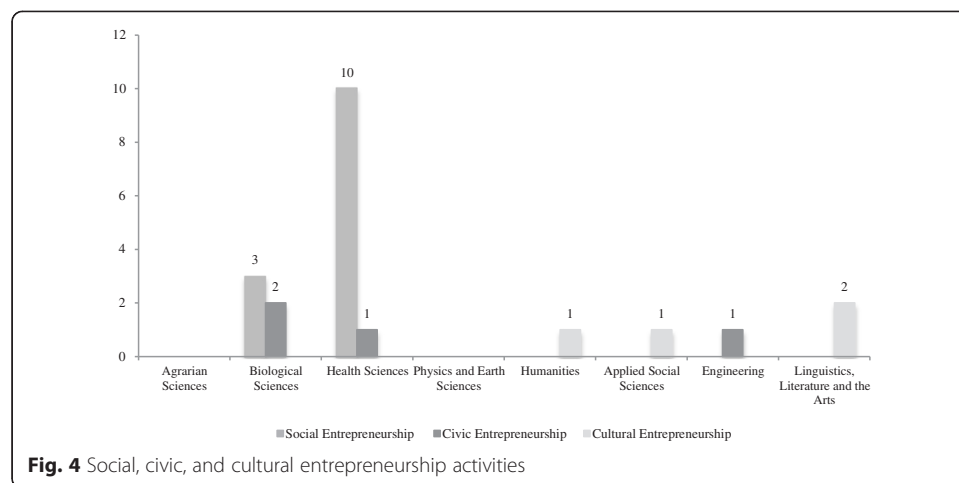
although it has been 10 years since the Innovation Law was passed. Under that law, there is a prevision that it would occur within 2 years.

Social, civic, and cultural entrepreneurship

The activities considered as social and civic entrepreneurship were defined from the questions about the benefits to and impacts on society from the research carried out. Looking at the nature of the activities in relation to the definitions of civic and social entrepreneurship, the following categories presented in Fig. 4 were determined.

Among the CNPq’s fields of knowledge, the one with the greatest number of groups citing social entrepreneurial activities is Health Sciences. According to the Brazilian Ministry of Education, the university hospitals are part of the Brazilian public health





system (SUS—Sistema Único de Saúde) and are considered to be health training and technology development centers.⁵ For this reason, they deliver health services to the population, as a not-for-profit activity, without payment for services, and at the same time determine disease technical protocols and training practice for the students and researchers under professorial supervision.

The medical school's HIV/AIDS Epidemiological Studies research group is an example of the connection between national public health policies, teaching activities, research, and social entrepreneurship. In 1986, the Brazilian government established the Brazilian National AIDS Program, involving the free distribution of medicine to patients (Galvão 2002) and a structured network of comprehensive care for people with HIV, providing various services (Hallal et al. 2010), with financial support from the federal government. The researchers in this field at UNIRIO decided to create a research group and apply for approval to establish a master's course in HIV/AIDS infection and viral hepatitis. In 2014, besides student training, they provided care for 3200 patients with AIDS and 2500 patients with viral hepatitis.⁶

The Genetics and Molecular Biology research group is developing a research/extension project with the aim of conducting an Epidemiological and Molecular Study of Huntington's Disease, in a small town in Minas Gerais state, in order to provide support to patients and their families in which the students and researchers also participate. This research group also provides laboratory exam diagnosis for patients from three university hospitals in Rio de Janeiro, supported with financial resources from UNIRIO.⁷

In the Industrial Engineering School, the Collective Production and Savings research group is developing a project for setting up a National Solid Waste program at the university. Under the program public bodies, including the federal universities, will donate to associations/cooperatives of scrap collectors all the material the organization no longer has any use for, so that those groups can sell and thereby generate an income. The research group promotes selective waste collection at the university, provides training for employees and holds awareness building meetings and other events, as well as maintaining contact with the cooperatives so that they can collect and subsequently sell the material.⁸ In this way, it stimulates economic activity and income generation by excluded groups, through action that can be described as civic entrepreneurship.

In the Scenic, Dramaturgical and Poetic Creation Processes, Methodologies, and Languages research group, connected to the Theater School, one of the professors participating in the group is running a Community Theater project wherein theater course students conduct classes and organize shows for residents of the Maré *favela* (slum), in Rio de Janeiro. It has thus effectively become a theater company, although its activities are not-for-profit and it is supported by UNIRIO and the Ministry of Education and Culture.⁹

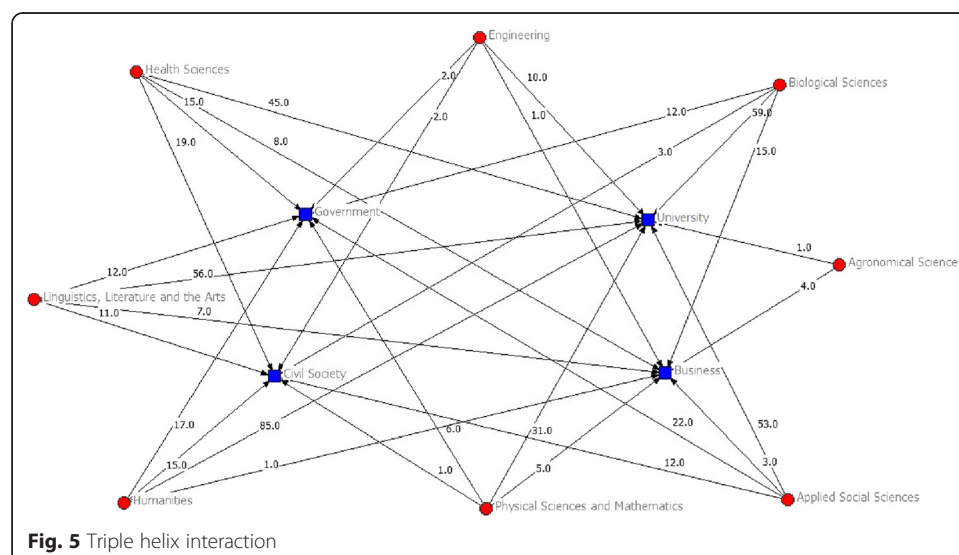
In the examples of research groups that carry out social, civic, and cultural entrepreneurial activities, there is a similar process going on to that described by Etzkowitz (2003), when talking about quasi-firms, where research groups act as if they were companies, but without the prospect of or interest in financial gain. Professors take on the management activities, both internally, by coordinating the activities of students and specialists, and in seeking financial resources to sustain the research and activities.

Triple helix interactions

Analysis of the interaction involving the three spheres of the triple helix—university, business and government—and also including civil society, was performed using the interview responses and Ucinet software (Borgatti et al. 2002), yielding the results shown in Fig. 5.

One can see that the greatest number of interactions took place with universities (340), followed by government (86), civil society organizations (63), and business (44). University interactions covered both Brazilian (242) and foreign (98) universities. According to Katz (2000), smaller educational institutions are more likely to collaborate both with other educational institutions and with local companies, and this tendency is confirmed in relation to UNIRIO.

The number of interactions with incubators, incubated companies, and spin-offs is on a ratio of four is to one. Although the university incubator was only established in 2012 and interaction with incubators and their companies is more complex, this number is still low. Interaction with companies was more common in the knowledge fields



of the Biological Sciences, Health Sciences and Linguistics, and Literature and the Arts, due to their different internal dynamics. In the Biological Sciences, interaction with companies is represented by food quality analysis, monitoring the quality of the marine ecosystem and the nutrition of high performance athletes, and technology transfer in relation to newly developed drugs. In the Health Sciences, interaction comes about through analysis of the quality and side-effects of drugs, medical equipment studies, and food quality control. Meanwhile, the field of Linguistics, Literature and the Arts includes Theater and Music courses. The city of Rio de Janeiro is well-known as a national center in this cultural and economic segment. Internal expertise combines with external opportunities to create this interaction.

Conclusions

This paper examines a period when the routines of commercial entrepreneurship were under development, when patenting, technology transfer, and spin-offs were new and untested.

In this context, the commercial entrepreneurship activities are subject to divergent interpretation, embodied in the new university proposals, but in practice in few research group activities.

Consequently, the introduction of entrepreneurial activities incorporating a third mission is not a simple matter. Tensions arise not only from the introduction of research activities but also in relation to the third mission. The predominant interactions within the helix are still with universities, followed by government and then business. It should be emphasized that the change in organizational culture to introduce an entrepreneurial vision, as well as concern over contributing to economic development, are still ongoing, thus generating conflicts and tensions over different views regarding the university's contribution to society.

Analysis of the activities related to entrepreneurship, in a broad sense, considering the different approaches to this concept and the revised concept of the entrepreneurial university, offers the possibility of shedding light on less appreciated but equally important aspects of the activities performed by universities, representing an initiative focused on social and humanistic activities. It is this set of endeavors, aimed at the commercialization of technology and appropriation of knowledge, along with others aimed at creating social value, that comprise the entrepreneurial university.

Endnotes

¹Available at <http://www4.unirio.br/escolademedicina/>; accessed on May 9, 2015.

²Available at <http://www.unirio.br/cursos-1/graduacao>; <http://www.unirio.br/cursos-1/pos-graduacao>; accessed on April, 10, 2015.

³Available at <https://sucupira.capes.gov.br/sucupira/public/consultas/coleta/programa/listaPrograma.jsf>; accessed on December, 1, 2015.

⁴Almeida, M.: Information received by e-mail from Evelyn Goyannes Dill Orrico, Dean of Research and Graduate Studies, on December 1, 2015.

⁵Available at: http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7082.htm; accessed on May 5, 2015.

⁶Almeida, M interview with Fernando Raphael de Almeida Ferry, UNIRIO professor, research group coordinator and director of UNIRIO's Gafrée & Guinle University Hospital, on December 18, 2014.

⁷Almeida, M. interview with Carmen Lucia Antão Paiva, Unirio professor and research group coordinator, on August 25, 2014.

⁸Andrade, L.A. interview with Heloísa Quaresma, UNIRIO professor and research group coordinator, on June 6, 2014.

⁹Andrade, L. A. interview with Rosyane Trotta, Unirio professor and research group coordinator, on July 22, 2014

Additional file

Additional file 1: Translation of the abstract into Arabic. (PDF 321 kb)

Competing interests

The authors declare that they have no competing interests.

Author contributions

All authors read and approved the final manuscript.

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