

The role of university incubators in stimulating academic entrepreneurship

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Received 19 August 2015; accepted 14 January 2016

Available online 17 May 2016

Abstract

Many Brazilian universities have technology-based incubators, but there is a small presence of firms created by students, alumni or teachers (spin-offs). Thus, such incubators do not encourage the transfer of technologies developed in universities to society, through the creation of new businesses, one of the main ways of university–industry interaction. To test this assumption, we studied eight university incubators. As a theoretical basis, we used the concepts of open innovation and entrepreneurial university; as a methodology, we adopted a qualitative approach through the use of bibliographical, documental and field research, with in-depth interviews. Results show that there is no priority for companies created from academic research results, despite the incubators' preference for projects that have a high potential for interaction with the university. Also, there are few efforts to attract the academic audience, which leads to underutilization of this important channel for the transfer of research results.

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Keywords: University incubators; Academic spin-offs; University–industry relations; Entrepreneurial university

Introduction

Closed innovation was the pattern adopted by companies until the early 2000s, in which research and development (R&D) were conducted solely in their own laboratories, using qualified professionals and significant resources. However, in the last decade, open innovation emerged as a new model, in which companies take advantage of the creativity of customers, suppliers, universities, research institutes or independent inventors, through partnerships, thereby obtaining more innovation, faster and with less spending. Inventions generated within companies that are not used may be offered to the market, bringing additional revenue (Chesbrough, 2006).

In the open innovation model, universities are more demanded, and closer ties with the productive sector are considered as their third mission, besides teaching (the first and

traditional) and researching (the second mission), as mentioned by Etzkowitz (2008) and Laredo (2007). The recognition of the third mission has increased during the last decade, and it involves all relationships between the university and non-academic partners, known as *capitalization of knowledge*. The vision of an “entrepreneurial university” is discussed by several authors (Etzkowitz, 2008; Mowery, Nelson, Sampat, & Ziedonis, 2001), in which technology licensing or business creation by researchers are the main forms of transferring the results of academic research.

The generation of spin-offs based on the use of university research results is better accepted by the academic community than the transfer of results to established companies (Kenney & Patton, 2011). In fact, in Brazil there still remains an academic behavior against the transfer of results to large companies (Closs & Ferreira, 2012), whose roots can be found in the organizational culture of public universities, supported by ideological values, and also to different interests - the university seeks academic results and companies want to develop new products and processes (Puffal, Rufoni, & Schaeffer, 2012).

Freitas, Gonçalves, Cheng, and Muniz (2011) consider academic spin-offs a new topic that has received little attention in

Peer Review under the responsibility of Departamento de Administração, Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo – FEA/USP.

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Brazil. The authors consider the Innovation Act of 2004 as the legal framework for the creation of these companies, and mention the higher number of Brazilian researchers in universities than in companies, which justifies the support for this important means of knowledge transfer to the business sector. They searched the SciELO Brazil database, in November 2010, and found only three articles on this subject (Araújo et al., 2005; Costa & Torkomian, 2008; Gomes & Salerno, 2010).

We have updated the research done by Freitas et al. (2011) until December 2014, using the SPELL (Scientific Periodicals Electronic Library) database, a collection of articles published in Brazilian journals of Business Administration, Accounting and Tourism, where we have identified 11 other items under the keywords *spin-off*, *academic spin-offs*, *academic entrepreneurship* and *scientific entrepreneurship*, which will be described in the following item. However, none of them addressed the topic of this article – university–industry relations from the perspective of university incubators, and their role in the transfer of research results by encouraging the creation of academic spin-offs.

This paper aimed to analyze the role of technology-based university incubators on the attraction of companies created by their academic members, based on the study of eight cases. It is divided in five items, including this Introduction. In the literature review, we discuss topics related to the entrepreneurial university and technology-based incubators. Then we present the methodology, the results and their analysis and discussion, followed by the conclusions and the list of references used in the paper.

Literature review

University–industry interaction and the growth of the entrepreneurial university

Universities and companies are natural partners in developed countries, where firms seek external sources of knowledge to complement their human resources and R&D laboratories. Currently, creating new products and services requires sources of creativity beyond the companies' boundaries, involving cooperation with customers, suppliers, research institutes and even competing companies (Chesbrough, 2006).

In those countries, universities are the preferred partners in new technological fields where business results are uncertain; but this cooperation is even more necessary in developing countries, where universities are the main source of knowledge for innovation.

Perkmann and Walsh (2007) summarize the main forms of cooperation between universities and companies, as shown in Table 1. It is important to note that academic entrepreneurship appears as an important form of collaboration as of the 1990s, with the growth of business incubators located at universities.

Licensing is still the most common tool to market universities' intellectual property, but in recent years the creation of spin-offs has gained importance (Kenney & Patton, 2011; Siegel, Wright, & Lockett, 2007). It results from changes in legislation that transferred intellectual property of research carried out with public funds to universities or researchers, and to the creation

Table 1
University–industry relations.

Research partnerships	Inter-organizational arrangements for conducting collaborative R&D
Research services	Activities commissioned by companies, including contract research and consulting
Academic entrepreneurship	Development and commercial exploitation of technologies by academic scientists through the creation of firms (alone or with partners)
Human resources transfer	Multi-context learning mechanisms such as training of companies' employees at the university; postgraduate activities in firms; graduate trainees; and temporary transfer of scientists to companies
Informal interaction	Formation of social relationships and networks at conferences, etc.
Commercialization of property rights	Licensing of university-generated intellectual property (patents) to firms
Scientific publications	Use of codified scientific knowledge within industry

Source: Perkmann and Walsh (2007).

of technology transfer offices, which made technology diffusion easier. The generation of companies from research institutions is considered one of the most effective forms of exploration and commercialization of new knowledge and technologies, and is different from licensing models or joint ventures. Named spin-offs, spin-outs or start-ups, they are created through the transfer of people and intellectual property from the home institution. To Pirnay, Surlemont and Nlemvo (2003), academic spin-off arises out of the knowledge generated in universities' research, with the participation of the scientists involved. On the other hand, Djokovic and Souitaris (2008) state that spin-offs evolve from academic knowledge, but are not necessarily created by the same people who developed it. Faculty involved in the research may not be interested, and a colleague or a graduate student can do it, or even a person not connected to the university, who becomes aware of the research and decides to take the risk.

Despite differences in the definition, Araújo et al. (2005) mention some common attributes of academic spin-offs: they are companies that originate from universities; they explore inventions, patented or not, and also knowledge accumulated by researchers in academic activities; they are for-profit entities and independent from the universities; they are companies founded by at least one university member (faculty, student or employee).

Even in developed countries, the creation of spin-offs is quite concentrated in some universities that have a strong entrepreneurial bias. American universities, on average, generate 1.91 spin-offs per year, while MIT [Massachusetts Institute of Technology] has already created 31 companies in a single year, and that is its main way of transferring technology (O'Shea, Allen, Chevalier, & Roche, 2005). One explanation is the availability of venture capital, because such investments are mainly local, to allow a close follow-up of the companies' performance.

According to Etzkowitz (2008), an entrepreneurial university is supported by four pillars: academic leadership, which is able to formulate and implement a strategic vision; legal control over its resources, including buildings, equipment, and also

intellectual property that results from research; organizational ability to transfer technology through patenting, licensing and business incubation; and an entrepreneurial “ethos”, a set of habits or beliefs that define an entrepreneurial community, formed by its leaders, faculty and students. Not all universities will follow this model. Some focus on teaching and research, and have no interest in marketing inventions.

Technological Innovation Centers [NITs] were created in Brazil, in 1981, by the National Council for Scientific and Technological Development [CNPq], to encourage the transfer of knowledge and technology from universities and research institutes to companies (Medeiros, Stal & Souza, 1987). They have become mandatory instances in federal universities as of 2004, when the Innovation Act was launched, which defined the legal framework for patenting and transferring research results. In the 1980s, and especially in the 1990s, incubators were established first in public universities, and then in private ones. The creation of the National Program for Supporting Business Incubators and Science Parks [PNI], in 2000, and the Economic Subvention Program, in 2005 (which gives non-reimbursable funds to companies), stimulated a more active participation of universities in innovation, sharing the costs and risks of entrepreneurship. Also, emphasis on entrepreneurship education shows concern with the creation of new businesses. There are dozens of disciplines (mostly in undergraduate or graduate courses in Business Administration and Engineering) and specific courses that prepare students for an alternative career besides being employees in large companies, and there is a current discussion about considering Entrepreneurship a specific area of knowledge.

However, there are few articles that address the phenomenon of spin-offs in Brazilian universities. Araújo et al. (2005) highlight their important role for technological, economic and social development of a country and for the universities. Costa and Torkomian (2008) present the profile of academic spin-offs in a study that involved 33 companies created in nine universities; Gomes and Salerno (2010) approach the specificities of the development of the first products of an academic spin-off, and suggest a particular model. Luz, Kovaleski, Andrade, and Betim (2010) present a case study of five spin-offs originated from Ponta Grossa State University and incubated at INTECPONTA. Ipiranga, Freitas, and Paiva (2010) address the qualification of the university for academic entrepreneurship and for cooperation with companies and government, focusing on the Technological Development Park of the Federal University of Ceará.

Renault, Fonseca, Cunha, and Carvalho (2011) analyze the process of creation and development of four technology-based companies created by faculty and graduate students of Engineering at Federal University of Rio de Janeiro [UFRJ]. Borges and Fillion (2012) studied the evolution of the entrepreneurial social capital during the process of creating a university spin-off, through eight case studies.

Garcia, Araújo, Mascarini, Silva, and Ascúa (2012) conducted a survey with 530 college students, to identify the main factors that stimulate business creation. Santos and Teixeira (2012) studied the process of creating spin-offs at the Federal University of Sergipe, based on an European model, in

three companies located at Sergipe Incubator Center. Testa and Luciano (2012) analyze the success factors of Zero-Defect company, a spin-off for software testing, set up in 2004 at RAIAR, the incubator of the Catholic University of Rio Grande do Sul [PUC-RS]. Andrade (2012) shows how the registration of patents stimulated the entrepreneurial behavior of Northeastern public universities, for commercially exploiting academic knowledge.

Bernardes, Varela, Consoni, and Sacramento (2013) investigated the trajectory of two biotechnology firms – Alellyx and CanaVialis – created under the Genome Project, financed by the State of São Paulo Foundation for Research Support [FAPESP]. Days and Porto (2014) studied the University of São Paulo [USP] Innovation Agency, which is the university’s NIT, interviewing directors and professionals. They found that the main mechanisms of technology transfer are patent licensing, collaborative research projects with companies, and the creation of spin-offs.

Incubators for technology-based firms

Incubators provide a suitable environment for housing micro and small enterprises, especially technology-based ones. They offer facilities, support services, knowledge of the market, knowledge of technologies and their legal aspects, and access of funding sources, aiming to leverage existing resources and foster synergy among the companies.

According to the National Association of Organizations for the Promotion of Innovative Ventures [ANPROTEC], an incubator offers support to entrepreneurs, for the development of innovative ideas and their transformation into successful companies. To do this, it offers infrastructure, qualification and management support, in order to reduce their mortality rate. Today there are different types of incubators in Brazil: technological, traditional, mixed, cultural, social, agro-industrial and service incubators.

PNI (MCTI, 2009) defines an incubator of technology-based companies as one that houses firms whose products, processes or services originate from applied research results, of which technology represents a high added value. The first technological incubators were established in Brazil in the 1980s – the first one in São Carlos. In the late 1990s there were more than 100, most of them in universities, others created by governments. However, in an assessment of the Brazilian experience, Medeiros and Atas (1994) found that about half of the incubators were “loose”, with little integration with R&D activities conducted in those institutions. Twenty years later, in 2014, a similar scenario persisted, and several incubators had been closed, after the withdrawal of public incentives and support instruments.

Plonski (1999) mentions the dissemination of different institutional spaces in the Brazilian environment, to encourage university–industry cooperation, such as business incubators and technology parks. If the incubators are created by universities, their intermediation role becomes more relevant if they house spin-offs created by faculty or students. Sbragia and Pereira (2004) emphasize the easier access to universities’ courses and laboratories, since entrepreneurs come from that environment and know scientists and professors.

Methodology

We used a qualitative approach, exploratory and descriptive. The eight university technology based incubators were selected through a mixed sampling – by convenience and intentional. Bibliographical and documentary research was also done, along with semi-structured interviews with incubators' managers.

Sampling by convenience (Mattar, 2005) allows the choice of the sample and data collection to meet the researcher's convenience (physical proximity, most accessible members of the population, ease of data collection, knowledge of the selected people, etc.). In intentional sampling the researcher assesses which members of the population hold a higher knowledge on the topic, and chooses those who may be good sources of information. For data collection, we used multiple sources. The sample included the Center for Innovation, Entrepreneurship and Technology [CIETEC], partner of USP and the Institute of Energy and Nuclear Research [IPEN]; the Incubator of COPPE at the Federal University of Rio de Janeiro [UFRJ]; INCAMP, the State University of Campinas [Unicamp] incubator; GENESIS Institute, the Catholic University of Rio de Janeiro [PUC-RJ] incubator. We conducted semi-structured in-depth interviews at these four incubators.

In the other four we got information by e-mail or by telephone interviews, besides getting data from websites and articles found in academic journals, about their experience with incubation. Those were the incubator of the Innovation Agency of Federal University of Paraná [UFPR]; RAIAR (the incubator of the Catholic University of Rio Grande do Sul [PUC-RS]; Technological Incubator of Santa Maria, at Federal University of Santa Maria [UFSM]; and INOVA, of the Federal University of Minas Gerais [UFMG]). We also accessed the ANPROTEC website, where 105 university technology-based incubators are listed. We did not consider incubators created by research institutes, technology parks, commercial or industrial associations, sectorial associations (software, textiles) or city governments, because our interest was to estimate the population of academic incubators.

The interview script covered some topics that formed categories of analysis for the discussion of results: requirements for entry; number of incubated companies; annual vacancies for new companies; number of graduated firms; patents; process and period of incubation; revenue and number of jobs created; exploration of research results at the university; incubator's advertising activities; percentage of companies created by university members.

Results

Table 2 presents data on the eight incubators of our sample.

1) CIETEC – Center for Innovation, Entrepreneurship and Technology

CIETEC is a not-for-profit civil society, with administrative and financial autonomy, responsible for managing the São Paulo Technology-Based Companies Incubator, whose

partners are USP and the Nuclear Energy Research Institute [IPEN]. It is the largest incubator of Latin America, and requirements for firms are the business plan and potential to interact with the activities developed by CIETEC partners. It does not demand a formal link of the candidate firms with the university.

The process starts with a pre-selection, after the candidates send a business plan. Those pre-selected take part in a 40-h workshop, and afterwards they have a month to improve and resubmit the proposal of their business plans for the final selection.

CIETEC began its activities in 1998. Each year, around 25–30 companies enter the incubator. At the end of 2013, there were 109 associated firms (19 in pre-incubation, 54 incubated and 36 in post-incubation), which made R\$ 53 million and kept about 890 skilled jobs. The total number of incubated companies in CIETEC until 2013 was 421, compared to 991 that participated in the various announcements, and 123 companies were graduated. The incubation period varies with the sector – IT companies generally leave faster. The survival rate is 70% after the first three years. By 2013, 119 patents were filed by the companies, and 34 had been conceded. Around 200 projects were supported by government programs such as the Innovation Program in Small Companies [PIPE], funded by FAPESP, “Researcher in Company”, by federal agency CNPq, and Economic Subvention, by federal agency FINEP, exceeding R\$ 112 million.

However, only one third of the companies were created by USP students, alumni or faculty, or by IPEN or IPT (Institute for Technological Research, a former partner) scientists. Some candidates, despite being former students, brought projects with no links to ongoing or recent academic research.

2) Enterprise incubator of COPPE/UFRJ (Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering)

The incubator started small, in 1994, with space for only eight companies. It grew, and today up to 30 ventures can be located. The original objective was to encourage companies' generation based on technological knowledge developed at UFRJ research groups.

Announcements are public. Prerequisites for entry are a high degree of innovation and economic feasibility of the products or services to be offered, which should promote a modernization impact on the economy, besides the potential interaction with research activities conducted in the university, in other research institutes located on campus (CENPES, CEPTEL, IPEN), and with other companies settled in the Technology Park. This link is a selection criterion of the edict. According to the incubator's manager, “we do not require a formal relationship with the university, but it is necessary to have a cooperation project (current or previous). The incubation period lasts three years, extendable for one more, and the average stay lasts around 42 months”. As of the third year, the incubated company starts to pay 1% of its net revenues, for a period equivalent to the total time spent there.

Candidate/vacancy ratio is high. A pre-proposal must be submitted, followed by a pre-selection phase, when about

Table 2
Data Summary of incubators – categories of analysis.

	Entry requirements	Number of incubated firms; places available per year; number of graduated firms; patents	Incubation process; period of incubation	Revenue; number of employees; number of jobs created	Search of university results	Incubator advertising at the university	% of firms created by university members
CIETEC	Business plan and potential to interact with USP and IPEN; candidates are not required to be USP members	421 (1998–2013), out of 991 registered; 25 a 30/year; 123 graduated; 119 patents	Pre-selection, 40-h workshop, improvement of BP, final selection; Not defined	At the end of 2013, 109 incubated firms made R\$ 53M, and had 890 qualified jobs	No	Yes, through lectures	33%, from USP, IPEN and IPT
COPPE (UFRJ)	High degree of innovation; potential to interact with research conducted at UFRJ, CENPES, CETEM, CEPTEL and IEN. Formal link with UFRJ is not required	67 (up to June 2013) 5 per year; 48 graduated	Pre-selection, 40-hour workshop, improvement of BP, final selection; 3 years, extendable for one more (average 42 months)	In 2012, 1.148 qualified jobs (218 Masters and PhDs), revenue of R\$ 220M	Joint work of incubator and UFRJ Innovation Agency	Lectures and competition of ideas	Around 80%
GENESIS (PUC-RJ)	Assessment of entrepreneurial profile; only projects linked to PUC are accepted; external candidates must join an internal research group	68 (until the end of 2013); Around 5; 58 graduated;	Pre-selection and 6 hours of consulting for the BP; From 6 months to 3 years	Most are IT companies; around 90% of these in Computer Science generate spin-offs; 50 of them make R\$ 1.5 billion/year	Yes	Yes, by incubator itself and by the Coordination of Entrepreneurship Teaching	Over 90%
INCAMP (Unicamp)	Does not require that project originates from Unicamp, but must have potential to interact with R&D groups. Accepts research results from institutes and other universities in the region	In 10 years, 43 have graduated; 5–6 vacancies/year;	12-month pre-incubation (Inova Semeia); Up to 36-month incubation (Inova Cultiva). BP is not required, but considers candidate profile and resumé.	N.I.	Yes. This is one of the reasons to join INCAMP to Innovation Agency INOVA	“Technological Coffee” events, guided tours; Unicamp Challenge of Technological Innovation	Over 90%
ITSM (UFESM)	Demands link with university; BP, resumé, social contract, letter from teacher that will guide technical part	From 2002 to 2012, 19 graduated; in 2013, 11 incubated and 7 pre-incubated; on average, 5 vacancies per year.	Selected firms are pre-incubated (6 to 12 months), and then incubated (up to 3 years)	N.I.	No	Yes	100%
INOVA (UFMG)	Not exclusive for UFMG members; innovation; market and technical feasibility; impact on economy; profile; resource attraction	Since 2003, 64 firms have graduated; 6–8 vacancies/year; 8 national patents, one international	N.I.	1500 jobs.	No	Yes	N.I.
RAIAR (PUC-RS)	Priority to internal candidates; Technical-economic feasibility; market differential; profile and qualification of proponents	From 2003 to July/2014, 60 graduated; In July/2014, 24 incubated; Entry of 7–8/year.	Helps pre-incubated firms in preparing BP; helps incubated firms in strategic planning and sales plan	N.I.	No	Yes	N.I.
Innovation Agency (UFPR)	Requires link with university; innovative projects/prototypes must be technology-based	Created in 2008; in Jan./2015, 7 were incubated and 3 had graduated; 1–3 vacancies/year	Up to 24 months	N.I.	Yes, as an Innovation Agency activity	Yes, given that the incubator is one of the 3 coordinations of the Innovation Agency	100%

BP, business plan; university member: student, ex-student, faculty, or employee; N.I., no information.

50 candidates are interviewed, of which 20 are chosen to participate in a 40-h entrepreneurial qualification course, to help prepare the business plan. Next, around 10 proposals are submitted to the incubator board, and five new companies are accepted each year. The focus is the project, with little concern about the entrepreneurial profile.

Until June 2013, 48 companies had graduated and 19 were residents. In July 2014, there were 26 resident companies, of which 21 belonged to UFRJ students or faculty. Almost all pertain to master and doctorate students, and new ventures result from dissertations. There is also a growing number of professors as partners. Skilled jobs created amount to 1148, of which 218 for Masters and PhDs. In 2012 this set of companies earned R\$ 220 million and COPPE/UFRJ was chosen by ANPROTEC as Incubator of the Year.

3) Gênesis Institute (PUC-RJ)

Created in 1997 to consolidate PUC-RJ as the first entrepreneurial university in Brazil, GENESIS was formally established in 2000 as an independent institute, a complementary unit of the university. The incubator was planned in 1992, with a Convergent Media Project (TV, movies, audiovisual), which was the university's area of competence. Afterwards it expanded to the cultural and social areas.

It is small (space for 20 companies), and only receives projects that have links with PUC. All enterprises have one student, former student, teacher or a professional affiliated to projects conducted at the university research laboratories as a partner. About 90% of the theses in Computer Science generate ventures. If an external candidate has a strong entrepreneurial profile, he or she is put in touch with researchers, or is encouraged to enroll in a Master program at PUC. The major concern of the institute is to prepare entrepreneurs, not projects, as these are seen as consequences. The focus is on the person, rather than the project.

The selection process is similar to other incubators: a pre-selection based on the application form and guidance to prepare the business plan. The second stage consists on the analysis of the partners' entrepreneurial profile and the business plan itself, regarding financial, marketing and technical aspects, and includes a presentation to a selection board. The chosen candidates can join the incubation or pre-incubation phases, in a process that can last from six months up to three years.

During its 17 years, GENESIS has generated 68 ventures. At the end of 2013 it showed 58 graduated companies, 10 residents and six in the pre-incubation phase (three residents and three virtual). The incubator also supported "satellite companies", which received funding from FINEP's PRIME program ("First Innovative Company"), and Creative Rio program, a total of 140 projects. Of these, about 50 are Information Technology companies that earn about R\$ 1.5 billion per year. In 75% of cases, the entrepreneur was a Master or PhD student. Although there is a share option for PUC in the contracts, it cannot legally exercise this option, and the solution was to create a corporation apart from the university: BRAIN Ventures – Brazilian Acceleration of Innovation.

PUC transfers its share to this company, which in turn makes a donation to the university.

More than 90% of the projects are related to research projects developed at the university. Some of the faculty have shares (a university document limits participation to less than 50%, and no management positions can be held).

4) Incubator for technology-based companies at Unicamp (Incamp)

Founded in 2001 and incorporated into Unicamp Innovation Agency (INOVA) in 2003, INCAMP is an environment that encourages the creation of technology-based companies through infrastructure provision and technological and managerial training for new entrepreneurs. The incubated companies benefit from the proximity of the university laboratories and researchers. It also accepts projects resulting from research carried out in the regions' different institutes, such as the Research Center Renato Archer (IT), the Food Technology Institute, the Campinas Agronomic Institute, and in other universities such as PUC-Campinas, Federal University of São Carlos [UFSCar] and USP campus at São Carlos.

There is a pre-incubation program – Inova Semeia (*Inova Sows*) – up to 12 months, which supports entrepreneurs in transforming ideas into new businesses. And Inova Cultiva (*Inova Cultivates*), the incubation program with a maximum duration of 36 months that supports the development phase, and is oriented to projects that have already generated firms, or are in the process of doing so. Although INCAMP does not require that candidates belong to the university, the 2014 edict emphasized the "potential for interaction with Unicamp in order to generate or strengthen R&D efforts". This criterion has a greater weight in the selection, and aims to focus on research results, not necessarily from the university.

In the selection process team there are people from the market and entrepreneurs, who assess the candidate's profile and his previous activities. A business plan is not required, because the challenge is to foster entrepreneurship. Despite Unicamp being a university with an entrepreneurial bias, and its innovation agency very efficient in the protection of knowledge, there is only room for nine companies in the incubator, which conflicts with its marketing efforts, such as free courses, disciplines, lectures with successful entrepreneurs, and "Technological Coffee" events. In 10 years only 43 companies have graduated, and on average, five to six companies are accepted each year.

In July 2014 there were 215 companies listed on the site, of which 172 (80%) with declared links with the university – one or more members are students, alumni, faculty or employees. Only 10 declared having no bonds, and the others did not mention the partners' name or their relationship with Unicamp. But according to the incubator's manager, the percentage of companies originated from the university is close to 100%. In December 2014, among 11 companies incubated at INCAMP, one belonged to a USP student, the others originated from Unicamp.

Few professors have an entrepreneurial activity (about 2%), even after the Innovation Act of 2004, which allows

them to take a leave of absence for up to three years (extendable for another three) for the purpose of creating spin-offs.

Another important event held since 2011 is the Unicamp Challenge of Technological Innovation, a competition whose aim is to stimulate the creation of technology-based businesses from university's protected technologies – patents and computer programs. It is oriented toward potential entrepreneurs, especially undergraduate or graduate students across the country. This is the main difference from other competitions that use business plans developed from entrepreneurs' own ideas (Toledo, Santos, Martelli, Lotufo, & Bonacelli, 2013). Patents and software are pre-selected by the INOVA team, based on their technological and market potential. From there on, the candidates can make their choice.

5) Federal University of Santa Maria Technological incubator (ITSM)

Established in 1999, ITSM is an extension project of the Technology Center of Federal University of Santa Maria (UFSM). The basic purposes of the incubator are to develop new entrepreneurs, to contribute to the economic and social development of the region, and to transfer technology through the pre-incubation of projects initiated in the university. The requirements are the business plan, the academic résumé of the candidates, a copy of the social contract, evidence of the link with UFSM of at least one partner (student or employee), the application form and the letter of consent of the teacher who will guide and monitor the technical part of the project. Selected companies are pre-incubated from six to 12 months, after which there is a maximum incubation period of three years. On average, five companies are accepted per year.

At the pre-incubation stage, courses and technical visits are offered. Following an assessment, the project may (or may not) continue toward incubation. Between 2002 and 2012, 19 companies have graduated, and in 2013 there were 11 incubated and seven pre-incubated. Half of the partners have a master degree, 10% are specialists, 30% are graduates and 10% are undergraduates (Silva et al., 2013).

6) INOVA/UFGM [Federal University of Minas Gerais]

INOVA/UFGM is a multidisciplinary technological incubator, established in 2003 after the merger of two incubation and entrepreneurship programs created by the initiative of university faculty. It supports projects in different areas of knowledge, and operates in an integrated way – business incubation, training of new entrepreneurs, and search of strategic partnerships. Each of these actions contributes to boost business creation, leading technology and innovation to the market.

The 2014 announcement invited entrepreneurs and researchers interested in developing innovative products, processes or services, for the choice of up to eight projects. The selection process was open to UFGM internal and external communities, and no links with the university were required. Also, the company did not need to be formally established by the time of the submission. However, the approved projects would have 30 days, from the publication

of the results, to create the company. Selection criteria included: development of products, processes or services with innovative technological content; technical and economic feasibility; commercial feasibility of the venture; work plan appropriate to the project's objectives; potential impact on the local or regional economy; candidates' managerial and technical capability; commitment and availability to develop the project; candidates' entrepreneurial profile; ability to generate or attract resources. Six companies were selected in 2014.

Data available on the website show 64 companies/projects supported since its inception, which represents an average entry of seven to eight companies per year. The firms filed eight national patents, one international and created 1500 jobs between 2001 and 2012.

7) RAIAR – Multi-sectorial technology-based and innovation Incubator of PUC-RS

Raiar was founded in 2003 to give support and conditions for the creation of sustainable innovative ventures, encouraging the entrepreneurial capacity of PUC-RS academic community. It accommodates technology-based emerging companies that result mainly from research projects. There are two units, in the cities of Porto Alegre and Viamão.

Other objectives include housing embryonic ventures (spin-offs) from established companies in the technology park TECNOPUC; encouraging the development of business networks; developing entrepreneurial skills in young businessmen; contributing to reduce the mortality rate of new businesses; stimulating the association between researchers and businessmen; and prospecting and capturing potential ventures, by promoting internal and external links with the university.

The target audience are undergraduate and graduate students and alumni; professors and researchers from PUC-RS; TECNOPUC companies; and external entrepreneurs. There are two forms of incubation – resident and associated companies – and both have access to the services offered by the incubator. The selection criteria for business plans are: priority for PUC students, alumni and faculty; technical and economic feasibility of the project; market differential and product or service competitiveness; qualification of proponents; entrepreneurial profile; and dedication to the project. The Support Service for Business Management (SAGE) helps pre-incubated companies to develop their business plans, and supports incubated firms in their strategic planning and sales plan. In July 2014, there were 24 incubated companies, and 60 had graduated, representing an average entry of seven to eight new companies per year. RAIAR was elected by ANPROTEC, in 2014, the best Brazilian incubator oriented to the generation and intensive use of technologies.

8) Business incubator of UFPR [Federal University of Paraná] Innovation Agency

Created in 2008 to register and protect the university's scientific production, UFPR Innovation Agency is the main instance for partnership with the productive sector.

The 2014 edict received proposals from undergraduate or graduate students, faculty, technical and administrative staff

and alumni, with technology-based projects or prototypes, functional and innovative, for business incubation as “resident” or “non-resident”. In either case, the maximum stay is 24 months. Resident companies are located beside a university laboratory, and must be approved by the responsible department. Non-residents may eventually use the Innovation Agency facilities to host meetings or other activities related to incubation. In that announcement, only one company was selected. In 2013, the Catalogue of Incubated Companies listed eight firms. In January 2015, three appeared as graduated and seven incubated. The average entry of new firms is low, one to three companies per year.

Results analysis and discussion

Information related to the researched incubators reveal their preference for projects from the academic community, or those that have the potential to interact with the university research activities, as is the case of CIETEC, COPPE and INCAMP – for the last two this is a selection criterion. RAIAR also gives priority to the internal origin of the candidates. At GENESIS, whose greater interest is the entrepreneur and not the project, if the person is not a student or ex-student, he/she will have to get a master degree from the university or prove some sort of relationship with a research group. ITSM and UFPR require links with the university, while INOVA/UFMG does not make any requirement in this sense.

Most of the incubators showed a clear preference for ventures that result from research, even if developed at other universities or research institutes, rather than an entrepreneur’s individual project. At CIETEC, besides having few candidates from USP, where they have graduated or got a Master/PhD degree, some projects do not or would not have any links with a university lab. According to its manager, it would be desirable that the project resulted from research carried out at the institution, featuring a spin-off with all its potential for technology transfer (Kenney & Patton, 2011; Perkmann & Walsh, 2007). The results also show that the incubators of the sample have few vacancies for receiving companies (between three and 10). Exceptions are CIETEC, which can house up to 120 companies, and receives between 25 and 30 new companies per year, and COPPE, with 30 places. Considering that each company remains, in general, for 36 months, this results in a small number of graduated firms. Hence, efforts to attract academic audience (through lectures, events, or classes on Entrepreneurship) are blocked by the low capacity to receive new interested companies.

Many Brazilian universities are increasingly showing features that match the definition of “entrepreneurial universities” (Etzkowitz, 2008; Mowery et al., 2001), expanding their traditional scope. However, among the four pillars mentioned by Etzkowitz (2008), the entrepreneurial “ethos” is still fragile in Brazilian universities, given their public origin, financed by the state, and most of them focused on teaching, research and extension activities, the latter generally meaning welfare work. Entrepreneurship is an important alternative source for generating qualified jobs in technology-based companies; and the formation of entrepreneurs has motivated countless

courses, disciplines, lectures in universities, for both internal and external audiences. Brazilian universities have intensified the creation of spin-offs, as mentioned in the papers of the literature review, following a worldwide movement (Siegel et al., 2007; Kenney & Patton, 2011). And therein lies the important role of university incubators.

According to ANPROTEC, there are 105 university incubators in Brazil. Most of them are open to any undertaking that meets the requirements for entry, such as technical and economic feasibility, market differential and product/service competitiveness, qualification of proponents, and entrepreneurial profile. Very few prioritize or serve exclusively internal members, such as students, alumni, faculty or employees, to encourage the use of technologies developed in their laboratories. On the other hand, focusing only on projects that result from academic research may deepen university’s isolation, adding another floor to the “Ivory Tower”.

Although currently most university incubators have limited space for receiving new companies, if there were restrictions toward projects generated outside the universities, there would be unfilled vacancies, especially in the larger ones. Interviews showed that efforts to attract students and alumni have not been sufficient to fulfill all available places.

These incubators give preference to new ventures arising from research carried out at the university or with potential to interact with research in progress, but not exclusively. COPPE and INCAMP have succeeded in attracting this audience because they have few vacancies. However, CIETEC would have great difficulty in attracting 120 projects resulting from research conducted exclusively at USP. However, there are other 175 incubators (not all technology-based) created by state research institutes, technology parks, private foundations, business associations (FIESP, SENAI) and city governments throughout the country that can receive entrepreneurs whose businesses do not the result from academic research.

The Unicamp Challenge of Technological Innovation (Toledo et al., 2013) can be seen as a relevant initiative, by transferring technologies and protected computer programs developed in university laboratories to companies. It is a way to engage young entrepreneurs, and meets the spin-off definition of Djokovic and Souitaris (2008).

Concluding remarks

This article aimed to analyze the performance of technology-based university incubators on the attraction of spin-off companies created by university members. According to the literature, this is one of the two main ways to transfer knowledge and technology from universities, the other being patent licensing to established companies.

Brazilian universities and research institutes are more attentive to technology protection, according to the latest report “Intellectual Property Policy of Scientific and Technological Institutions in Brazil” (MCTI, 2013) – data were sent by 193 organizations. However, to date, some federal universities have not yet implemented NITs, a requirement of the 2004 Innovation Act. There was a record of 1769 applications for intellectual

property protection in 2012, particularly of computer programs. The financial values of technology transfer agreements show significant increase over previous years, but the implementation and consolidation of the NITs are still considered as challenges.

At the 14th Conference on Technological Innovation, promoted by the National Association for Research and Development of Innovative Companies [ANPEI] in April 2014, several sessions devoted to technology-based entrepreneurship acknowledged progress in this direction, despite recognizing universities' poor entrepreneurial qualification. Venture capitalists pointed out the acquisition of small technology-based firms by large companies as a demonstration of their importance in strengthening university–industry relations.

University incubators are achieving their objectives, in the sense of supporting the creation and growth of technology-based companies; but they have not emphasized the transfer of results of academic research through spin-offs. The entry of companies foreign to the university is not harmful, because the diversity of origins increases contributions. However, there is a passive attitude toward the attraction of ventures that result from academic research, failing to seize an important channel for technology transfer (Plonski, 1999).

Our suggestion is that they focus on three actions, together with the universities. The first would be to increase the supply of courses and disciplines on Entrepreneurship, because entrepreneurs lack managerial and financial attributes, which is a strong barrier for the development of consistent business plans. The second action is a stronger effort to transfer academic research results, with incubators working together with NITs, which are responsible for patenting technologies generated in universities. A more proactive attitude regarding faculty and students, both undergraduate and graduate, could identify research results and conclusion papers, dissertations and theses with a high probability of application, thus creating an entrepreneurial culture and valuing technology transfer from the university.

And the third action would be to expand incubators' capacity, allowing them to receive more companies. Most of them have little room for incubation – between five and 10 ventures per year, with the exception of CIETEC, which can house 30 companies. Incubators that harbor few companies serve more as showcases for the university than as agents to foster academic entrepreneurship.

With an intentional sample of eight major university incubators, this study shows that they put more effort in the promotion of entrepreneurship itself and in their own performance as incubators than in the transfer of academic research results to spin-off companies. They still lack the vision of academic spin-offs as a relevant channel to transfer technologies developed in a public environment to the market. In the absence of this channel, these technologies will have no commercial use.

Conflict of interest

The authors declare no conflicts of interest.

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