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Profile of academic entrepreneurship in Brazil: Evidence from the evaluation of former holders of undergraduate research, master and PhD scholarships

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Profile of academic entrepreneurship in Brazil

Evidence from the evaluation of former holders of undergraduate research, master and PhD scholarships

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Abstract

Purpose – This paper aims to understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs.

Design/methodology/approach – The authors collected data from a more comprehensive research, whose objective was to evaluate the scholarship programmes of São Paulo Research Foundation (FAPESP). For data collection, the authors used an online questionnaire, pre-filled with information from the Lattes Curriculum of the sample individuals, as well as information obtained from FAPESP and from coordination for the improvement of higher education personnel. The response rate of the questionnaires was 21 per cent. The authors sought to explore the variables regarding entrepreneurial activities carried out by former scholarship holders, by relating them to other key variables identified in the literature review and explained in the hypotheses.

Findings – The results indicate that entrepreneurship rates decrease with the higher academic level of the researcher; in general, academic entrepreneurs come from families with a good financial situation, and applied sciences are the areas of knowledge with more entrepreneurs.

Originality/value – Despite the great number of theoretical and empirical studies found in the literature on entrepreneurship and academic entrepreneurship, there is still a shortage of practical studies on this latter topic in Brazil. This gap is even more evident when the authors consider the significant growth of entrepreneurial activity in the country in the past years. This paper contributes to fill this gap, and it aims to

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understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs.

Keywords University, Spin-offs, Academic entrepreneurship, Entrepreneurial profile, Entrepreneurial activity, Technological entrepreneurship

Paper type Research paper

1. Introduction

Entrepreneurial activity is one of the world's main drivers of economic, technological and social change (Bygrave, 2009; Volkmann *et al.*, 2010). Entrepreneurship positively affects the economy through the development of technological innovations, creation of new companies and markets, generation of new short and long-term employment opportunities and encouragement of firms' competitiveness (Kritikos, 2014). Several authors have demonstrated the special relevance of small technology-based companies for innovation and job creation (Guerrero *et al.*, 2015; Sánchez and Maldonado, 2015).

Nowadays, entrepreneurship is also one of the main channels for carrying out universities' socioeconomic support functions – or what is commonly known as their third mission (Costa and Torkomian, 2005). According to Etzkowitz (1998), entrepreneurship in universities and research institutes is not an unprecedented phenomenon. Entrepreneurial initiatives have been growing since the 1970s, when researchers in the biomedical sector began to seek ways to capitalize on their research by founding or associating with private companies, thus characterizing an entrepreneurial branch that Stuart and Ding (2006) called academic entrepreneurship.

Despite the great number of theoretical and empirical studies found in the literature on entrepreneurship and academic entrepreneurship, there is still a shortage of practical studies on this latter topic in Brazil. This gap is even more evident when we consider the significant growth of entrepreneurial activity in the country – from 2002 to 2016 the number of entrepreneurs grew 15 per cent, reaching 36 per cent of the population between 18 and 64 years old [Global Entrepreneurship Monitor (GEM), 2017].

This paper contributes to fill the gap and aims to understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs. To do this, we compared the profile of the academic entrepreneur found in the study – former scholarship holders of undergraduate, master and PhD research – with the profile described in the literature, through the analysis of factors that affect their decision to start a business.

The research question that guided the paper was:

RQ. How personal factors and professional trajectory affect academic entrepreneurship carried out by former undergraduate, master and PhD scholarship holders in the state of São Paulo, Brazil?

The article also contributes with inputs for the elaboration of policies and strategies by the government, universities and research institutes, to encourage academic entrepreneurship, aiming to achieve positive impacts on technological, economic and social development.

To attain its goal, we organized the article in six sections, including this introduction. Section 2 presents the literature review, which highlights the concepts and determinants of academic entrepreneurship to support the hypotheses. Section 3 describes the methodology, considering the broader context where data were collected. Section 4 displays the results, followed by their discussion in Section 5. Section 6 presents some final remarks.

2. Concepts and key factors of academic entrepreneurship

The original concept of entrepreneurship is attributed to economists Cantillon (1755) and Say (1821). Since then, several authors have expanded the discussion on what is entrepreneurship and who is the entrepreneur (Austin *et al.*, 2006; Druilhe and Garnsey, 2004; Gartner, 2008). In general, the authors in this area choose two different streams:

(1) entrepreneurship linked to value creation through innovation, not necessarily involving the creation of companies (Filion, 2004; Hisrich, 1990; Schumpeter, 1934); and

(2) entrepreneurship that takes advantage of business opportunities for creating companies (Cole, 1968; Vesper, 1982; Gartner, 1989; Lumpkin and Dess, 1996; Bygrave, 2009), whether innovative or not. We adopted this second perspective in this article, applied to academic entrepreneurship.

Academic entrepreneurship, in turn, regards entrepreneurial activities carried out by researchers, based on intellectual capital acquired or developed in universities or research institutes, within each researcher's educational field (Franzoni and Lissoni, 2006).

In addition to the creation of technology-based companies, commonly referred as spin-offs (Smilor *et al.*, 1990; Jones-Evans, 1995; Oakey, 2003; Pirnay *et al.*, 2003; Brennan *et al.*, 2005; Freitas *et al.*, 2011; Cantaragiu, 2012), the concept of academic entrepreneurship can also include knowledge trading activities (Gibbons and Wittrock, 1985; Louis *et al.*, 1989); technology transfer activities, such as patents and licensing (Birley, 2002; Nicolaou and Birley, 2003); and activities of social value creation (not-for-profit actions, such as developments and services to needy communities).

Although we recognize the importance and validity of academic entrepreneurship categories, this research emphasizes the idea of companies' creation, understood as the practice of transferring to society the knowledge derived from research carried out in universities or research institutes (the parent organizations) by their members or former members, such as teachers, researchers, employees, undergraduate or graduate students (Costa and Torkomian, 2005).

We chose this delimitation because the available data refer to the creation of companies by former students who received scholarships to carry out undergraduate, master and PhD research. We further explain this point in the Methodology section. In addition, this definition facilitates the comparison of findings in different circumstances and countries, since the other categories of academic entrepreneurship may be subject to local definitions and cultural interpretations (Cantaragiu, 2012).

There are many drivers of academic entrepreneurship, as well as many authors who have studied this topic, among them Carayannis *et al.* (1998), Louis *et al.* (1989); Moore (1986), Filho Pedrosi (2012); Radosevich (1995), Roberts and Malonet (1996); Shane and Stuart (2002); and Steffensen *et al.* (2000).

Based on these studies, we divided the determinants of academic entrepreneurial activity into three major groups. These are environmental factors, related to the macro-environment of the researcher's home institution (Etzkowitz, 1998; Llano, 2010; Louis *et al.*, 1989), organizational factors, related to the features of the researcher's institution or group (Clark, 1998; Roberts, 1991; Roberts and Malonet, 1996; Kenney, 1988; Mathieu *et al.*, 2008; Lockett and Wright, 2005; Siegel *et al.*, 2007; Louis *et al.*, 1989; Moore, 1986), and personal determinants, related to the attributes of the academic entrepreneur, such as psychological features and professional experience (Clarysse *et al.*, 2011; Haeussler and Colyvas, 2011; Louis *et al.*, 1989; McClelland, 1967).

Among the personal factors, some authors analyze entrepreneurs' motivational factors or psychological traits that influence the creation of companies (Brockhaus, 1982; Dubini, 1989; Roberts, 1991), such as wish for autonomy (McQueen and Wallmark, 1985; Roberts and Wainer, 1971), creativity (Filion, 2004; Moore, 1986), loss or dissatisfaction with the job (Dubini, 1989; Moore, 1986; Wadhwa *et al.*, 2009), among others. In a research with Brazilian university students, Garcia *et al.* (2013) and Ferreira *et al.* (2017) address these points by highlighting the search for income and the possibility of putting their ideas into practice as the more relevant motivational factors, besides self-fulfillment and social reasons.

Others analyze the influence of human and social capital on academic entrepreneurship (Aldridge and Audretsch, 2011; Davidsson and Honig, 2003; De Clerq and Arenius, 2003). There are also those who examine more objective attributes of entrepreneurs, such as age (Van De Ven *et al.*, 1984), gender (Clarysse *et al.*, 2011; Haeussler and Colyvas, 2011), professional experience (Wadhwa *et al.*, 2009), academic education area (Haeussler and Colyvas, 2011) and level of education [Wadhwa *et al.*, 2009, Global Entrepreneurship Monitor (GEM), 2017].

Clarysse *et al.* (2011), using a panel of university scholars from the UK universities, studied the determinants of spin-offs' creation by professors and researchers, and concluded that personal determinants, especially previous experience with entrepreneurship, are the most important factors for the creation of such companies. However, Aldridge and Audretsch (2011), through interviews with scientists of the US National Cancer Institute, highlight that social factors (measured by the scientist's relationship with the private sector) are more relevant than environmental and personal factors in a scientist's decision to become an entrepreneur.

Although there are theoretical and empirical studies on the determinants of academic entrepreneurship, there is no consensus on what is the specific set of factors that drive a scientist to become an entrepreneur. This paper contributes to this understanding in a particular context, based on objective personal attributes, such as socioeconomic profile (measured by family income), level of education, professional experience, gender and area of study. From a literature review on the influence of these factors on academic and nonacademic entrepreneurship, we developed the guiding hypotheses of the research.

As to family income, Wadhwa *et al.* (2009) used a sample of 549 American entrepreneurs and observed that the majority came from middle-class (71 per cent) or upper middle-class (22 per cent) families. Some authors do not relate this fact to the financial capital but rather to the opportunity for a higher income to create human and social capital for such individuals (De Clerq and Arenius, 2003; Jayawarna *et al.*, 2014).

This issue is linked to recent conclusions about the motivations for entrepreneurial activities being generally focused on the search for opportunities rather than the satisfaction of needs (GEM, 2017). Although this is a general trend, data from this same study show important differences between countries. In Brazil, for example, there is a balance between the two types of motivations.

It is worth noting that while there are studies about the influence of socioeconomic status on entrepreneurial profile, as mentioned above, we found no references on the relationship between this fact and academic entrepreneurship.

Therefore, the first research hypothesis is based on the general discussion of entrepreneurship:

H1. Researchers that come from higher-income families (above nine minimum wages) are more likely to become academic entrepreneurs than those from lower-income families.

Wadhwa *et al.* (2009) also showed that 75 per cent of the individuals in the entrepreneurs' sample had previously worked for other companies for more than six years, before creating their own firms. Sieger *et al.* (2011), who carried out a study with 695 entrepreneurs from 30 countries, also mention the importance of prior participation in the labor market. According to their research, 58 per cent of entrepreneurs had previously worked as employees, and 33 per cent considered a previous employment experience as the main factor of success for the entrepreneurial activity.

Jones-Evans (1992, 1995) identified four types of academic entrepreneurs, based on their previous work experience and highlighted that such experience, either purely academic or purely productive and commercial, strongly affects the participation of individuals in the activities of business creation. Shane and Khurana (2003) also found a positive relationship between professional experience and the likelihood of an invention being commercialized through start-up companies. This study was based on MIT patents filed in the USA between 1980 and 1996. According to the authors, professional experience affects knowledge about the issues that an entrepreneur will face. Another finding of this relationship comes from the paper by Mosey and Wright (2007), which highlights the importance of academic entrepreneurs' previous experience with their own companies, for building their networks of relationships.

Given the convergent view on the importance of previous work experience for academic entrepreneurship, we suggest the following hypothesis:

H2. Researchers who work during their undergraduate studies are more likely to become academic entrepreneurs than those who did not work during this period.

For Sieger *et al.* (2011), the second factor of success in entrepreneurial activity, after a previous work experience (33 per cent), is higher education (30 per cent). Research by Wadhwa *et al.* (2009) on the profile of companies' founders – mainly North American and technology-intensive firms – strengthens this issue, as 95 per cent of the entrepreneurs had at least a college degree, and 47 per cent had graduate studies' degrees.

These results are distinct from those by De Clerq and Arenius (2003), who conducted a study based on data from the 2002 Global Entrepreneurship Monitor survey with 4,536 individuals that lived in Belgium and Finland. They analyzed the influence of human capital (in terms of educational level) on start-ups, and concluded that the likelihood of becoming an entrepreneur is inversely proportional to the level of qualification (considering formal education). That is, the probability of someone with a university degree creating a company is lower than that of a person with a high-school certificate. However, they found a positive relationship between education and the individual's perception of his entrepreneurial abilities, which, in turn, positively affects the creation of firms.

Louis *et al.* (1989) speculate on the existence of a relationship between a researcher's age and advanced types of academic entrepreneurship. For them, more experienced scholars are likely to engage, for example, in consulting activities due to their reputation and visibility achieved during their academic life, as well as in initiatives to get research funding and patent filing. However, such experience showed a negative relationship with the creation of companies and equity stake.

A more recent study by Abreu and Grinevich (2013) draws similar conclusions, and it found in a large sample of British scholars that senior researchers are more likely to engage in informal commercial activities (such as consulting or research projects) than those with shorter career time, although there is no relationship between seniority and the creation of companies. Goethner *et al.* (2012), in turn, studied German scientists and went beyond the

level of seniority, by concluding that the achievement of a PhD degree has no influence on their intentions toward academic entrepreneurship.

Haeussler and Colyvas (2011) reached different conclusions in their study with a sample of 4,621 German and British biologist researchers, who published or patented between 2002 and 2005. They concluded that academic experience, revealed, among other facts, by the higher number of publications, positively affects the commitment to industry and the use of entrepreneurial opportunities. Aldridge and Audretsch (2011) arrived at the same conclusion by examining scientists who had received funding from the National Cancer Institute (USA).

Based on the non-consensual findings of the literature, we suggest the following hypothesis:

H3. The higher the researchers' level of qualification (understood as formal education – Graduation, Master and PhD), the higher the probability of becoming academic entrepreneurs.

An analysis of the overall profile of entrepreneurs from GEM (2017) data indicates that, globally, women are less prone to become entrepreneurs than men. Nevertheless, there are significant differences between countries and cases in which this ratio, measured by entrepreneurship rates at the initial stage, is equal, as in Brazil and Mexico.

De Clerq and Arenius (2003) also examined the effect of gender on enterprise creation. Although the probability of men engaging in entrepreneurial activities was higher in their sample, the difference in relation to women was not significant.

However, most of the studies point out that, as occurs in general entrepreneurship, male's participation in academic entrepreneurship is more significant than female's. According to Abreu and Grinevich (2013), Clarysse *et al.* (2011); Haeussler and Colyvas (2011); and Klofsten and Jones-Evans (2000), male researchers are more likely to engage in this type of entrepreneurship when compared to women. Clarysse *et al.* (2011), through a scholars' panel from the UK universities, concluded that women have 40 to 50 per cent less chance to start a company than their male colleagues.

Haeussler and Colyvas (2011) present similar results as those by Clarysse *et al.* (2011) but with a less obvious difference. In their study, male researchers have a slightly higher tendency to register patents (8 per cent higher) and create firms (4 per cent higher). However, the study observes that in the case of consulting, women show equal levels of entrepreneurship. This is because this activity requires smaller investments, a lower level of engagement and time availability, suggesting that these variables impose structural restrictions on women.

Rosa and Dawson (2006) also studied gender influence in academic entrepreneurship. They analyzed 20 of the UK's leading universities, concluding that the percentage of female entrepreneurs was low (12 per cent) when compared to male researchers. For them, the small share of women that create companies is related to their under representation in scientific research, as well as to the fact that few women occupy senior positions in research (where the interest for products' commercialization is generally higher). Klofsten and Jones-Evans (2000) also argue that gender difference in academic entrepreneurship may be a reflection of the current structure of academic careers, dominated by men.

Based on this aspect, we suggest the fourth hypothesis of the research:

H4. Male researchers are more likely to become academic entrepreneurs than female researchers.

Another determinant of academic entrepreneurship is the knowledge area, as highlighted in the paper by Kenney and Richard Goe (2004). In this regard, Louis *et al.* (1989) used two

surveys conducted in 1985 with a sample of healthcare scientists and managers from 50 of the most relevant research universities in the USA. They found no evidence that healthcare scholars are more prone to entrepreneurial activities than to other academic activities.

Haeussler and Colyvas (2011) also discuss the influence of the knowledge area on academic entrepreneurship. They stratified the large biological sciences area into four subareas: basic area, clinical area, engineering area and others. The research results suggest that active researchers in the clinical area (clinical medicine, oncology and pharmaceutical sciences) and in engineering (bioinformatics and bioprocess engineering) are more involved in commercial activities than the others, and they are more prone to entrepreneurship.

More comprehensively, the study by Goethner *et al.* (2012) goes in the same direction, by concluding that scientists involved with applied research are more inclined to entrepreneurship than those that deal with basic research. Abreu and Grinevich (2013) strengthen this aspect by reckoning that scholars in biological sciences, engineering and physics are more prone to licensing and spin-off activities than in other areas. Hence, we propose the fifth and final research hypothesis:

H5. Researchers in the areas of biological sciences and engineering are more likely to become academic entrepreneurs as compared to those in other areas.

3. Methodology

We collected data for this study from a more comprehensive research, whose objective was to evaluate the scholarship programs for Undergraduate research (IC), Master (MS) and PhD (DR) of São Paulo Research Foundation (FAPESP). The study was carried out between 2010 and 2012, and it used a quasi-experimental design, where the treatment group was composed by individuals who had requested IC, MS and DR scholarships to FAPESP between 1995 and 2009, had their submissions approved and finished their projects by the end of 2009. On the other hand, the control group gathered individuals who had their applications denied by FAPESP, but they received grants from other funding agencies such as the National Council for Scientific and Technological Development and the Coordination for the Improvement of Higher Education Personnel (CAPES). Hence, the assessment focused on the effect of peer review – the model used by FAPESP – for the selection of fellows, compared to the quota model adopted by the other agencies.

For data collection, we used an online questionnaire, pre-filled with information from the Lattes Curriculum of the sample individuals, as well as information obtained from FAPESP (database with information from applicants and submitted projects and their status – denied, approved in progress or approved completed) and from CAPES (database of graduate students in Brazil). The questionnaire had information on the following: the socioeconomic profile of former scholarship holders; their academic trajectory throughout graduation and, where appropriate, graduate studies; their professional career; and their scientific and technological production, coordination, participation in projects and supervision of dissertations.

The questionnaire was available on the internet from February to March 2012, through a link sent to sample individuals by e-mail. We sent 57,490 e-mails, of which 39,765 successfully reached the recipients. Failure to reach the whole sample was due to outdated electronic addresses in FAPESP and CAPES databases. The response rate of the questionnaires that reached the recipients and were satisfactorily filled out was 21 per cent, that is, 8,682 questionnaires, which is representative of the research universe.

We sought to explore the variables regarding entrepreneurial activities carried out by former scholarship holders, by relating them to other key variables identified in the literature review and explained in the hypotheses.

To identify entrepreneurial activity, we started with a question about the individual being a founding partner of an enterprise or employing organization for which he had declared an employment relationship (whether the link had occurred shortly after graduation or at the moment of data collection). To determine if we could consider such entrepreneurial activity as academic, we used the answer to the question about the creation of the company or organization being related to some stage of his/her academic education. Figure 1 shows the chain that allowed classifying respondents into non-entrepreneurs, academic entrepreneurs (in which there is a relationship between education and entrepreneurship) and nonacademic entrepreneurs (where there is no relationship). The Appendix presents the research tool used to collect data.

The analysis of questionnaires shows that among the 8,682 satisfactorily filled out, there were 3,336 complete answers on the involvement with entrepreneurial activities (based on the question "Were you one of the founding partners of this company/employer organization?"). From this number, 115 individuals gave positive responses. Since three of them did not answer about the relationship between entrepreneurial activity and their academic trajectory, we removed them from the sample of entrepreneurs (see Table I).

Table II, in turn, shows the stages of the academic path to which entrepreneurial activity relates, in the case of academic entrepreneurs. It shows a balanced distribution of academic levels.

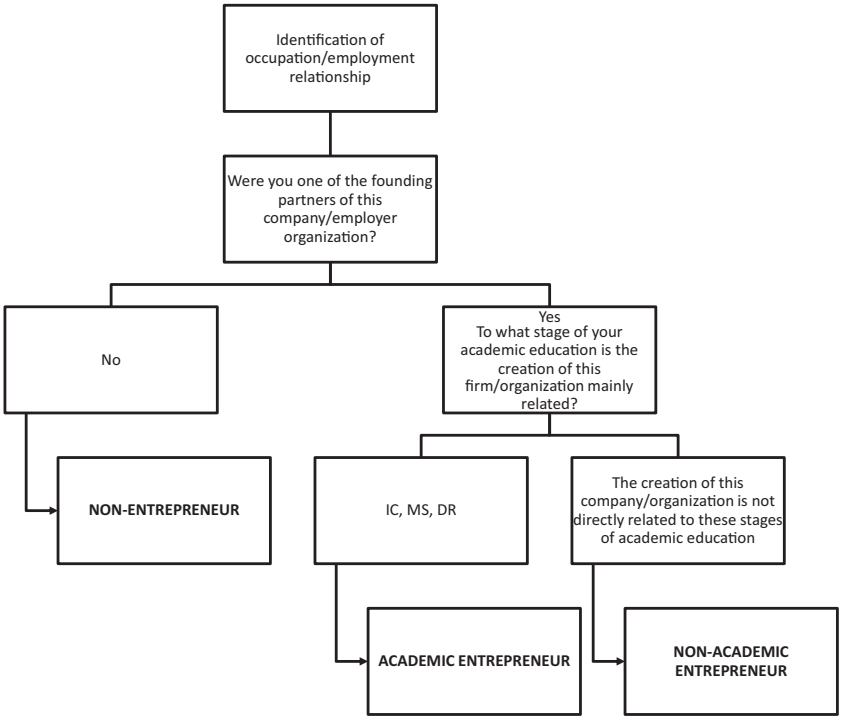


Figure 1. Linkage of questions to identify entrepreneurial activities

These are the other variables used in the study: monthly family income at the beginning of the former scholarship holder's academic career (measured in number of minimum wages), work during graduation (since, as former scholarship holders, respondents should not have employment links during master and PhD studies), maximum level of education (graduation, master or PhD), gender and knowledge area. Sections 4 and 5 present and discuss the relationships between these variables and the categories used in the research.

Statistical analysis comprised crossed tables or graphical representations of these tables, of the "entrepreneurial activity" variable with those that answer the hypotheses, through absolute and percentage frequencies. We used Pearson's chi-square test to check the association between crossed variables, and we considered p-value < 5 per cent (0.05) for rejecting the null hypothesis, where there is no association. The low frequency of entrepreneurial activity categories, as shown in Table I, did not enable multivariate analyses or multiple crossings.

4. Results

After completing the sample's general characterization, this section presents the results from the online questionnaire, organized according to the research hypotheses. All the analyses considered the frequencies for each of the three categories identified: non-entrepreneurs, academic entrepreneurs and nonacademic entrepreneurs.

To test *H1*, related to the "income" factor, we analyzed the distribution of monthly family income (in minimum wages – SM) of the researchers, when they began their academic trajectory, that is, at the time they started graduation (Figure 2).

Regarding family income, results show that the profile of academic and nonacademic entrepreneurs and of non-entrepreneurs, prior to entrepreneurial activity, is similar, as in all cases, there are mainly individuals whose monthly family income at the beginning of graduation was higher than nine minimum wages.

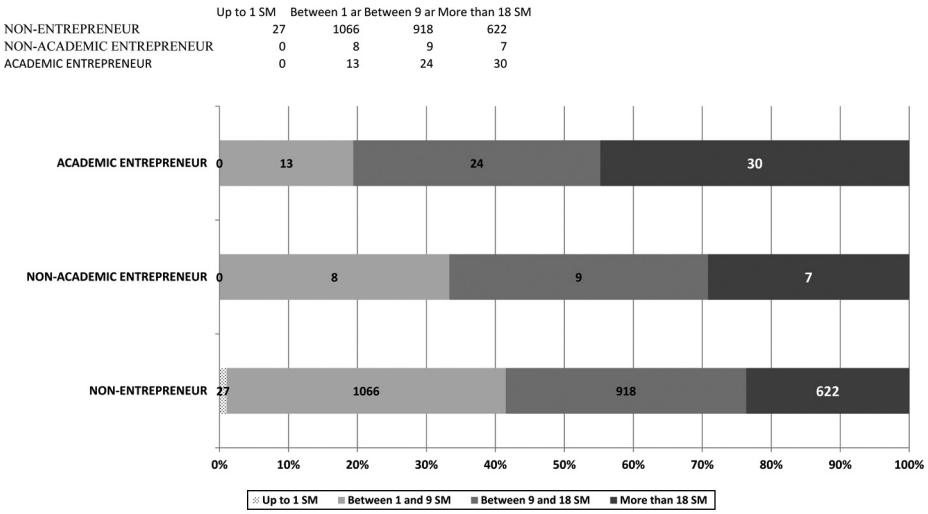
Despite the similar pattern and specificity of the sample, there is an important difference when comparing entrepreneurs with non-entrepreneurs and even when comparing academic entrepreneurs with nonacademic (difference of 14 per cent in the latter case), with p-value = 0.02 (chi-square = 20.9; 6 degrees of freedom). Thus, *H1* was confirmed, since researchers originating from families with higher income were more entrepreneurial than those with lower-income levels.

Table I. Sample distribution by entrepreneurship category

Entrepreneurship category	Frequency	(%)
Non-entrepreneur	3,221	96.6
Academic entrepreneur	82	2.5
Nonacademic entrepreneur	30	0.9
Total	3,333	100

Table II. Academic stages of the category "academic entrepreneur"

Academic stage	Frequency	(%)
IC	31	38
MS	23	28
DR	28	34
Total	82	100



Note: p-value < 0.05

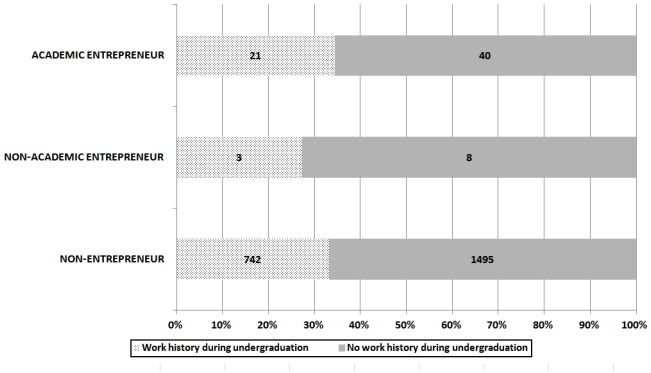
Figure 2. Monthly family income at the beginning of academic path, by category

To check *H2*, related to previous work experience, we examined the work history of former scholarship holders during undergraduation (Figure 3).

Figure 3 shows a similar pattern between the different profiles of former grantees. This situation contradicts the profile described in the literature, where previous work experience indicates a propensity for entrepreneurship. Thus, from the sample data *H2* was rejected ($p = 0.9$; chi-square = 0.21; 2 degrees of freedom).

To test *H3*, on the influence of the level of academic education, we checked the maximum level achieved by former scholarship holders (Table III)

Table III shows that the rate of academic entrepreneurship is higher at the graduation level, and PhDs are less entrepreneurial (p-value = 0.07; chi-square = 14.2; 4 degrees of



Note: p-value = 0.9

Figure 3. Work history during undergraduation, by category

freedom). Hence, *H3* was rejected. However, when considering entrepreneurship in general, there is an increase in entrepreneurial activity according to the level of education.

Table IV displays the sample profile for the variable "gender" to test *H4*.

Regarding the sample's general profile, 56 per cent of the former grantees are females. This same percentage applies to non-entrepreneurs, while for nonacademic entrepreneurs the proportion is 77 per cent. However, for academic entrepreneurs, the relationship reverses, with 48 per cent of former female grantees and 52 per cent of men, showing a higher balance. With p-value = 0.02 (chi-square = 7.6; 2 degrees of freedom), *H4* can be accepted.

To test *H5*, we used data from the knowledge area of the former beneficiaries for each entrepreneur category. Table V shows education areas in which entrepreneurship rates are higher: Biological Sciences (21 per cent of academic entrepreneurs and 18 per cent of nonacademic entrepreneurs) and Engineering (19 per cent of academic entrepreneurs and 5 per cent of nonacademic). Together, they represent 40 per cent of academic entrepreneurs. An aggregate analysis shows that Applied Sciences (including Engineering, Applied Social Sciences, Agricultural Sciences and Health Sciences) represent a majority (54 per cent) among academic entrepreneurs.

From these data, we can confirm the final hypothesis. It is worth mentioning that the profile of nonacademic entrepreneurs is quite different when we consider the distribution by knowledge areas, since the highlights in this case are former scholarship holders from the areas of Biological Sciences and Human Sciences. The p-value for this table was less than 0.0001, but should be interpreted with care, given the large dimension of the table (chi-square = 952.6; 27 degrees of freedom).

5. Discussion

This research had the purpose of studying personal determinants that affect academic entrepreneurship. We carried out bibliographical and documentary research and an online

Table III. Maximum level of academic education by category

Academic education	Academic entrepreneur Freq.	(%)	Nonacademic entrepreneur Freq.	(%)	Non-entrepreneur Freq.	(%)	Total Freq.	(%)
Graduation	24	4.56	4	0.76	498	94.68	526	100
Master	25	2.51	12	1.20	959	96.29	996	100
PhD	33	1.82	14	0.77	1,762	97.40	1,809	100

Note: $p = 0.07$

Table IV. Gender by category

Gender	Academic entrepreneur Freq.	(%)	Nonacademic entrepreneur Freq.	(%)	Non-entrepreneur Freq.	(%)	Total Freq.	(%)
Women	39	48	23	77	1,812	56	1,874	56
Men	43	52	7	23	1,412	44	1,462	44

Note: $p < 0.05$

Education area	Academic Entrepreneur Freq.	(%)	Nonacademic entrepreneur Freq.	(%)	Non-entrepreneur Freq.	(%)	Total Freq.
Biological Sciences	15	21	4	18	374	17	393
Engineering	14	19	1	5	255	11	270
Applied Social Sciences	9	12	0	0	154	7	163
Agricultural Sciences	9	12	2	9	224	10	235
Exact and Earth Sciences	8	11	1	5	342	15	351
Health Sciences	8	11	2	9	321	14	331
Human Sciences	4	5	3	14	345	15	352
Linguistics, Literature and Arts	4	5	2	9	147	7	153
Multidisciplinary	2	3	2	9	54	2	58
Information unavailable	0	0	5	23	11	0	16
Total	73	100	22	100	2,227	100	2,322

Table V. Education areas by category

survey with former scholarship holders for undergraduate, master and PhD research who requested support from FAPESP.

The first result to highlight (Table I) is the small number of entrepreneurs among former scholarship holders (3.4 per cent), which shows a lack of connection between researchers' qualification and the creation of companies. The majority of Brazilian researchers – especially PhDs have links with teaching and research institutions and a little involvement with companies, which reflects the low intensity of research and development activity in these organizations in the country, according to the Center for Management and Strategic Studies in Science, Technology and Innovation [Centro de Gestão e Estudos Estratégicos (CGEE), 2016]. As explained in the final section, this finding should be the focus of attention of Brazilian public policies.

Regarding the attributes examined, Table VI shows the behavior of the three profiles of former scholarship holders, and a fourth profile that does not distinguish between academic and nonacademic entrepreneurs. They are quite similar in all features, with differences for academic entrepreneurs in terms of gender and area of study.

The explanation for the profiles' similarity relates to the research universe itself. Mostly composed by former students from public research universities, it regards a part of the population that is financially privileged. Because of the low number of vacancies in public

Attributes of former scholarship holders	Academic entrepreneur	Nonacademic entrepreneur	Academic and nonacademic entrepreneur	Non-Entrepreneur
Most researchers come from families with higher income	Yes	Yes	Yes	Yes
Most researchers worked during graduation	No	No	No	No
Most researchers are PhDs	Yes	Yes	Yes	Yes
Most researchers are of the male gender	Yes	No	No	No
Most researchers come from the Applied Sciences area	Yes	No	No	No

Table VI. Analysis of the determinants for each profile of former scholarship holders

institutions, the country's income concentration and the approval system for entering Brazilian universities, higher education in the country is elitist (Pinto, 2004). According to IBGE data (Góes and Duque, 2016), 46 per cent of the students in Brazilian public universities in 2013 came from families with an average monthly income above seven minimum wages.

As shown by Cardoso and Sampaio (1994), in a study with a sample of 2,226 students from higher education institutions in the state of São Paulo, there is a mismatch regarding the factor "labor", when comparing public and private universities, since 33.3 per cent of the students in public universities work, against 63.7 per cent of those in private universities. The explanation for this heterogeneity is the difference in profile of students of private and public higher education institutions in Brazil, according to the previous argument.

Therefore, we worked with a universe and a sample that comprised individuals from families of middle and upper classes, for whom the need to work during undergraduation was not significant.

There is also a prevalence of PhDs in the sample, much more related to methodological procedures than to the nature of the research universe. The response rate of the questionnaires was strongly influenced by the ease of access to former scholarship holders and by their interest in taking part in a FAPESP evaluation study. Considering the higher involvement of PhDs in the academic environment, this was the group most interested in answering the survey, and whose access channels were updated.

Table VII summarizes the information on the personal determinants of entrepreneurship described in the literature, compared to our findings and based on the hypotheses tests.

As discussed earlier, literature in the field is rather fragmented, because it deals with different personal determinants of academic entrepreneurship in cases or small groups of individuals, focusing, for example, on specific countries or regions or even on particular institutions. This prevents the creation of a single set of determinants and the generalization of results. This fact may be related to entrepreneur's own multifaceted attribute: there is no single type of entrepreneur (Fillion, 2004), and by analogy, there would not be a single type of academic entrepreneur. It is worth mentioning that there are still relevant gaps in the studies on academic entrepreneurship, especially the influence of family income. This article tries to assist this debate, although in a specific context of former scholarship holders of undergraduate, master and PhD research in the state of São Paulo, Brazil. We must consider that the environmental attributes of entrepreneurship, namely, the structures of Brazilian higher education system (marked by elitization) and Brazilian innovation system (low R&D activity in companies) affect the results.

With regard to family income, study results are compatible with the literature, which indicates that this factor positively affects the propensity for entrepreneurship. However, we must consider, according to previous discussion, that the whole sample of former beneficiaries has a similar income profile.

However, although a higher level of academic entrepreneurship of former grantees with higher family incomes may relate to greater access to family's financial resources, some authors observe that the main benefit associated with family income is the social capital. That is, the access to a network of partners, potential customers and business investors (Edelman *et al.*, 2016).

In the discussion about previous work experience, once again, the similar income profile of former grantees helps to explain why few of them worked during graduation. However, since it is not a significant element for our sample, it has little effect on the propensity for entrepreneurship.

Determinants	Literature	Hypothesis	Field research	Test result
Family income	In general, entrepreneurs come from middle- or upper middle-class families	*H1* – Researchers from higher-income families are more prone to become academic entrepreneurs than those from lower-income families	Academic and nonacademic entrepreneurs come from middle or upper classes	Confirmed
Professional experience during college	Work experience is one of the factors that explain the involvement with entrepreneurial activity	*H2* – Researchers who work during their undergraduate studies are more likely to become academic entrepreneurs than those who did not work during this period	It is not possible to state that professional experience during college has affected entrepreneurial activity	Rejected
Academic education	Higher education is a determining factor of entrepreneurial activity, but in the case of academic entrepreneurship, there is no consensus in the literature. More experienced scholars have a higher tendency to become involved with entrepreneurial activities but not necessarily with the creation of firms	*H3* –The higher the researchers' level of qualification, the higher the probability of becoming academic entrepreneurs	Academic entrepreneurship is higher at undergraduate level, and PhDs are little entrepreneurial	Rejected
Gender	There is a higher participation of men, both in general entrepreneurship and in academic entrepreneurship	*H4* – Male researchers are more likely to become academic entrepreneurs than female researchers	The difference between male and female participation in academic entrepreneurship is small, with a slight advantage for men	Confirmed
Area of study	There is evidence that researchers in applied areas, such as Engineering, are more prone to entrepreneurship	*H5* – Researchers from Biological sciences and Engineering are more prone to become academic entrepreneurs than researchers from other areas	The majority of academic entrepreneurs are former scholarship holders in Applied Sciences	Confirmed

Table VII. Comparison of literature with research findings on personal determinants

With regard to the level of education, we observed that the rate of academic entrepreneurship is higher at the undergraduate level, and PhDs are less entrepreneurial. This finding confirms the proposition by Louis *et al.* (1989) that the entrepreneurial initiative of creating companies has a negative relationship with academic activity, measured by the number of publications.

One possible explanation for this behavior is the global trend for PhDs to seek professional positions in their own universities, based on teaching and research (Bin *et al.*, 2015). This situation is not only the reflection of a tradition in PhD s education – largely centered on the self-reproduction of the academic model – but the lack of opportunities to work in sectors other than education, especially in developing countries and the lack of encouragement for entrepreneurship (both in terms of public policies and the way PhD education takes place). In Brazil, a recent report by CGEE (2016) on PhDs' trajectory proves this model.

However, when we consider entrepreneurship in general, the situation is a bit different. University graduates and PhDs are similarly involved in entrepreneurial activities but with less emphasis than masters.

Regarding gender, our findings partially confirm the literature, because in the case of academic entrepreneurship, men have a slight advantage, but among nonacademic entrepreneurs the number of women is higher (77 per cent). We must also consider the contextual element, since among research scholarship grants in Brazil, especially for graduate studies, men are the largest beneficiaries (Artes, 2013).

One factor that may have influenced these numbers concerns the greater difficulty of women to follow an academic career because of time and effort devoted to the family (Jacobs and Winslow, 2004; Probert, 2005; Winslow, 2010). Faced with difficulties at the university and with professional placement, some of these women may be starting their own businesses, whether or not related to the research they developed. This hypothesis should be explored in future studies.

Finally, data on entrepreneurial activity and knowledge areas confirm the literature, with the Applied Sciences area standing out in both academic and general entrepreneurship. This is an important result, considering that former scholarship holders have a fairly equal distribution among knowledge areas, except for Applied Social Sciences and Linguistics, Literature and Arts, where numbers are lower.

6. Final remarks

The purpose of this article was to contribute to the understanding of the profile of entrepreneurial researchers in the Brazilian academic context, with focus on the state of São Paulo. It contributes to the development of the topic of academic entrepreneurship in the country, both from the conceptual and empirical points of view, based on the presentation and discussion of data on the entrepreneurial activity of a sample of former scholarship holders of undergraduate, master and PhD research.

From research results, we can conclude that the researcher's family income, level of education, gender and knowledge area are factors associated (to a greater or lesser degree) with academic entrepreneurship. That is, higher family income, lower levels of education, male gender and more applied areas of knowledge shape the profile of the academic entrepreneur. On the other hand, a previous work experience during graduation does not have a direct relationship with entrepreneurial activity.

These conclusions find support in the literature on academic entrepreneurship, as well as in the profile of undergraduate and graduate students of public universities in the state of São Paulo, who comprise the majority of those that apply for FAPESP undergraduate,

master and PhD scholarships. As already mentioned, there is evidence that public higher education in Brazil is elitist; the upper social class drives its resources to careers of higher economic returns, and research scholarships' grantees are mostly men.

In addition, results also find support in the configuration of the National Innovation System in Brazil, especially marked by higher R&D investments from the public sector – mainly in universities and research institutes – compared to private investments. The low level of entrepreneurship (academic and nonacademic) of the research sample is surely a reflection of this configuration.

It is worth mentioning some limitations of the study. The first and most evident is the sample cutting, as data refer to the group of individuals who requested a scholarship to FAPESP under the categories undergraduate, master and PhD, which was granted or denied. It is a group with special attributes, mostly made up of students from public universities in the state of São Paulo, with academic performance and supervisors' profile compatible with the Foundation's criteria.

The second important limitation concerns the set of explored variables, since, as discussed in the literature review, the determinants of academic entrepreneurship are often classified into three groups (environmental, organizational and personal determinants). By the nature of the research that originated this article, we favored more objective personal determinants.

The third limitation concerns the concept of academic entrepreneurship used in the study. Although the focus was the creation of start-up firms, literature describes a much broader scope for the concept – although there is no convergence on such boundaries yet.

Hence, although the paper brings important conclusions, we expect that future studies related to entrepreneurial activities of former undergraduate, master and PhD students will be conducted with a wider universe of individuals, addressing other determinants and including new types of academic entrepreneurship to get a broader understanding of this phenomenon.

On the paper developments in terms of policies and strategies, we can highlight three points. The first concerns the need for greater encouragement to academic entrepreneurship in Brazil, especially for masters and PhDs, whose main recipient today is the education sector. This reflects the lack of opportunities in other economic sectors because of limited investments in research, development and innovation in the country but also to PhD education, focused on self-reproduction. This means that in Brazil masters and PhDs have few employment opportunities outside the academy, and that graduate courses do little toward an entrepreneurial qualification that supports these students, so that they can identify business opportunities from the results of their research. Therefore, it is urgent to rethink master and PhD education, as has been discussed globally (Gould, 2015; Thiry *et al.*, 2015) and also locally (Schwartzman and Balbachevsky, 2014), with emphasis on new possibilities of action, including the entrepreneurial activity.

FAPESP's own experience with the Small Business Innovative Research Program (PIPE) is a path in this direction, as it stimulates the association between academic researchers and companies for the development of research projects, aiming at technological innovation (Salles-Filho *et al.*, 2011). Initiatives for the creation of an industrial academic PhD, still recent in Brazil, also strengthen such changes.

The second issue, still less explored, refers to the creation of incentives for entrepreneurship in Basic sciences. Although we expect more entrepreneurial activity from former students of Applied sciences, it is necessary to rethink how to create alternative paths and careers for graduates from other areas.

We can highlight a third implication of the research, although of a more comprehensive nature than the others, and with an indirect relationship with the discussion developed in the article. This is the problem of the elitization of access to higher education in Brazil, which is naturally reflected in the profile of the local academic entrepreneur. We understand that the incentives previously mentioned and associated with the democratization of access to higher education may not only expand academic entrepreneurship in Brazil but also make family income less determinant for this type of activity.

Such political orientations could contribute to the dissemination of results from research developed in Brazil, so as not being restricted to the scientific community but also used by society and local industry. In addition, such guidelines can assist in establishing new possibilities of professional trajectories – including entrepreneurship – for graduates of higher education in Brazil. Therefore, we could expect positive impacts on the country's indicators of technological, economic and social development.

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Appendix

As presented in the methodology section, data used in this paper came from a more extensive research. This appendix shows part of the questionnaire used in that research, emphasizing the relevant questions for the discussion on entrepreneurship.

Topic 1 – stages of academic education

- First, write your name.
- Indicate how many undergraduate courses you have concluded in your academic path and/or if you are currently attending an undergraduate course.
- Indicate how many undergraduate researches you have concluded during the undergraduate course previously mentioned. consider as indication of conclusion the delivery and approval of the final report of the undergraduate research. undergraduate researches that were renewed to continue the initial research project must count only once.
- Identify the big area and the prevalent knowledge area of your undergraduate research.

- Indicate how many academic masters, PhDs and direct PhDs you have concluded in your academic trajectory. Consider as indication of conclusion the presentation and approval of the dissertation or thesis.
- Identify the big area and the prevalent knowledge area of your Master, PhD and direct PhD research.

Topic 2 – socioeconomic profile

- Write your gender.
- At the beginning of your academic trajectory, what was the monthly family income? Consider as family income the sum of your income with the income of the people who lived with you. Consider as the beginning of your academic trajectory the moment immediately before you begin to attend an undergraduate course.
- Did you work (or do you work) during undergraduation? Consider as a work situation the one in which you had (or have) a formal link with the company/employer organization and salary, including internships of different kinds.

Topic 3 – professional trajectory

- Did you have any occupation/employment link after the conclusion of your undergraduate course? Do not consider post-doctoral as occupation/employment link; only consider occupations/employment links where you stayed for at least one year; do not restrain yourself to links related to your academic and research path that you eventually developed afterwards.
- For the first and final occupation/employment links after the conclusion of your undergraduate course, mention the work regime or relationship (Civil servant; employee with signed work permit; employee without signed work permit; serviceman at the Army, Navy, Air Force, Military Police or Fire Department; self-employed/autonomous/consultant (private individual); employer/businessman; volunteer)
- Were you one of the founding partners of this firm/employer organization?
- To what stage of your academic education is the creation of this company/organization mainly related?

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