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Oscarina Conceição
Ana Paula Faria
Margarida Fontes

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Location of research-based spin-offs: how relevant are regional effects?

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Abstract

Using a unique self-collected dataset that comprehends the population of research-based spin-offs created in Portugal from 1995 until to 2007, we investigate the location choices of these firms. In order to do so we control for both university- and region-related mechanisms. Our results suggest that the latter play a lesser role than university-related mechanisms. Although the availability of qualified human capital and urbanization economies seem to exert some effect on the location choices of research-based spin-offs, our results suggest that the quality and prestige of the universities located in a region, as well as the presence of university-affiliated incubators and/or university research parks have a stronger impact on the intensity of RBSO location across regions.

Keywords: academic spin-offs; firm creation; location decision; count data analysis

Oscarina Conceição
DINÂMIA-CET, University Institute of Lisbon, Lisbon, Portugal & Polytechnic Institute of Cavado and Ave, Barcelos, Portugal.

Corresponding author: Oscarina Conceição. E-mail: oconceicao@ipca.pt

Ana Paula Faria
NIPE Research Unit & Department of Economics, University of Minho, Braga, Portugal

Margarida Fontes
LNEG – National Laboratory of Energy and Geology. Lisbon, Portugal & DINÂMIA-CET, University Institute of Lisbon, Lisbon, Portugal

I. INTRODUCTION

Over recent years special attention has been given to the role played by the set-up of new firms that take to the market technology and knowledge generated by public research institutions, the so-called academic or research-based spin-offs (henceforth RBSOs) (Rothaermel et al., 2007; Bathelt et al., 2010). RBSO are of particular interest because they combine the traditional problems associated with the start-up of a new business with the difficulties associated with the development and commercialization of new technologies (Vohora et al, 2004).

In the process of RBSO creation, access to key resources is crucial, namely technical knowledge, specialized human capital, and physical assets, such as R&D laboratories, (Knockaert et al., 2010; Mustar et al., 2006; Wright et al., 2012). Hence, the access to these resources becomes decisive in the location of the new firm. The literature emphasizes that, in the particular case of RBSOs, location choice depends on the assessment of traditional regional mechanisms, i.e., if a region provides these resources; but it also depends on the existence of university level support mechanisms. In fact the resources made available by universities can be complementary or even substitutes for resources at local level, in particular, access to academic incubators, venture funds and specialized human capital through their students and graduates (Fini et al., 2011).

For these reasons the role of the parent institution can be critical to the set-up the new firm. In fact, several studies mention that RBSOs tend to be clustered around the parent institution, as a firm strategy to access knowledge spillovers, to benefit from other cost advantages and to be better able to mobilize their social capital (Asterbo and Bazzazian, 2011; Egeln et al., 2004; Heblich and Slavtchev, 2013; Shane, 2004).

Understanding the mechanisms that foster the entry of RBSOs may be important to both research institutions and local policy makers. However, despite a growing number of studies aiming to explain academic entrepreneurship across different institutions, there still is limited evidence regarding the role played by geographic effects on the location and clustering of these firms. As such, this paper aims at empirically assessing the importance of local resources and characteristics in determining the intensity of RBSOs firms in a given region. The paper is in line with research conducted by Egeln et al. (2004), Buenstorf and Geissler (2011) and Heblich and Slavtchev (2013) but adds to it in three important

ways. First, we employ a richer data set that allows us to employ panel-data analysis, hence to deal with unobserved heterogeneity across regions. Second, our data allow us to investigate the role of regional effects by employing proxies for localization and urbanization economies, while controlling for the parent characteristics.

Finally, we contribute to the literature by extending the empirical research, that has so far focused exclusively on the case of Germany, to a significantly different context: Portugal, a small, peripheral country, that is also a small, open economy. These features may lead regional aspects to play a different role, as compared to Germany, which is a large country and large economy.

II. RESEARCH-BASED SPIN-OFFS LOCATION CHOICES

2.1 University-specific mechanisms

It has been observed that the number and characteristics of the universities in a region leads to an increase in the number of spin-offs, highlighting the role of universities as anchors of regional development (Audretsch and Feldman, 2004; Casper, 2013). Empirical evidence has shown that RBSOs tend to be clustered around the parent institution (Asterbo and Bazzazian, 2011; Egeln et al., 2004; Shane, 2004). Various contributions have sought to understand which mechanisms might explain this clustering. One is the access to knowledge spillovers. In particular, the spatial proximity to the university facilitates research collaboration and favors the flow of tacit knowledge (Audretsch and Stephan, 1996; Druilhe and Garnsey, 2003).

In addition, being in the vicinity of a university provides important cost advantages. By keeping a formal relation with their parent university, spin-offs can minimize investment in fixed capital as they can make use of the parent's infrastructures. Also, by staying in the parent region, it will be easier for the spin-off founders to mobilize their social capital, which can be crucial for a new firm (Fontes, 2005; Heblich and Slavtchev, 2013; Lejpras and Stephan, 2011)

Previous research has also offered consistent evidence on the positive effect on spin-off formation of parent-specific characteristics such as reputation, area of research and university's policies toward technology transfer. Di Gregorio and Shane (2003) demonstrate a positive relation between spin-off creation and intellectual eminence/faculty quality, in the case of US universities. According to van Looy et al. (2011) the academics

from top universities may have easier access to resources for spin-off creation due to reputation effects. Colombo et al. (2010) found that the quality of university research influences RBSO's growth potential.

Considering the disciplinary area of research, a strong scientific and engineering base, with an orientation on life sciences, computer science and chemistry, can have a positive impact on the number of spinoff companies generated by a university (O´Shea et al. 2005). According to Audrestch et al. (2004) location is more important in the natural sciences, reflecting the specialized nature of scientific knowledge.

Finally, the literature emphasizes that university policies toward technology transfer are decisive to increase the creation of new firms (Di Gregorio and Shane, 2003; Friedman and Silberman, 2003; Lockett and Wright, 2005; O´Shea et al., 2005). Among these, the setting-up of infrastructures such as incubators and science parks, have been found to be particularly relevant. In fact, the business development capabilities of incubators make it possible to support spin-offs in the early stages, both in terms of opportunity recognition and in defining the suitable business model, thus minimizing the frequent lack of business competences of academic entrepreneurs (Heirman and Clarysse, 2004; Lockett and Wright, 2005; Mustar et al., 2006). This incubation supports spin-offs development, not only in terms of strategic management and business orientation and of access to knowledge necessary for completing the development of technologies or products, but also in what concerns access to physical facilities, particularly laboratories and administrative staff (Colombo and Delmastro, 2002; Lofsten and Lindelof, 2005; Wright et al., 2007).

In view of this evidence, we argue that the universities' characteristics matter to the intensity of RBSO creation in a given region and we advance the following hypotheses:

H1a: *RBSOs are more likely to be created if located in a region with a high number of universities;*

H1b: *RBSOs are more likely to be created if located in a region with high-quality/prestige universities;*

H1c: *RBSOs are more likely to be created if located in a region with universities that have a strong science and engineering disciplinary base;*

H1d: *RBSs are more likely to be created if located in a region with research parks and/or incubators.*

2.2 Region-specifc mechanisms

RBSOs must also assess the regional characteristics, i.e., the resources available in a given region. The joint consideration of the conditions found in the university and at regional level may lead to the RBSO decision of locating in a region distinct from its parent. This happens when the spin-off feels the need to engage in technological cooperation with other knowledge sources; and when it needs to access resources that are scarce in that region, such as highly qualified labor or supplier networks (Egeln et al. 2004).

One of the relevant regional factors in location decision of high-technology firms are the agglomeration or external economies, i.e. positive externalities resulting from co-location. In this sense, several studies show that different factors associated to regional characteristics are also crucial for the location of high-technology firms (Audretsch and Feldman, 2004; Baptista and Mendonça, 2010; Buenstorf and Geissler, 2011; Woodward et al., 2006). Thus, regional characteristics may assume a leading role in the location of RBSOs at the time of their creation.

However, it should be noted that not all of the observable clustering is necessarily the result of agglomeration economies (Buenstorf and Geissler, 2011). Instead it may be the result of heritage where new entrants predominantly locate close to their geographic 'roots' (Jaffe 1989; Salter and Martin 2001). Thus, entrepreneurs may decide to locate the spin-off in the region where they reside and where have built social networks that allow access to resources needed for creating the company (Casper, 2013; Sousa et al., 2011; Stam, 2010).

In seeking to understand the role of agglomeration economies one has to distinguish between externalities that arise from the co-location of producers active in the same industry (known as localization economies) and those that extend across industries (urbanization economies).

A high density of high-technology firms can attract new companies to that research intensive region, allowing them access knowledge spillovers (Armington and Acs, 2002; Friedman and Silberman, 2003; Lach and Schankerman, 2008). Urbanization economies are another feature of the region relevant in the choice of location. In fact, the larger the market the bigger its "power" to attract start-ups (Baptista and Mendonça, 2010). Thus, urban areas can be particularly favorable, given the high population density and the relative ease of access to customers (Buenstorf and Geissler, 2011; Stam, 2010). They are also more likely to offer the inputs required for the firm's operation: labor, capital, suppliers.

With regard to human capital, regions that have a high level of employees with higher educational levels are related to higher levels of start-up activity (Armington and Acs,

2002; Figueiredo et al., 2002). In the specific case of high-technology firms, access to specialized and qualified labor is an essential resource, so its existence directly influences location decisions (Audretsch et al., 2005; Piva et al., 2011¸ Kim et al., 2012; Woodward et al., 2006).

According to Figueiredo et al. (2002) the regional concentration of companies is also explained by the need of start-ups to be located in metropolitan areas and urban centers that are characterized by extensive resources, concentration of higher education institutions, technological research facilities and a wide range of market opportunities. Subsequent studies confirm that this proximity to urban centers is a crucial factor for the science-based firms (Baptista and Mendonça, 2010; van Geenhuizen, 2008; Woodward et al., 2006).

Therefore, considering that regional characteristics do matter with regard to the intensity of RBSO creation in a given region, we advance the following hypotheses:

H2a*: RBSOs are more likely to be created if located in a region with a high level of localization economies;*

H2b*: RBSOs are more likely to be created if located in a region with a high level of urbanization economies;*

H2c*: RBSOs are more likely to be created if located in a region with a high level of human capital available;*

H2d*: RBSOs are more likely to be created if located in a region near the major urban areas.*

III. DATA

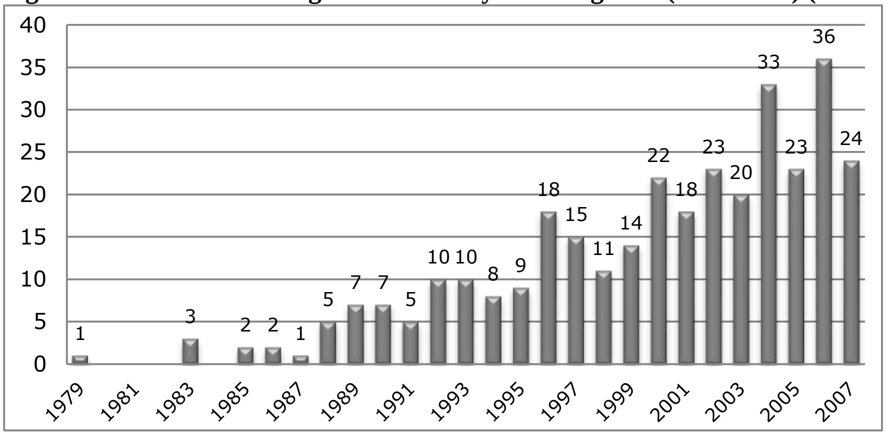
3.1 Data collection

This study uses the population of Portuguese RBSOs created between 1979 and 2007. For this purpose we considered firms created by people with some connection with a university or other research institution, such faculty members, researchers and graduates students, who are applying knowledge obtained or technology developed as part of their activity in that organization; and firms created by external entrepreneur based on the transfer of technology developed by the research institution. In order to identify this population we draw on information from publicly available sources and on data obtained from universities and/or its TTOs or incubators.

As a result of this search we ended-up identifying a total of 327 spin-off firms legally set up until the end of 2007. For all these firms, we collected information on the year of creation, location, sector of activity, number of employees at founding date and parent organization.[1]

The first Portuguese RBSO was created in 1979 (to the best of our knowledge), but the formation of spin-off firms from universities and other research organizations only became more frequent from the mid 1980's onwards (Figure 1). A closer analysis of the evolution of Portuguese RBSO creation over time shows that their numbers started to increase in the 1990s and continued to grow into the 2000s. Indeed, 39.45% of the firms identified were created between 1990 and 2000, and 54.13% after 2000.

Figure 1- Number of Portuguese RBSOs by founding date (1979-2007) (n=327)



Source: Own calculations.

This evolution follows the European trend and reflects the adoption, by several European countries (including Portugal), of regulatory frameworks to promote the entrepreneurial mission of universities (e.g. Claryssse et al., 2011; Matias and Fontes, 2013).

The vast majority of the RBSOs (78.9%) originate from the seven largest and most prestigious Portuguese public universities[2], or from research organizations associated to them. The remaining RBSOs originate from other public universities and public research laboratories, although there are also some private universities and a couple of polytechnic institutions among the parent organizations. This is in line with the literature; in fact the

[1] This data was obtained from firms' documents (anual reports and websites) complemented or validated, when necessary, through direct contacts.

[2]These seven universities represent the only Portuguese universities included in the Top 500 academic rating score of universities published in the *Webometrics Ranking of World Universities.*

spin-offs tend to originate from a small number of eminent universities (Di Gregorio and Shane, 2003; Rasmussen and Borch, 2010).

3.2 Location of Portuguese RBSOs

Portuguese RBSO firms tend to be located in the main cities or in their metropolitan areas. The Portuguese mainland is divided into eighteen districts[3] and 308 municipalities, but we only recorded RBSO creation in just 53 municipalities. Over the period observed only 27 spin-offs (8.26%) changed their starting location.

As can be seen in Figure 2, RBSOs were mostly concentrated in the largest cities of the coast. In fact, 52%, were located in the districts of Lisbon and Porto (30.28% and 21.71%, respectively) followed by Coimbra (15.29%), Braga (11.62%) and Aveiro (5.81%) (see also Table 1).

79% of RBSOs, i.e. 258 firms, were located less than 25 km from parent, which is in line with the clustering pattern of RBSOs. A similar pattern was reported by Shane (2004) and Asterbo and Bazzazian (2011).

Of these firms located less than 25 km from parent, 100 (i.e. 38.76%) were located in the parent's premises at the date of creation (0 km distance) and 77% of (i.e. 253 firms) were integrated in a university-affiliated incubator at the date of creation.

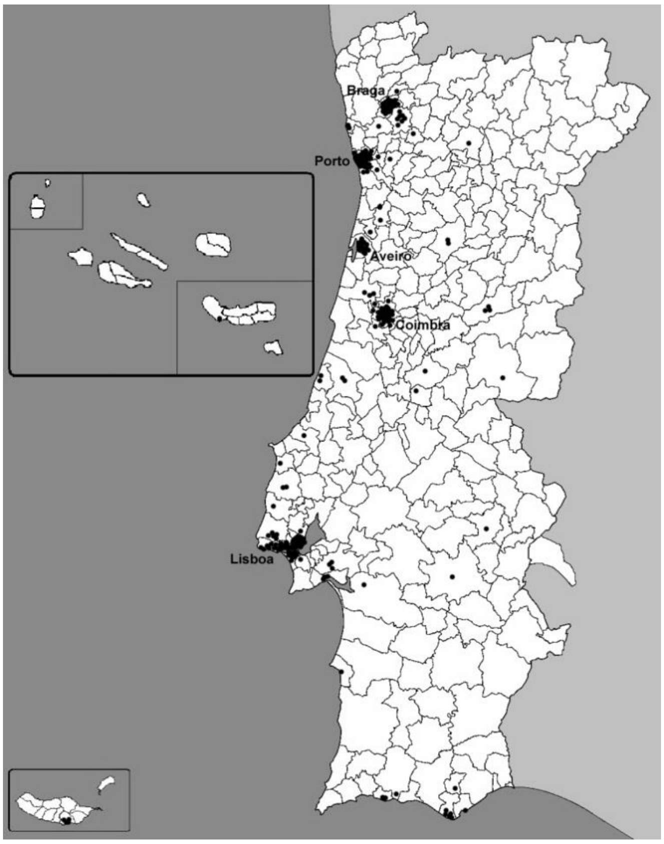
Table 1 – Distribution of Portuguese RBSO

Districts	*RBSO Number*	*RBSO Percentage*
Aveiro	19	05.81
Braga	38	11.62
Coimbra	50	15.29
Lisboa	99	30.28
Porto	71	21.71
Others[1]	50	15.29
Total	327	100

[1]*Others* relate to 8 Districts with less than 10 spin-offs firms. Source: Own calculations.

[3] District is an administrative region, which is composed by several adjacent municipalities (*concelhos*).

Figure 2 – Spatial distribution of Portuguese RBSO per municipalities (1979 – 2007)



Note: Each dot = 1 spin-off firm. Source: Own calculations.

IV. EMPIRICAL ANALYSIS

4.1 Data for the empirical model

For our analysis we will only consider the RBSO created in mainland Portugal between 1995 and 2007, in a total of 261 firms. This is due to data constraints regarding the universities, which is only available from 1994 onwards. It should be noted that RBSO creation in Portugal, as generally in Europe, occurred predominantly in the mid-nineties, (EC, 2003). This sample keeps the pattern of cluster location identified in the population; in fact 78.54% of the spin-offs created between 1995 and 2007 are located less than 25 km from the parent.

Each RBSO was assigned to a region – the Portuguese municipality where it was located. The information concerning the characteristics of the universities, and the characteristics of the region was also collected at the level of municipalities - our regional unit of analysis.

As we saw in section 3.2 and from Figure 2 Portuguese RBSOs are concentrated in just 53 regions. In fact, there are 255 regions where RBSO creation never occurred, over these 13 years. Since the object of this paper is to analyze the determinants of the intensity of creating RBSOs in a given location and considering the specifics of this event, we will restrict our analysis to the regions where the event under analysis actually took place.

Region-specific data were collected from the "*Quadros de Pessoal"* database, which results from information gathered yearly by the Portuguese Ministry of Social Security and Labor, for the period 1986 to 2009, on the basis of mandatory information submitted by firms. Data related to population density and the distances between regions were collected from the National Institute of Statistics (INE). Data on research organizations was collected from the Ministry of Science and Higher Education (MCTES) and from the *Webometrics Ranking of World Universities.*

4.2 Empirical model

Our aim is to investigate the intensity of spin-offs creation across regions, by focusing on the characteristics of the university and the region in which in the spin-off is located. Thus, our reduced form model is:

$$RBSO_{it} = f(U_{it}, R_{it}) \qquad (1)$$

where, $RBSO_{jt}$ denotes the entry of spin-off firms in region *I* at time period *t*, U_{it} is a vector of university characteristics, and R_{it} is a vector of region-specific characteristics that vary across region and time.

The dependent variable used is a count of the number of RBSO created in each year in each region. The preponderance of zeros, the small values and the discrete nature of the dependent variable (Table 2) suggest that we could improve the linear model with a specification that accounts for these characteristics (Cameron and Trivedi, 1998; Faria et al., 2003).

Table 2 - RBSO Creation: frequency distributions.

Count	0	1	2	3	4	5	6	7	Mean	Variance
Frequency	444	83	28	15	5	4	5	1	0.446	1.066

Relative frequency	0.759	0.142	0.048	0.026	0.009	0.007	0.009	0.002

Notes: N = 261firms; 585 municipality-year spells, i.e., 45 municipalities over 13 years.

In order to test our hypotheses we used as predictor variables the measures for universities' characteristics and regional characteristics. Descriptive statistics of empirical variables are presented in Table 3.

In order to control for university-level mechanisms that may determine the location choice of RBSOs we included in our regression the variables *Universities Number*, *Top Universities*, *Universities Tech* and *Incubators. Universities Number* is the number of private and public universities and polytechnics per region and aims to control for knowledge spillovers and other benefits associated with geographical proximity with the parent. *Top Universities* aims to control for university´s reputation and is measured by a dummy variable that equals 1 if there is at least one university located in the region among the Top 500 in the *Webometrics Ranking of World Universities, and zero otherwise. Universities Tech* controls for the university´s disciplinary research area and is measured by a dummy variable that equals 1 if there are, in the region, universities with a science and engineering disciplinary base. *Incubators* controls for the university´s policy towards spin-offs and is measured by a dummy variable that equals 1 if there are, in the region, infrastructures such as incubators and/or science parks, and zero otherwise.

Regarding the region-level mechanisms that may determine the location choice of RBSOs, we included the variable *Localization economies*, measured by the ratio of the number of firms in high-technology industries by the total number of firms per region, and the variable *Urbanization economies*, in which we followed Buenstorf and Geissler, (2011) and used as a proxy the logarithm of total population per square meter. Urban accessibility was measured by two variables: *Major urban accessibility*, i.e., access to largest markets, is the distance in kilometers (km) to the two major urban areas of Portugal (Lisbon and Porto), and *Minor urban accessibility*, i.e., access to regional markets, is the distance in km from each region to the corresponding district's administrative center. Regarding the availability of *Human capital,* we took into account the level of qualified human capital available in the region, measured by the ratio of the number of employees with high school education, or higher, to the total number of employees in the region.

As additional controls we included the covariate *Years* dummies to account for annual variations in spin-off activity and *Regional* dummies to control regional differences, namely dummies for the Districts (Lisbon, Porto and others) and for the NUTS 2 regions (North, Centre, Lisbon, Alentejo, Algarve).

Table 3 - Descriptive statistics of predictor variables.

Variable	%	Min	Max	Mean	S.D.
Universities Number		0	38	2.28	5.63
Top Universities	13.33				0.34
Universities Tech	53.33				0.50
Incubators	31.11				0.46
Localization economies		-6.93	-1.85	-4.51	2.22
Urbanization economies		2.20	8.91	5.90	1.50
Human capital (ln)		-5.04	-1.39	-2.84	0.60
Distance to administrative center		0	127	26.67	27.66
Distance to Porto		0	564	215.28	175.50
Distance to Lisboa		0	399	214.58	118.64

Notes: All variables are defined at regional level unless otherwise stated.

In Table 4 we present the correlation matrix. Correlation analysis indicates medium to low levels of correlations. The highest correlation was between the *Universities Number* and *Top Universities* (0.62), suggesting that multi-collinearity was absent.

Table 4 - Correlations for the dependent variable and predictor variables.

	1	2	3	4	5	6	7	8	9	10
RBSOs creation										
Universities Number	0.56***									
Top Universities	0.54***	0.62***								
Universities Tech	0.28***	.035***	0.37***							
Incubators	0.43***	0.38***	0.58***	0.53***						
Localization economies	0.05	0.04	0.07*	0.18***	0.07*					
Urbanization economies	0.35***	0.47***	0.38***	0.35***	0.22***	0.38***				
Human capital	0.41***	0.41***	0.36***	0.25***	0.35***	0.29***	0.39***			
Distance to administrative center	-0.25***	-0.27***	-0.28***	-0.37***	-0.33***	-0.30***	-0.33***	-0.39***		
Distance to Porto	-0.09**	-0.03	-0.15***	-0.23***	-0.08**	-0.20***	0.08**	-0.36***	0.21***	
Distance to Lisboa	-0.09**	-0.22***	-0.07	0.04	0.07*	0.03	-0.27***	0.02	-0.23***	-0.49***

Note: **, * means significant at 1% and 5% level, respectively.

4.3 Method

Given the discrete nature of our data, i.e., the number of spin-off firms created in a given region, we employed count data regression analysis.

The starting point for count data regression is the Poisson model (Hausman et al., 1984), where the univariate Poisson distribution for the number of occurrences of the event y over a fixed exposure period has the probability function

$$\Pr(Y = y) = \frac{e^{-\mu}\mu^{y})}{y\,!}, \qquad y = 0, 1, 2, ... \tag{2}$$

where μ is the shape parameter which indicates the average number of events in the given time interval. The Poisson distribution assumes that the mean and the variance of the process are equal

$$E(Y) = Var\,(Y) = \mu \tag{3}$$

This equidispersion assumption is violated when overdispersion (underdispersion) of the data is observed, i.e., the variance exceeds (is less than) the mean. Among the reasons

that may lead to the violation of this assumption are the unobserved heterogeneity and a high frequency of zeros in the data (Cameron and Trivedi, 1998).

The negative binomial model (NB) provides a solution for the unobserved heterogeneity by incorporating an unobserved specific effect α. The NB probability distribution of Y is

$$\Pr(Y = y \backslash \mu, \alpha) = \frac{\Gamma(\alpha^{-1} + y)}{\Gamma(\alpha^{-1})\, \Gamma(y+1)} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu}\right)^{\alpha^{-1}} \left(\frac{\mu}{\mu + \alpha^{-1}}\right)^{y} \ldots. \quad (4)$$

where Γ is the gamma function. The mean of the negative binomial distribution (like the Poisson) is μ but the variance is μ (1 + αμ), where α is called the dispersion parameter. The NB model is more general than the Poisson model because it accommodates overdispersion and it reduces to the Poisson model as α →0.

Considering longitudinal count data regression models, Cameron and Trivedi (1998) define that are standard count models, with the addition of an individual specific term reflecting individual heterogeneity.

For count models for longitudinal data or panel data the Poisson regression model with exponential mean function and multiplicative individual specific term α_i

$$y_{it} \sim \mathrm{P}\, (\mu_{it} = \alpha_i \lambda_{it}) \quad (5)$$

$$\lambda_{it} = \exp(x'_{it}\, \beta) \qquad i = 1, \ldots \ldots . n, \quad t = 1, \ldots \ldots \ldots ., T.$$

In the random effects model for count data the Poisson random effects model is given by (5), that is, y_{it} conditional on α_i and λ_{it} is idd Poisson ($\mu_{it} = \alpha_i \lambda_{it}$) and λ_{it} is a function of x_{it} and parameters β. Different distributions for α_i lead to different distributions for $y_{i1}, \ldots \ldots y_{iT}$.

Hausman et al. (1984) proposed a conjugate-distributed random effects where the gamma density is conjugate to the Poisson and additionally considered the negative binomial case. The joint density for the i^{th} individual in Poisson random-effects model (with gamma –distributed random effects) is given by

$$\Pr\, (y_{i1}, \ldots \ldots y_{iT}) = \left[\prod_t \frac{\lambda_{it}{}^{y_{it}}}{y_{it}\, !}\right] \frac{\delta}{\sum_t \lambda_{it} + \delta} \, (\sum_t \lambda_{it} + \delta)^{- \sum_t y_{it}} \frac{\Gamma\, (\sum_t y_{it} + \delta)}{\Gamma\, (\delta)} \quad (6)$$

where α_i is idd gamma (δ, δ) so that E [α_i] = 1 and V[α_i] = 1/ δ

Regarding the negative binomial random effects model the joint density for the i^{th} individual is given by

$$\Pr(y_{i1}, \dots \dots y_{iT}) = \left[\prod_t \frac{\Gamma(\lambda_{it} + y_{it})!}{\Gamma(\lambda_{it})!\ \Gamma(y_{it}+1)}\right] \frac{\Gamma(a+b)\Gamma(a+\sum_t \lambda_{it})\Gamma(b+\sum_t y_{it})}{\Gamma(a)\ \Gamma(b)\Gamma(a+b+\sum_t \lambda_{it}+\sum_t y_{it})} \quad (7)$$

V. RESULTS

In order to investigate the determinants of the intensity of RBSOs across regions we employed a count data regression analysis for a span year of 13 periods.

Assuming that unobserved heterogeneity is randomly distributed across regions we rely on a random effect model (Hausman et al., 1984). In fact, the high variability in the number of spin-offs created across regions excludes a fixed effects model. Furthermore, we add to the initial model (Model 1) regional dummies in order to control for regional differences not accounted for the variables included in the model.

We first run Poisson regression models and then compared them with negative binomial models. In fact, in our data the sample variance is higher than the sample mean (see Table 2.2), i.e., the equidispersion Poisson distribution assumption is rejected because of overdispersion of dependent variable. The likelihood-ratio test on the hypothesis that the overdispersion parameter alpha is equal to 0 presents a p-value of 0.000 in Model 1 and a p-value of 0.077 in Model 2 and thus we find alpha is significantly different from zero and thus reinforces that the Poisson distribution is not appropriate to our sample (Cameron and Trivedi, 1998). Given the presence of considerable overdispersion in our data, the negative binomial model should be considered (Table 5).

Table 5 - Poisson and negative binomial estimates of the intensity of RBSOs in Portuguese regions

	(1)		(2)	
Covariates	**Poisson**	**Negative Binomial**	**Poisson**	**Negative Binomial**
Universities Number	-0.001	-0.001	-0.009	-0.009
	(0.017)	(0.017)	(0.015)	(0.015)
Top Universities	0.571*	0.577*	0.614*	0.616*
	(0.306)	(0.307)	(0.318)	(0.320)
Universities Tech	0.067	0.085	0.136	0.148
	(0.282)	(0.287)	(0.261)	(0.265)
Incubators	0.908***	0.873***	1.010***	1.000***
	(0.287)	(0.298)	(0.268)	(0.274)
Localization economies	-0.068	-0.066	-0.070	-0.069
	(0.079)	(0.080)	(0.071)	(0.072)
Urbanization economies	0.164*	0.162*	-0.030	-0.033
	(0.097)	(0.098)	(0.167)	(0.168)
Human capital	1.100***	1.110***	1.177***	1.169***
	(0.355)	(0.362)	(0.422)	(0.428)
Distance to administrative center	-0.001	-0.003	-0.006	-0.007
	(0.006)	(0.006)	(0.006)	(0.007)
Distance to Porto	-0.001	-0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.003)	(0.003)
Distance to Lisboa	-0.000	-0.000	-0.004	-0.004
	(0.001)	(0.001)	(0.003)	(0.003)
Dummy for Years	YES	YES	YES	YES
Dummy for Distrito	_____	_____	YES	YES
Dummy for Nuts2	_____	_____	YES	YES
Constant	0.118	3.022	0.298	3.259
	(1.505)	(2.056)	(2.598)	(3.057)

Notes: Number of observations: 585. Standard errors are shown in parentheses. ***, **, * means significant at 1%, 5%, 10% level, respectively.

Regarding university-specific mechanisms our results show that the most relevant are the university´s reputation and the availability of incubators. Neither the total number of universities in region nor the university´s technology research focus seem to be relevant in explaining the intensity of RBSOs in a region. These results are consistent with Avnimelech and Feldman, 2011 Di Gregorio and Shane, 2003; O´Shea et al., 2005; van Looy et al., 2011; Colombo and Delmastro, 2002; Link and Scott, 2005; Salvador, 2011; Wright et al., 2007).

Our results suggest that regional effects have a lesser role than university-specific ones in explaining the entry of RBSOs in a region. Indeed, existing industry agglomerations do not seem to favor higher rates of academic entrepreneurship, a result that is consistent with

Buenstorf and Geissler (2011). Although *Urbanization economies* appear to have a positive influence on spin-off activity, suggesting that regions with higher population density contribute to the start-up of RBSOs, this effect seems to loose statistical significance as when we control for other regional differences with the dummy variables (see Guimarães et al. (2000) for a similar effect). Likewise, urban accessibility does not seem to have an impact on the intensity of spin-off creation. Yet, this result should be analyzed with care, because the vast majority of our sample is located in the large urban centers (52% in Lisbon and Porto).

Finally, our results corroborate the importance of the availability of qualified human capital in the region, which seems to be an important mechanism to the set-up RBSOs, therefore providing support to Hypothesis *2c*.

VI. CONCLUSIONS AND POLICY IMPLICATIONS

Reflecting the increasing number of research based spin-offs (RBSOs) created since the nineties previous studies focused their analysis on the factors that influence university entrepreneurship. However, empirical studies that investigate the determinants of variation on RBSO creation across regions are scarce.

In this paper we approached this topic from a regional perspective, using a unique self-collected dataset that includes the population of RBSOs created in Portugal from 1979 until 2007. More specifically, we investigated the impact of factors related both to characteristics of universities and to characteristics of the region on the intensity of RBSO across regions. Our data revealed that, as elsewhere, Portuguese RBSOs tend to be clustered around the university of origin.

Our results suggest that the quality and reputation of the university and the presence of university-affiliated incubators and/or university research parks in the region are the key university-specific mechanisms in favoring the entry of RBSOs. From a policy standpoint these results recommend that the government continue investing in science and technology policies which contribute to improve the quality scientific research as well as to reinforce the infrastructures that assist its commercial exploitation.

Overall, regional effects seem to play a lesser role in explaining spin-off location than university-specific mechanisms, which supports the idea that RBSOs are indeed different from other start-ups. Nevertheless, the availability of qualified human capital in the region turns out to be an important driver of RBSOs, which are knowledge-intensive by nature.

This result also has relevant implications for both central and regional governments. The former should launch national policies that increase the population´s education level, while the latter should design policies for attracting the educated population into the region.

The main limitation of our data is the impossibility of assessing the specific characteristics of the TTO, namely age, size and experience of the staff that have been pointed out as influencing their effectiveness (O´Shea et al., 2005). This issue will be addressed in subsequent research. Further research, could also explore the role of local R&D capabilities and the impact of factors related with individual choices - such as whether founders live and work in the region and are reluctant to move – on the location decision of RBSOs.

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References

Armington C, Acs Z (2002) The Determinants of Regional Variation in New Firm Formation. Regional Studies, 36(1):33-45

Asterbo T, Bazzazian N (2011) Universities, entrepreneurship and local economic development., in: M. Fritsch (ed) Handbook of research on entrepreneurship and regional development. Cheltenham: Edward Elgar.

Audretsch D, Feldman M (2004) Knowledge spillovers and the geography of innovation", in: Henderson V, Thiesse JF (eds) Handbook of regional and urban economics. Elsevier: 2713-2739

Audretsch D, Stephan P (1996) Company-scientist locational links: the case of biotechnology. The American Economic Review, 86(3):641-652

Audretsch D, Lehmann E, Warning S (2004) University spillovers: does the kind of science matter and new firm location. Industry and Innovation, 11:193 –205

Audretsch D, Lehmann E, Warning S (2005) University spillovers and new firm location. Research Policy, 34(7):1113 – 1122

Avnimelech G, Feldman M (2011) The Impact of Institution Quality, Cluster Strength and TLO Licensing Capacity on the Rate of Academic Staff Spin-offs, in: Proceedings of the DRUID Conference 2011, 15-17 June 2011, Copenhagen, Denmark

Baptista R, Mendonça J (2010) Proximity to knowledge sources and the location of knowledge-based start-ups. Annals of Regional Science, 45:5-29

Bathelt H, Kogler D, Munro A (2010) A knowledge-based typology of university spin-offs in the context of regional economic development. Thecnovation, 30:519-532

Buenstorf G, Geissler M (2011) The origins of entrants and the geography of German laser industry. Papers in Regional Science, 90:251-270

Cameron A, Trivedi P (1998) Regression analysis of count data. Cambridge: Cambridge University Press

Casper S (2013) The spill-over theory reversed: The impact of regional economies on the commercialization of university science. Research Policy, 42:1313-1324

Clarysse B, Tartari V, Salter A (2011) The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. Research Policy, 40:1084-1093

Colombo M, Delmastro M (2002) How effective are technology incubators? Evidence from Italy. Research Policy, 31:1103-1122

Colombo M, D'Adda D, Piva E (2010) The contribution of university research to the growth of academic start-ups: An empirical analysis. Journal of Technology Transfer, 35:113-140

Di Gregorio D, Shane S (2003) Why do some universities generate more start-ups than others? Research Policy, 32:209-227

Druilhe C, Garnsey E (2004) Do academic spin-outs differ and does it matter? Journal of Technology Transfer, 29:269-285

Egeln J, Gottschalk S, Rammer C (2004) Location decisions of spin-offs from public research institutions. Industry and Innovation, 11(3):207-223

European Commission (2003) Third European Report on Science and Technology Indicators - Towards a Knowledge-based Economy. Brussels: EU

Faria A, Fenn P, Bruce A (2003) A Count Data Model of Technology Adoption. Journal of Technology Transfer, 28:63-79

Figueiredo O, Guimarães P, Woodward D (2002) Home-field advantage: location decisions of Portuguese entrepreneurs. Journal of Urban Economics, 52:341-361

Fini R, Grimaldi R, Santoni S, Sobrero M (2011) Complements or substitutes? The role of universities and local context in supporting the creation of academic spin-offs.Research Policy, 40:1113-1127

Fontes M (2005) Distant Networking: The Knowledge Acquisition Strategies of 'Out-cluster' Biotechnology Firms. European Planning Studies, 13(6):899-920

Friedman J, Silberman J (2003) University Technology Transfer: Do Incentives Management, and Location Matter? Journal of Technology Transfer, 28(1):17-30

Guimarães P, Figueiredo O, Woodward D (2000) Agglomeration ans the Location of Foreign Direct Investment in Portugal. Journal of Urban Economics, 47:115-135

Haussman J, Hall B, Griliches Z (1984) Economic models for count data with an application to the patents-R&D relathionship. Econometrica, 52:909–938

Heblich S, Slavtchev V (2013) Parent universities and the location of academic startups. Small Business Economics, 42:1-15

Heirman A, Clarysse, B (2004) How and Why do Research-Based Start-Ups Differ at Founding? A Resource-Based Configurational Perspective. Journal of Technology Transfer, 29 247–268

Jaffe A (1989) Real effects of academic research. American Economic Review, 79:957-970

Knockaert M, Spithoven A, Clarysse B (2010) The knowledge paradox explored: what is impeding the creation of ICT spin-offs? Technology Analysis & Strategic Management, 22(4):479-493

Kim Y, Kim W, Yang T (2012) The effect of the triple helix system and habitat on regional entrepreneurship: Empirical evidence from the U.S.. Research Policy, 41:154-166

Lach S, Schankerman M (2008) Incentives and invention in universities" Rand Journal of Economics, 39(2):403-433

Landry R, Amara N, Rherrad I (2006) The determinants of university spin-offs: evidence from Canadian universities. Research Policy, 35(10):1599-1615

Lejpras A, Stephan A (2011) Locational conditions, cooperation and innovativeness: evidence from research and company spin-offs. Annals of Regional Science, 46:543-575

Link A, Scott J (2005) Opening the ivory tower's door: An analysis of the determinants of the formation of U.S. university spin-off companies. Research Policy, 34(7):1106-1112

Lockett A, Wright M (2005) Resources, capabilities, risk capital and the creation of university spin-off companies. Research Policy, 34(7):1043-1057

Lofsten H, Lindelof P (2005) R&D networks and product innovation patterns – academic and non-academic new technology-based firms on Science Parks. Thecnovation, 25:1025-1037

Matias S, Fontes M (2013) Policies to Foster the Creation of Research-Based Spin-offs in Portugal, DINÂMIA'CET-Working Papers, 2013/15, Lisboa: DINAMIA´CET

Mustar P, Renault M, Colombo M, Piva E, Fontes M, Lockett A, Wright M, Clarysse B, Moray N (2006) Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. Research Policy, 35:289-308

O´Shea R, Allen T, Chevalier A, Roche F (2005) Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. Research Policy, 34(7):994-1009

Piva E, Grilli L, Rossi-Lamastra C (2011) The creation of high-tech entrepreneurial ventures at the local level: the role of local competences and communication infrastructures. Industry and Innovation, 18:6, pp. 563-580

Powers J, McDougall P (2005) University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. Journal of Business Venturing, 20:291-311

Rasmussen E, Borch O (2010) University capabilities in facilitating entrepreneurship: A longitudinal study of spin-off ventures at mid-range universities. Research Policy, 39: 602-612

Rothaermel F, Agung S, Jiang L (2007) University entrepreneurship: a taxonomy of the literature. Industrial and Corporate Change, 16(4):691-791

Salter A, Martin B (2001) The economic benefits of publicly funded basic research: A critical review. Research Policy, 30:509-532

Salvador E (2011) Are science parks and incubators good “brand names” for spin-offs? The case study of Turin. Journal of Technology Transfer, 36:203-232

Shane S (2004) Academic entrepreneurship: University Spinoffs and wealth creation. Cheltenham: Edward Elgar.

Sousa C, Fontes M, Videira P (2011) The role of entrepreneurs' social networks in the creation and early development of biotechnology companies” International Journal of Entrepreneurship and Small Business, 12(2):227-244

Stam E (2010) Entrepreneurship, Evolution and Geography, in: Boschma R, Martin RL (eds) Handbook of Evolutionary Economic Geography:307-348. Cheltenham: Edward Elgar

Vohora A, Wright M, Lockett A (2004) Critical junctures in the growth in university high-tech spinout companies. Research Policy, 33:147-175

Van Looy B, Landoni P, Callaert J, van Pottelsberghe B, Sapsalis E, Bebackere K (2011) Entrepreneurial effectiveness of European universities: an empirical assessment of antecedents and trade-offs. Research Policy, 40:553-564

Van Geenhuizen M (2008) Knowledge networks of young innovators in the urban economy: biotechnology as a case study. Entrepreneurship & Regional Development: An International Journal, 20(2):161-183

Woodward D, Figueiredo O. Guimarães P (2006) Beyond the Silicon Valley: University R&D and high-technology location. Journal of Urban Economics, 60:15-32

Wright M, Clarysse B, Mustar P, Lockett A (2007) Academic Entrepreneurship in Europe. Cheltenham: Edward Elgar.

Wright M, Clarysse B, Mosey S (2012) Strategic entrepreneurship, resource orchestration and growing spin-offs from universities. Technology Analysis & Strategic Management, 24(9): 911-927

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