

Analyzing the Effects of Institutional- and Ecosystem-Level Variables on University Spin-Off Performance

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Abstract

Academic entrepreneurship has been one of the main research fields over the past 20 years, specifically due to the interest of policy makers in this topic. Initially, this interest focused on the creation of university spin-off (USO) firms; although given the new circumstances of the university and its context, there is a need to steer the research topic toward survival. This is because the simple creation of USOs, without their being able to survive or create value, is useless. This article focuses on one of the determining factors of the success of USOs, as measured by employment and sales growth: the influence of institutional- and ecosystem-level variables. Through a backward sequential process, our results show that the business size and the public support in the field of training and bureaucracy are the main elements that affect success.

Keywords

USO, firm performance, public policy, success factors, academic entrepreneurship

Introduction

The past decades have been especially important for universities, producing changes in their aims. The university of the 21st century has thus added to its already traditional roles as center of education and conservator of knowledge (teaching) and creator of knowledge (researching) the mission of transferor of new knowledge and exploiter of the research results (technology transfer). This knowledge transfer can take many forms (Grimaldi et al., 2011), among which the creation of spin-off stands out as one of the most common ones (Berbegal-Mirabent et al., 2013).

Although it is true that there is no consensus in the academic field about the definition of university spin-offs (USOs; Vesperi et al., 2018), they can be defined, generally speaking, as companies founded by individuals from the academic community, including people with research experience, and based on a technology that is transferred from the parent organization to society. With this definition in mind, we can affirm that, in recent years, research on academic entrepreneurship has grown in parallel with the flourishing of entrepreneurship in the university context. The phenomenon of the USOs has received increased attention in recent years from governments, universities, and policy makers (Huynh et al., 2017). This increased attention is the result of trends in the current economy, emphasizing knowledge as a system of wealth creation (Brinkley & Lee, 2006), as well as

the recent development of new technologies and the social, economic, and political changes of the past decades (Pérez & Carrasco, 2009). These changes have led the university to become a source of socioeconomic development of the region in which it is located (Fini et al., 2018), as well as to be more dynamic, with a greater capacity for adaptation and creativity, thus being able to respond to the needs of the society in which it is located (Adams, 1993; Bienkowska et al., 2016; Bienkowska & Klofsten, 2012; Etzkowitz, 1998, 2004, 2013; Etzkowitz et al., 2000; Klofsten & Jones-Evans, 2000; O'Shea et al., 2007; Roberts & Malone, 1996). However, the phenomenon of USOs is multifaceted and not easy to interpret, due to the complexity of the environment and the variety of factors influencing their creation and success (Vesperi et al., 2018). Academic entrepreneurship and, more specifically, the success of the USOs are largely influenced by outside elements, especially regarding public policies and support (Fischer et al., 2019). To achieve the desired transformation, universities and governments must focus on the transfer of the technology produced (Guerrero et al., 2016)

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and the creation of concrete support policies that will maximize the creation and *success* of USOs (Hayter, 2016). The public administrations, therefore, have a fundamental interest in increasing the quantity and quality of USOs. Central governments, regional governments, and the universities themselves have created programs to support the creation of this type of company. The objectives of these public support programs are focused on promoting the transfer of knowledge from universities to the productive sector and achieving greater regional growth thanks to the creation of technology-based companies (Budyldina, 2018).

However, what happens in many cases is that these programs focus on stimulating the creation of new USOs but forget to support their subsequent development, which would allow them to move from the creation phase to the consolidation phase (Fernández-Alles et al., 2015). Very few academic companies reach this stage, given their high mortality, with an average life span of 3.56 years in the Spanish case (Pazos et al., 2016). This stage of consolidation, also called the growth phase by some authors (Ndonzau et al., 2002; Vohora et al., 2004), is characterized by the increase in sales and the greater ease of access to resources, especially financial resources, which is why the literature has focused on this topic as a key aspect of public policies, being one of the topics with the greatest need for discussion in the field of academic entrepreneurship (Helm et al., 2018).

This topic is, clearly, understudied (Prokop et al., 2019), and this is precisely the gap that this article seeks to fill. This factor is extremely relevant today, both economically and socially. From an economic point of view, it is relevant as long as the public administrations are devoting a large amount of resources (economic and human) to the approval and implementation of policies that result in the improvement of USOs' prospects for survival. From the social point of view, it is relevant due to the accountability that citizens demand regarding the allocation of public money and its usefulness. With all that in mind, the objective of this research is to study the influence of institutional- and ecosystem-level variables in USOs, understanding success as growth in sales and employment. This is a subject scarcely analyzed in the literature (Mathisen & Rasmussen, 2019): Although several studies have demonstrated the influence of this type of policy (e.g., Sánchez et al., 2012), there are no studies that analyze which specific policies have the greatest impact on the results of the USOs.

The remainder of the article is structured as follows. Section "The Success of the USOs" offers an overview of the research carried out to date on the factors that determine the growth of a USO. Section "Method" presents the database and the methodology used in this study. The empirical results and their interpretation are the focus of Section "Results." Finally, Section "Conclusion" presents the conclusions and the main implications for the management of the results obtained and also proposes future lines of research.

The Success of the USOs

According to Mathisen and Rasmussen (2019), to understand the phenomenon of USOs, it is very important to consider how these firms develop, grow, and perform over time, since the existing literature has so far been based on the study of the creation of USOs, disregarding these other important aspects. Thus, it is crucial to know the factors influencing the growth and success of USOs. The first step for being able to study the success factors of USOs is to consider what is meant by the word *success*. For USOs, the term *success* has several connotations.

Some authors consider that the success of a USO is achieved simply by its permanence in the sector, that is, by remaining listed in the registry, irrespective of whether it shows activity (Leitch & Harrison, 2005; Rothaermel & Thursby, 2005a; Shane, 2004; Shane & Stuart, 2002). However, this aspect is not of interest for our study since, as Roberts (1991) demonstrates, the usefulness of this simple survival criterion is too limited.

Other authors consider that the success of a USO depends on its ability to achieve certain goals, depending on the stage they are in (Lockett & Wright, 2005; Wright et al., 2006), or to achieve an enormous volume and variety of specific objectives (Hayter, 2013; Link et al., 2007; Zucker et al., 2002). However, as Hayter (2015) establishes, "Although such an approach may yield insight about spin-off success, its contribution is dependent on robust longitudinal data that, unfortunately, rarely exist" (p. 7). In addition to this, the difficulty of having to adapt each of these objective criteria to each sector of activity, the fact that some of them cannot be applied to the USOs created in the field of social sciences, and the long list of goals that could be created make this definition of success ineffective.

Finally, there are those authors who consider that the success of the USO is directly related to growth (Clarysse et al., 2011; Khadhraoui et al., 2019; Migliori et al., 2019; Rodríguez-Gulías et al., 2016a). In this way of thinking, a USO is considered a successful firm if, in addition to surviving for a certain period of time, it is able to grow in its levels of employment and sales (Bessière et al., 2017; Bock et al., 2018; Mustar et al., 2008; Niosi, 2006; Shane & Stuart, 2002). Previous studies, such as the one by Niosi (2006), establish that the factors most influential for growth in sales and employment are the type of activity carried out, the age of the USO, the support received, and the existence of patents.

In our study, we will apply this last definition of success, given that we understand it to go far beyond merely surviving in the market. This is due to the fact that, in many cases, the survival of a USO is simply curricular, that is, the USO is inactive in the market. We want to establish a clear differentiation between those USOs that engage in activity in the market and grow, and those that do not carry out any activity. In short, success in this study is measured as the ability to

grow in sales and employment, this being the most operational and transversal definition that can be given (Rodríguez-Gulías et al., 2016b). Thanks to this, USOs from different fields of expertise and with different characteristics can be compared.

Where growth in employment is concerned, it needs to be noted that one of the main characteristics of USOs is their clear limitation in number of jobs created, as illustrated by the tendency of USOs in France not to have more than 10 employees after 6 years of existence (Mustar et al., 2008). This index is considered a good indicator of the growth capacity of new projects, according to Clarysse et al. (2011), and has been widely used as a synonym for the success of USOs (Clarysse et al., 2011; Niosi, 2006; Visintin & Pittino, 2014). In addition, this aspect is pivotal to the analysis of why academic companies are created, as one of their main purposes is to provide employment or placement for students, especially doctoral students or doctoral graduates who have lower standing in the university system; these are the students who play a key role in the USO and its development and future growth (Hayter, 2016). Notwithstanding, the difference between USOs in terms of sector in which they are developed is essential, with a growth rate of 44.9% for technology-based USOs and 26.2% for all others (Rodríguez-Gulías et al., 2016a).

As for growth in sales, this index is presented as very relevant, given that there are some USOs that never reach the stage of conducting sales transactions, which muddies the very definition of a USO. This index is important because some USOs are purely curricular, that is, they have been created to enhance the CVs of the researchers involved. Here, the existence and growth of sales transactions are a key element of success, because in the long term, only those that are able to compete will be able to stay in the market, and for that they must transact business regularly, continuously, and progressively. In fact, the low growth of the USOs is one of the fundamental barriers to overall growth, mainly related to training in commercial skills (Van Geenhuizen & Soetanto, 2009) and to the networks created (Bock et al., 2018).

Toward a USO Success Model

Because of the special nature of USOs, one of the most prolific research areas on the subject has been the study of the factors that determine their success. In this line, Helm and Mauroner (2007) conducted an exhaustive analysis of 71 articles that studied these factors, reaching the conclusion that there are three categories of factors: those involving the founding person, the environment, and the company itself. Some time later, Bigliardi et al. (2013) proposed a new classification, based on a Delphi study in which 20 experts on the subject participated. From that research, those authors classified the factors that influence the success of USOs in four groups: factors related to the characteristics of the university, the founder, the environment, and technology.

According to Corsi and Prencipe (2015), there are three levels of influential factors: macro-level, related to environment; meso-level, focused on parent university and the influence of the technology transfer office (TTO); and micro-level, which focuses on the analysis, specifically, on the firm, the human resources that form it, and their relationships. The need for this meso-level study has been clearly demonstrated in recent studies such as those by Prokop et al. (2019) and Mathisen and Rasmussen (2019), who have called these aspects “institutional and ecosystem-level determinants.”

As can be seen, the classifications of the determinants of entrepreneurship are numerous, although the majority of the authors agree on the existence of a gap in the study of the nonindividual determinants of the success of the USO (Vesperi et al., 2018). Next, we proceed to analyze the main determining factors of success that we include in our proposed model.

The academic and familiar nucleus of the academic condition greatly determines one's predisposition and one's vision of entrepreneurship, meaning that those academics with greater support from their families and colleagues will be more likely to pursue entrepreneurship (Shane, 2004). In this sense, the support of a close nucleus in the academic milieu, and also the experiences lived in that environment, seems to condition one's inclination toward entrepreneurship, as well as one's success. This aspect, moreover, is related to the business experience, discussed below.

Many authors have also analyzed the important role that the existence of a TTO holds for the success of a USO (Bessière et al., 2017; Gras et al., 2008; Helm & Mauroner, 2007; Lockett et al., 2005; Rothaermel & Thursby, 2005a). In Spain, these TTOs are responsible for aspects related to the protection of technology (Erden, 2017), so they play a very important part in obtaining patents based on research results and the subsequent commercialization of these patents. In short, the literature shows the importance of the entrepreneurial environment on the success of a USO. Therefore, we propose the following hypotheses:

Hypothesis 1a: The existence of an environment that favors entrepreneurship positively influences growth in sales.

Hypothesis 1b: The existence of an environment that favors entrepreneurship positively influences growth in employment.

An important factor to take into account when assessing a USO's success, as we have defined it, is the degree of support received from the university (Goldfarb & Henrekson, 2003; Mustar et al., 2008). A university's public policies are geared toward achieving a clear goal, the transformation of universities in order to ensure that research contributes value to economic growth and employment creation.

Based on this, we propose the following hypotheses:

Hypothesis 2a: The support received from the university positively influences growth in sales.

Hypothesis 2b: The support received from the university positively influences growth in employment.

By the same token, the support for the USOs shown by the regional government and other institutions in the area where the university is located is decisive for its success (Sternberg, 2014). This support can vary from elements such as counseling in its various phases (Gras et al., 2008; Vinig & Van Rijsbergen, 2010; Vohora et al., 2004) to training for the improvement of management and marketing capabilities (Di Gregorio & Shane, 2003; Siegel et al., 2003a), without forgetting the support in gaining access to financial resources through the presence of the parent university in the capital of the USO (Iacobucci & Micozzi, 2015; Lockett et al., 2005; Smilor & Matthews, 2004), as well as nonfinancial resources, such as the grant of physical space (Epure et al., 2016).

For all of these reasons, we propose the following hypotheses:

Hypothesis 3a: The support received from public administrations positively influences growth in sales.

Hypothesis 3b: The support received from public administrations positively influences growth in employment.

According to some authors, the existence of an international scope in the USO has a favorable effect on growth (Fernández-López et al., 2018; Pazos et al., 2016). This may be due to the fact that the market for a USO, a company highly specialized in research issues, may be very small at the national level, thus limiting growth. Therefore, expanding the market beyond the country's borders may become the only way to grow. According to Fernández-López et al. (2018), a USO has a 7.8% greater chance of enjoying high growth if it is internationalized than if it is a nonexporting concern. These same authors observe that internationalizing an academic company not only fosters growth but also accelerates it, concurring with other authors in their conclusions (Moreno & Coad, 2015). Consequently, the following hypotheses are proposed:

Hypothesis 4a: Internationalization positively influences growth in sales.

Hypothesis 4b: Internationalization positively influences growth in employment.

Pazos et al. (2016) and Bessière et al. (2017) found that the existence of patents was associated with greater growth. In this sense, both existing patents and those created during the life of the USO are associated with an improvement in the growth of the USO. These works allow us to pose the following hypotheses:

Hypothesis 5a: The existence of patents positively influences growth in sales.

Hypothesis 5b: The existence of patents positively influences growth in employment.

Finally, several previous works relate the size of the USO (measured by the number of employees) with its growth (Phillips & Kirchhoff, 1989; Popkin & Kirchhoff, 1991; Wagner, 1992; Fernández-López et al., 2018). This fact leads us to think that the number of workers can be a determining variable of growth, hence the following hypotheses:

Hypothesis 6a: The number of employees positively influences growth in sales.

Hypothesis 6b: The number of employees positively influences growth in employment.

Taking all this together, our study proposes the model shown in Figure 1.

With this model, based on the work of Mathisen and Rasmussen (2019), we aim to study the factors at the firm level and at the institutional and ecosystem levels that lead the USO to have a greater probability of success in the growth level of both sales and employment.

Method

Having analyzed the different factors identified in the literature on university entrepreneurship, it is necessary to measure or estimate the impact of these factors on the success of the USOs. In this work, the increase in the number of workers and the increase in the transaction volume of the USO are used as indicators of success. Both being binary or dichotomous variables—an increase or no increase in hiring or sales—the most suitable econometric model is a binary choice model. Therefore, the model does not estimate frequencies, but rather the probability that a specific event will occur. In this case, the event is an increase in the success indicator. This probability model is expressed as a function that depends on a set of explanatory factors, collected in the vector \mathbf{x} together with the impact the factors have on the probability, which is collected in the parameter β :

$$Prob(Y = 1) = F(\mathbf{x}, \beta). \quad (1)$$

Although the specific probability model is not defined in Equation 1, the most used models have the form of a regression model that will depend on the chosen probability density function: a uniform, Gaussian, or logistic one. In this case, it is assumed that $F(\mathbf{x}, \beta)$ is a logistic distribution, so the model used in this study to estimate the probability of success of the USO will be a logistic regression model, commonly known as a logit model, as shown in Equation 2:

$$Prob(Y = 1) = \frac{e^{\beta \mathbf{x}}}{1 + e^{\beta \mathbf{x}}}. \quad (2)$$

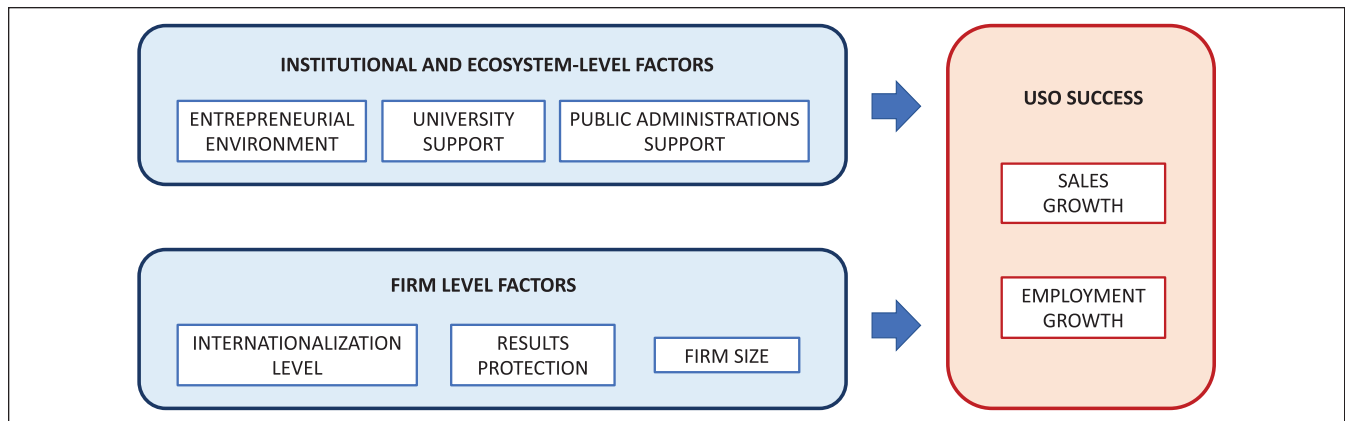


Figure 1. The proposed study model.

This estimation provides as outcomes coefficient estimates or odds ratios. While the former show the impact of each variable on the probability of success, the latter reports the relative impact of a specific variable compared with the impact on the opposite category of the dependent variable.

The large number of variables considered in the model, as well as the possible relationships between them, may lead to an inefficient estimation due to an excess of explanatory variables. Therefore, a backward stepwise process to select explanatory factors is required. This process starts from the saturated model, that is, the one with all the independent variables. After that, the least significant variables are sequentially removed to reach a set of explanatory variables with a sufficient level of significance.

Data Collection and Sample

In this study, we consider USOs to be those companies created to market results from commercial operations obtained within a university academic research setting. This definition of USO is one of the most commonly used among academics (Corsi et al., 2017).

The sample used for this research comes from the USOs created under the auspices of higher education institutions in Spain. The questionnaires were sent by mail to 966 founders, of which a total of 97 usable questionnaires were obtained (see the appendix). The research was carried out during September 2018, and those USOs with less than 5 years of life were not taken into account. We performed a nonresponse analysis when comparing early versus late responses, as well as responses versus no responses. The tests indicated that there were no statistically significant differences in the mean responses for the research variables. Therefore, nonresponse bias is not likely to be a problem when interpreting the study findings.

The USOs of our sample belong to diverse industrial sectors: information and communication technologies (29.5%), biotechnology and life sciences and health (26.3%), and environment and renewable energies (13.7%). The average

age of the participating USOs is 7.9 years. Regarding the number of employees, only 29.2% have more than five employees, 34.4% have between three and five employees, 26% have either one or two employees, and 10.4% have no employees.

By region, Andalusia is the most representative (20.62%), followed by Community of Madrid (14.43%), Galicia (12.37%), and Castile-Leon and Catalonia (10.31%). The average age of the USOs that are part of the sample is 8.66 years.

Variables

The data obtained in this study have been used to create a set of variables that allow for the study of a USO's success in terms of growth in sales and employment. Table 1 shows the variables that have been found to be significant, due to their contribution to the growth of sales and/or employment.

Dependent variables. The success of the USO has been measured through growth indicators, since growth is considered the most appropriate dimension of success in new companies (Weinzimmer et al., 1998). Following the methodological recommendations and recent work on the USO's success (Visintin & Pittino, 2014; Wennberg et al., 2011), a multidimensional approach has been adopted and evaluated in two aspects: sales growth and employment growth during the 3 years after the year of the USO's founding. Specifically, distinct dichotomous variables have been considered to reflect the existence of changes in the two aspects of growth, constructed from the information provided by the individuals surveyed, taking the value 1 for those cases in which this support has been received or the answer is affirmative, and 2 for the case of negative responses.

Independent variables. To analyze the entrepreneurial environment, we consider a series of aspects of the locale where a USO is born and grows, factors that could help in its consolidation. Thus, in the first place, the support received by

Table 1. Estimation of the Probability of Growth in Sales and Number of Employees.

<i>Work_g/l</i>	Coefficient of sales growth	Z	<i>p</i> > Z	Coefficient of employment growth	Z	<i>p</i> > Z
<i>Uni_Train</i>	2.546659	0.019	.019	—	—	—
<i>Uni_Bureau</i>	2.239112	0.039	.039	—	—	—
<i>N_Work</i>	1.002463	3.32	.001	0.3372125	2.20	.027
<i>Internat</i>	—	—	—	1.666221	2.04	.042
<i>Inst_Train</i>	—	—	—	3.740098	2.48	.013
<i>Inst_BP</i>	—	—	—	-2.397948	-1.92	.054
<i>_cons</i>	-3.608231	-3.40	.001	-2.588,315	-0.38	.701
No. of observation		97			77	
Pseudo <i>R</i> ²		.5404			.3036	
Likelihood-ratio $\chi^2(6)$		54.77			18.05	
Probability > χ^2		.0000			.0012	
Log likelihood		-23.288865			-20.707045	

Source. Own elaboration.

the promoters is measured, including eight binary variables that take the value 1 if the main support has come from one of the following sources, and 0 if no support has been received from that source: family (*Fam*), friends (*Friend*), companions of the department or research group (*Mates*), the Office of Transfer of Results (*OTRI*), a science and technology park (*Park*), institutions of the corresponding regional government (*Govern*), and other companies (*Companies*).

Then, through seven dichotomous variables, the support of the university during the USO's first 5 years of life is described, taking value 1 if support has been received and 0 if no support has been received in each of the following aspects: training (*Uni_Train*), drafting of the business plan (*Uni_BP*), bureaucratic procedures for setting up the company (*Uni_Bureau*), granting of space and infrastructures (*Uni_Infrast*), business advice (*Uni_Adv*), financial advice (*Uni_Financ*), direct financial support (*Uni_Invest*), and advertising support (*Uni_Marketing*).

Finally, this battery of questions is replicated with eight other binary variables that analyze the same types of supports received from public administrations external to the university (*Inst_Train*, *Inst_BP*, *Inst_Bureau*, *Inst_Infrast*, *Inst_Adv*, *Inst_Financ*, *Inst_Invest*, *Inst_Marketing*). Internationalization (*Internat*) is also analyzed by means of a binary variable, if the USO has had international clients in its first 5 years of operation.

The *protection of results* dimension is measured by two binary variables. First, "initial patents" (*Pat_Init*) appears if it was based on one or several patents (or utility models) transferred from the university, and second, "patent applications" (*Pat_Post*) if in the first 5 years there was at least one request for protection of results. Both variables are binary.

Given the importance of the number of workers as an influential success variable, this aspect has been chosen. Number of workers (*N_Work*), a continuous variable, is used to take into account the size of the company in terms of

employment, where the average size of the workforce throughout the first 5 years of life is tabulated. It is important to keep in mind that the promoters and partners not hired as part of the labor force are not included here. The values of the variable are 0 employees, either 1 or 2 employees, 3 to 5 employees, and more than 5 employees.

Control variables. In addition, from among the variables indicated and following the recommendations in previous studies (Colyvas & Powell, 2007; Helm et al., 2018; Helm & Mauroner, 2007; Visintin & Pittino, 2014), we have included the following control variables:

Number of promoters of the company (*N_Prom*): a continuous variable that informs about the size of the USO's starting team. This continuous variable takes the values 1, 2, 3, 4, and 5 or more.

Nonacademic manager (*Prof_Manag*): a dichotomous variable that informs about the presence or absence of a manager external to the university in the company, giving a sense of the level of professionalization of the management.

University capital (*Cap_UNIV*): the participation of the university in the USO is measured by the percentage of the company's capital that was invested by the university during the USO's first 5 years of life. This variable takes continuous values, with values of 0%, between 1% and 5%, between 5% and 10%, 10% to 20%, and more than 20%.

With regard to resources and capabilities, the percentage of academic members in the team of promoters is included (profile differentiation), following Scagnelli et al. (2019). The division of the entrepreneurial team between academic and nonacademic members was measured by comparing the percentage of members belonging to the two subgroups

(*Academ*). A similar approach has been adopted in previous studies that addresses the separation of an executive team into two categories of members according to a single demographic attribute (Visintin & Pittino, 2014). The academic members include those who belong to the staff of the university as well as those who, though not enrolled, have some experience in the university (junior researchers, doctoral students, etc.). This variable could take as values no member, approximately 25%, approximately 50%, approximately 75%, and finally, 100% of the promoter team being academic. In addition, another variable related to the diversity in the academic position (*Categ*) has been the differentiation of the position of the respondent, distinguishing among managers, academic employees, nonacademic employees, and grantees/students.

Results

Given the large number of variables, a backward sequential process is carried out where those nonsignificant explanatory factors in the binary logit regression are eliminated, as explained in the “Method” section. The goodness-of-fit statistics show that both models are rather significant and they can be used to explain if the firms increase their sales or jobs. In this manner, the variables that will ultimately be considered to explain the USO’s success are those shown in Table 1. The results show that only six variables are influential in the growth of sales or the number of employees, according to the study.

In this sense, the variable *Uni_Train*, which represents the support that the USO receives from the university in the field of business training, is the most relevant in the case of sales growth. This variable takes a *p*-value of .019, that is, it is significant. The effect of this support increases the probability of selling more products.

Second, the bureaucratic support received by the university also influences the growth of sales in a positive sense. The more support the USO receives, the more likely is the increase in sales. *Uni_Bureau* takes a value of 2.239112, with a *p*-value below .05, being significant at a 95% level. Besides, given the relative relevance of both variables, the support of USO from their universities stands out as the key trigger.

The number of workers, *N_Work*, is also significant, being the only one of all the variables that influences both growths. In this sense, this variable takes a value of 1.002463 for the case of sales growth, being significant at 1%, given that its *p*-value is .001, and a value of 0.3372125 for the case of growth of employment, with a significance of 95%. So, a critical mass or minimum size is relevant to grow and to become a larger firm.

The remaining variables commented on in the article are only related to growth in employees. While internationalization and support in training from institutions increase the probability of hiring more employees, the support in creation of the business plan reduces it. A USO with a poorly designed

business plan, which must be monitored by the institutions, is likely to be unsuccessful. Similarly, the internationalization of the USE (*Internat*) is significant at 95% (*p*-value of .027); this variable takes a value of 1.666221.

The final variable that seems to have a positive influence on the growth of employment demanded by the USO is the support received in the field of training by the region’s institutions (*Inst_Train*), taking a value of 3.740098 and a significance of 95% (*p*-value of .013). At the same time, the support received by the institutions in the field of creation and monitoring of the business plan (*Inst_BP*) has a value of -2.397948 , that is, it negatively affects the growth of employment with a *p*-value of .054.

Discussion

The principal support for the success of the USO is the support received from the university and the institutions in the field of training (*Uni_Train* and *Inst_Train*), as these factors positively influence the growth of sales, a key element in achieving the objectives of what is known as an entrepreneurial university. This training should be directed, according to some authors, at enhancing the commercial expertise and industrial experience of the USO staff (Baldini et al., 2015; Boh et al., 2016; Krabel & Mueller, 2009; Murray, 2004; Siegel et al., 2003a). Some of these authors consider that it is precisely the lack of such training, especially in the financial field (Salman & Jamil, 2017), which causes the success of the USO to be very low or even negligible (Moray & Clarysse, 2005; Munari & Toschi, 2011; Wright et al., 2006). In any case, the training of the members of the USO is a key and fundamental element for its achievement of growth and development (Horta et al., 2016; O’Shea et al., 2005). This result is crucial, as it demonstrates that the success of a company depends not only on the quality or need of the product but on the management and market orientation capabilities of its managers. This aspect is of special interest, since it is not only a key factor for the success of the USO but also acts as a relevant factor in the creation of the USO and in the attitude toward academic entrepreneurship (Belas et al., 2019).

The second of the influential factors in the growth of sales is the support received in carrying out bureaucratic procedures (*Uni_Bureau*), that is, the administrative and bureaucratic role played by the university. This effect can be explained as allowing the company to orient itself to the market and to its own core activities, rather than devoting an enormous amount of time to administrative aspects. This factor is key in a country as bureaucratized as Spain, which occupies the 86th position in the world in terms of ease of opening a business, according to *Doing Business 2017*. In addition, in many of the cases analyzed, the excessive bureaucratic procedures necessary for the creation of a USO discourage promoters. This causes the promoters to shelve the initial interest in the entrepreneurial initiative, resulting

in companies not exploiting their potential for initial growth. In contrast, when the support of the TTO simplifies these procedures and the promoters feel supported from the beginning, advising them even in the search for possible funders, the USO enters into a positive dynamic that translates into greater chances of success in the market. This result is in line with, as well as transcends, the concern raised by Meoli and Vismara (2016), because those authors view bureaucratic procedures as a barrier to the creation of USOs, whereas our results postulate that they also positively influence a company's subsequent growth. This result is also in line with Fini et al. (2009), who showed that "the vexing bureaucracy of universities may be among the motivations for becoming academic entrepreneurs" in the field of USO creation, and with Lam (2011). This, moreover, is the cause proposed by some authors as a leading element in the decision of academics to opt for open transfer activities rather than activities such as USOs (Ferreira & Teixeira, 2019).

Third, our study appears to confirm a direct relationship between business size and growth of sales and employment. This relationship between dimension and growth contradicts what is known as Gibrat's law (Gibrat, 1931), which says that the growth of a company is independent of its size; it also contradicts some works that reject this law by showing an *inverse* relationship between dimension and growth (see Lotti et al., 2003). On the contrary, some authors, such as Ijiri and Simon (1964), consider that the real determining factor for the growth of the company is its past growth, so that the company that has grown in the past is more likely to grow in the future. This observation can be made from the perspective of growth itself, that is, those companies that are larger (because they have grown in the past) are more likely to grow. Along the same lines, authors such as Storey (2016) and De Fabritiis et al. (2003) have related current size to growth. In the area of start-up companies, authors such as Phillips and Kirchhoff (1989), Popkin and Kirchhoff (1991), and Wagner (1992) confirm the existence of a positive relationship between size and growth, although in the case of the former, they establish a threshold of five employees as the minimum size necessary to be able to grow. Where USOs are specifically concerned, this positive relationship can be explained, following some authors in this field, by such factors as the need to maintain the team of researchers and professors if they cannot find a place in the university system (Friedman & Silberman, 2003; Muscio et al., 2016; Nosella & Grimaldi, 2009; Rizzo, 2015). This fact may be not only due to the need for income to maintain the labor structure but also due to the fact of having different profiles in the USO, given that a greater number of workers are available (Horta et al., 2016; O'Shea et al., 2005), which makes for an advantage in the market. Other authors consider that this positive relationship is due to a greater orientation toward the market and a greater interdisciplinarity (Clarysse et al., 2002, 2005; Wright et al., 2007). In short, this relationship may be due to the fact that, in Spain, many USOs arise from the initiative of

a group of academics who subsequently do not devote the necessary time for the development of the company; thus, many of them close within a few years of their creation or are maintained but at a reduced level of activity and revenue. Only those that are committed to hiring specialized workers (not only technical, but especially commercial) are the ones that experience the greatest growth potential.

Likewise, the existence of an international clientele, that is, the international orientation of a USO, is a key factor for employment growth, in line with the results of Pazos et al. (2016) and Fernández-López et al. (2018). These authors conclude that the existence of international clients—or, which is the same, the fact of exporting—is a key element, since the success of these exporting USOs is far superior to that of USOs that do not export. They showed that internationalized companies are 7.8% more likely to have great growth and, consequently, to survive. This result is not surprising at all, given that dependence on the national market limits growth, whereas internationalization leads to new possibilities. In such a globalized world where competitiveness is so high and the market is so specialized, this seems to be the best growth option for most USOs (Fernández-López et al., 2018; Pazos et al., 2016). In addition, the fact that the USOs offer such specialized services related to technology makes internationalization a necessity, since the national market for such innovation can and usually does fall short.

Finally, the support received from institutions in the designing of the business plan (*Inst_BP*) is a factor that *negatively* influences the growth of employment, a finding that comes as a surprise. One possible explanation for this negative relationship may be the difficulty of creating a good business plan with realistic perspectives, an adequate index of certainty, and adequate planning, as shown by Clarysse et al. (2002). These problems or limitations in the writing of a good business plan may be due to the lack of specialization or appropriate training on the part of those public servants who are responsible for dispensing advice, who sometimes have to attend to multiple tasks and large bureaucratic workloads, unable to specialize adequately in this task, or not being able to devote the necessary time to help design a good business plan. This aspect, however, should be studied in greater depth and by a qualitative approach. In this way, it would be possible to know the exact determinants that cause this support to be negative, such as overestimation of demand, shortage of time, lack of objectivity, absence of market studies prior to conducting the study, existence of other consolidated companies that offer the same service and have been ignored in the analysis, lack of dedication after updating and evaluating the plan, and so on.

On the contrary, neither the participation of the university in the capital of the USO nor the existence of a nonacademic manager seems to influence the performance of the USO. As was the case in the work of Bock et al. (2018), the higher or lower percentage of participation in capital of the university does not affect the growth of the USO. This fact is explained

because, regardless of its participation in capital, in any of the cases analyzed, the university is involved in the decision-making of the USO. That is, what really affects the growth of the USO is not the participation of the university as a simple capital contributor but a real implication of it. The finding of the nonexistence of a nonacademic manager's positive impact on growth contradicts the proposed stages of Ndonzuau et al. (2002), Vohora et al. (2004), Lundqvist (2014), and Fernández-Alles et al. (2015), who propose that during the growth stages, a professional manager is approached who, in turn, improves the growth of the USO. Studies such as that of Migliori et al. (2019) shed light on this aspect, affirming that what is truly influential is the manager's strategic orientation, so we suggest that this negative result would depend on the leader's orientation toward the market, rather than the existence or nonexistence of a professional manager. This result is surprising, given the background on the matter. That is why further study should be carried out on the causes that lead to it. That study, in addition to deepening the explanations on this issue, could have important consequences for management. These data show that, effectively, the percentage of companies that grew up having a professional manager is similar to the USOs that grew up without one. Thus, the results may be due to the nature of the sample used.

There is still another series of variables that do not influence growth. This is the case with the university's support in the making of the business plan, which is why one would have to ask if this feature is due to the lack of specialization of the workers in the universities' research management services. This aspect may be the result of what has already been noted in the case of the support received from the public administration for the creation of the business plan, that is, lack of exclusive dedication of the people who elaborate the plan, lack of time to develop an adequate business plan, and so on. Nor does the support received in the field of infrastructures influence the success of the USOs, that is, the making available of infrastructures to the USO by the university and public institutions does not affect their success. This result can be understood as showing that these hold utility for creation and for the first stages (Clarysse et al., 2005; Grimaldi & Grandi, 2005), to fill gaps in access (Aguado Bloise et al., 2014; Arshad et al., 2016), but are not as influential in the subsequent success. In some cases, in fact, once the USO has a sufficient level of growth, it moves its headquarters outside the institution itself, given that the existing spaces in the universities are limited and may end up being constraining to the USO. The same applies to direct financial support and advertising support, which also have no effect on success. Some authors have suggested that training in these fields is more important than direct participation of the university or institutions in these activities (Baldini et al., 2015; Krabel & Mueller, 2009; Murray, 2004; Siegel et al., 2003a). This result can be explained as a consequence of the nature of the sample itself, which does not allow the result to be

generalized. In this sense, there are only 14 USOs that receive direct financial support and 29 that receive advertising support. This supposes that more than mere financial support, training support in these areas is what really influences the success of the USO, given that the capacity for real support from universities in the financial and advertising aspects is very limited.

Also failing to show relevance for growth are the existence of nonacademic members of the team and the categories to which they belong, which is the case in the creation of companies (Colyvas & Powell, 2007), as well as the support of OTRIs or scientific and technological parks, the university's administration, or other companies. In the case of the OTRIs and the scientific and technological parks, this fact can be explained as the special utility of these during the first stages of life of the company (Clarysse et al., 2005; Gielen et al., 2013; Grimaldi & Grandi, 2005; Rogers et al., 2001; Rothaermel & Thursby, 2005b), having no special influence on the growth stages (Di Gregorio & Shane, 2003).

Finally, neither the number of promoters nor of patents, nor the support received from family and friends, are factors of growth. These variables have been included for the purpose of validating the literature. In the case of the number of promoters, it may be due to the fact that the growth of a USO is more related to the characteristics of the founders (Phan & Siegel, 2006)—their professional orientation (Colombo & Grilli, 2010; Criaco et al., 2014; Egelin et al., 2003; Helm & Mauroner, 2007; Newbert et al., 2007, 2008; Vohora et al., 2004; Walter et al., 2006), their experience (Helm & Mauroner, 2007), and their multidisciplinary (Heirman & Clarysse, 2004; Visintin & Pittino, 2014)—than to the number of them.

In the case of patents, our results contradict Pazos et al. (2016) and Bessière et al. (2017), who found that the existence of patents was associated with greater growth. However, this result may be due to the preeminence of the sale of these patents to external companies, as opposed to the exploitation of those assumed risks that come with creation of a USO, in what Ndonzuau et al. (2002) and Vohora et al. (2004) called the prebusiness stage of academics. Likewise, this fact could be explained as a consequence of the short half-life of the USOs of the sample, since a large portion of the USOs participating in the study have a still short half-life. That is, there is a clear relationship between patents and benefits or growth in the medium and long term, but not in the short term. We must point out that, although the vast majority of USOs have a poor average life span, the general half-life of ours is distorted as a result of the existence of some USOs that have reached 20 years of life.

In the same way, the basic support of the family and area environment is not a determinant for growth either: although it is true that it can be a relevant factor for the creation of companies (Shane, 2004), it is not relevant for determining growth, given the existence of new sources of funding and the need for new resources beyond their reach. Likewise, support received from family and friends is a factor related

more to the creation of the USO than to its growth (Vega-Gómez et al., 2019).

All these noninfluential results may also be due to the nature of the sample, which is why, in the “Limitations and further research” section, it is proposed that the study be replicated with a larger sample of USOs analyzed.

Conclusion

One of the major gaps in the literature related to academic entrepreneurship is the study of the performance of the USO (Helm et al., 2018), since most of the literature has focused on the creation stage, especially the psychological factors that lead to the creation of USOs from an individual point of view (Al-Jubari et al., 2019). This research studies the influence of different variables on the growth of USOs (Bessière et al., 2017; Bock et al., 2018; Mustar et al., 2008; Niosi, 2006; Shane & Stuart, 2002).

From this study, both theoretical and practical conclusions and implications are obtained. In terms of theoretical contributions, the fact that the number of workers is the only variable that positively influences both growth rates stands out. Indeed, having a large number of workers enhances the subsequent growth in employment and sales, something that can be explained with a reciprocal influence: that is, a large number of workers leads to the need and, therefore, to the reality of more business being transacted. In the same way, a high number of employees leads to the hiring of new employees, due to the possibility of having more income.

The most important support for achieving growth is the training offered to USO promoters by the university itself. This result is in line with some authors who consider the lack of economic and business training to be not only a problem for the creation of the USO but also a serious obstacle to its growth (Baldini et al., 2015; Boh et al., 2016; Krabel & Mueller, 2009; Murray, 2004; Siegel et al., 2003b). This implies, as a necessary conclusion, that the university and the institutions should focus their support on the training of USO promoters, since it is a determining factor for USOs' success. This finding has enormous implications for university managers. In the first place, the fact that the founders of the USO are not experts in the areas of economics or business administration means that they need training in these areas, given that they are going to be managers of emerging companies, sometimes companies that are applying research that has been financed with public funds and even being subsidized for their creation. Second, training must specifically target areas such as seeking financing or advertising, as well as other aspects of management and marketing. Third, the existence of adequate training can lead to the success or failure of the USOs, which is why the possibility of training must be given in all its stages, not only during the creation stage. Fourth, there must be strong efforts made by the institution to reveal what the training needs are and thus be able to supply that need.

Another support of the university for growth is that which occurs in bureaucratic areas. This is due to two factors. On one hand, academicians are not experts in the field of business bureaucracy, an element that hinders entrepreneurial creation and growth (Sørensen, 2007), so they do not have enough knowledge or experience to be able to carry out these tasks efficiently. On the other hand, having support in the tasks that are not specifically core activities of the USO allows the USO members to dedicate themselves to its development, rather than having to devote time to that area that does not contribute directly to it. Within this area, the negative influence of aid for the creation of the business plan when it is proffered by public governmental institutions stands out in a surprising way, an aspect that should cause the institutions to reconsider the ways that they provide this service. In other words, for such support to be effective, administrations should have specialized personnel in this field or provide more resources to them, so that, in this way, they can draw up more realistic business plans that provide value for the creation of the USO strategy. In many instances, the university's support for the USO is not limited to advice on the procedures of incorporation of the company, but also includes advice or tutelage by experts in business planning management during the first years of life of the company. A good business plan helps companies in the decision-making process of their first years of life by influencing, as our study demonstrates, their growth. We consider this to be one of the most important contributions of our study to the literature. This implies that the policy makers of the universities and of the public administrations must act in two fundamental aspects. First, simplifying bureaucratic procedures. Second, maintaining and improving teams of people dedicated to helping with the red tape. In this way, the USO staff will be able to dedicate themselves exclusively to the core business, focusing their efforts and resources on achieving growth.

Finally, the policies planned by institutions and universities should be oriented toward the international operation of USOs, as well as the promotion of their long-term survival, factors that decisively affect their growth, as Pazos et al. (2016) and Fernández-López et al. (2018) also conclude. This finding has three implications. First, the institutions must focus their efforts on the training of USO personnel. Second, it would be interesting if the support from the universities could include the opening of visiting positions in international entrepreneurship, as is done with teaching and research positions. This would allow the creation of a network of international contacts that would help a university-based company to improve its international position. Third, the university can help foster internationalization by passing along secondary information about the international scene that would be of interest to the USO. For this effort, there should be specialized personnel who can analyze this information.

Notwithstanding all the aforementioned, attention must be drawn to the need for holistic support from public policy makers. That is, attention cannot be focused on providing aid for just one of the variables discussed here as being influential, but rather, the focus needs to be on several at the same time in order to have a decisive influence, as shown by the studies of Berbegal-Mirabent et al. (2015).

Limitations and further research

As concerns the limitations of the present research, there is a need to repeat this study over time, with the purpose of obtaining panel data that, beyond presenting a fixed picture of the success factors of a USO, consider its evolution over time and the stages of its life. In addition, it would be necessary to replicate this study with a greater number of observations, although the number presented meets all the paradigms and criteria to be considered. It is also possible to implement in future studies an analysis of factors of influence specific to growth, such as the type of participation in the capital of the USO and the financing systems it employs, in order to relate the rates of capital and financing with the performance of the USO. Likewise, it may be interesting to study the heterogeneity of the promoter team and to study the influence of this heterogeneity on performance.

In addition, it would be of special interest to study the influence of a USO's own formal and informal transfer activities on its growth, in order to have an overview of the synergies that form between both types of transfer, consistent with the proposals of Ferreira and Teixeira (2019). Likewise, a subsequent study should be carried out that relates entrepreneurial orientation and attitude toward entrepreneurship to the performance of USOs in general terms.

Appendix

Questionnaire: Determining factors for the growth of university spin-off companies in Spain (<https://forms.gle/jQDQpZjbqNpExTT57>).


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