University Research and Creation of Spin-Offs: The Spanish Case

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ABSTRACT

Public administrations are aware of the importance of generating intellectual capital for the economic growth of a nation. Therefore, they have increasingly required universities to play a more active role in developing and exploiting the results of their research. This challenge has been taken on by universities, which have added a new mission aimed at increasing the value of their research through the transfer of new knowledge, experience and technological solutions to the market.

The backbone of the European innovation strategy is knowledge transfer from universities to companies, being the programmes supporting the creation of university spin-offs one of its pillars. The aim of this paper is to find out the factors determining the commercial exploitation of university research through companies created for this purpose. Consulting the websites of Spanish universities and their respective Technology Transfer Offices led to the identification of 499 spin-offs. By correlating their number and technological nature with the research potential of the university of origin, the general economic situation and the assistance received in creating this type of companies, through discriminant analysis, a positive relation was found between the creation of university spin-offs and the average number of projects achieved by the university, and their technological nature is positively related to the number of patents awarded to the university. This paper focuses on Spain; however, the aspects addressed are common to other countries, and therefore its results may be of interest to universities and policy makers wishing to promote the commercialisation of research outcomes.

Keywords: University Research, Academic Entrepreneurship, Spin-off, Knowledge Transfer, Spain

1. INTRODUCTION

The worldwide socio-economic evolution resulting from the technological innovations of the second half of the 20th century has led to a change in the role played by universities: these are now required to respond to growing industry needs, providing the market with new knowledge, expertise and technology (Karlsen *et al*., 2012, Berbegal-Mirabent *et al*., 2013). Thus, universities' genuine missions of producing knowledge and subsequently disseminating it through teaching and scientific publications have been complemented by a third mission, namely transferring technology to the production sector, where three main facets converge: entrepreneurship, innovation, and social engagement (Vorley and Nelles, 2008).

The paper by Etzkowitz *et al*. (2000) suggests that, from different bases but on a worldwide scale, a pattern of transformation towards an entrepreneurial university is emerging, as a response to the increasing importance of knowledge in national and regional innovation systems and the recognition that the university is an effective and creative inventor and transfer agent of both knowledge and technology. This phenomenon can be said to have originated in the United States' adoption of the Bayh-Dole Act in 1980, which grants universities property rights over their inventions. Under this legislation, pioneering institutions such as MIT, the University of California, Berkeley, and Stanford University found licences and patents to be alternative sources of funding other than public funds (Aceytuno and Cáceres, 2009). Given the success of this initiative, the governments of developed countries have implemented different spin-off support programs to promote the commercialisation of research stemming from universities Beraza-Garmendia and Rodríguez-Castellanos (2015). Thus, they have encouraged the establishment of public-private research partnerships, the creation of specialised transfer units, and the setting up of science parks and business incubators in order to facilitate knowledge transfer to the production sector (Beraza and Rodríguez, 2010; Lockett *et al*., 2005).

Europe has been no stranger to this phenomenon and, in this regard, the last decade has seen increasing political pressure in many European countries towards promoting the transfer of research outcomes to the market and strengthening the ties between universities, industries and governments (Algieri *et al*., 2013). Similarly Spain has taken on this policy, including among the missions of its universities the economic and social developments of the region where they are located, in the framework of what are known as "entrepreneurial universities". To this end, Spain promotes the development of research of excellence "with the aim of contributing to the advancement of knowledge, to innovation, to improving people's quality of life, and to the competitiveness of companies" (Spain's Organic Law on Universities - LOU). Thus, these promotion policies have led to an increase in research transfer activities and, in particular, to a rise in spin-offs (hereinafter USOs) within Spain's university system. The Latin-American higher education is characterized by a great diversity in its academic offer, its organization and its quality. Although in recent years educational policies have been priority, higher education shows large differences in teaching and research training of university professor, in the incorporation of subjects appropriate to the knowledge society, and in the use of new technologies (Fernandez and Coppola, 2013). Moreover, the lack of experience in the management of intellectual property, the state bureaucracy, the limited technological resources and their low demand, are aspects that hinder the linkage between universities and industry (Morales *et al*., 2012). However, in the last years Latin America has encouraged the university entrepreneurship, and countries like Argentina, Brazil, Chile, Colombia and Mexico, have created instruments to facilitate the linkage between universities and business sector (Rodeiro *et al*., 2010).

The economic valorisation of public research is of the utmost interest for different agents and institutions. The government and its agencies seek to make public research more cost-effective, and to this end they support an innovative economy. Although it should be considered that the commercialisation of successful innovations requires a combination of entrepreneurship, effective management, and a nurturing culture for research commercialisation (Zhao, 2007). For the regions, the commercialisation of public research means the creation of qualified economic activity in their sphere of action. Finally, for researchers-entrepreneurs, exploiting the outcomes of their research means obtaining financial resources, but it also enables them to foster their production and scientific publication processes (Manifet, 2008). Moreover, commercialisation is considered a prime example for generating academic impact, because it constitutes immediate, measurable market acceptance for outputs of academic research (Perkmann *et al*., 2013).

Traditionally, the establishment of licences has been the route for the commercialisation of intellectual property (Lockett *et al.*, 2005), although in the past two decades the creation of new knowledge-based companies has received growing attention by policy makers and managers of higher education institutions. Underlying this interest is the idea that universities have an underused entrepreneurial capacity that could contribute to creating wealth and increasing competitiveness (Ortín-Ángel and Vendrel-Herrero, 2014). In this regard, universities and governments see academic spin-offs as a means to leverage research results and as engines for regional renewal (Wallin, 2012). For Algieri *et al*. (2013) they are an important means in the technology transfer process between the public and private sector. Perceived as flexible and dynamic, USOs give rise to new fields and markets, and play a key role in developing high-tech clusters (OECD, 2001). Indeed, it can be said that university spin-off are potentially the most efficient means of transferring new knowledge into business, into new products and services (Sternberg, 2014).

Thus, university spin-offs have become an international phenomenon and have sparked political and academic debate, which recognises the need to understand their nature and the context in which they occur (Mustar *et al*., 2006). The first references can be found in McQueen and Wallmark (1982), but most of the literature on this issue has been produced in the last 15 years. This literature addresses, on the one hand, personal, institutional and environmental factors connected to the creation of university spin-offs, and on the other, their functioning and economic impact on regional economies. As regards the entrepreneurial aspect, most of the articles focuses on universities, as the major stakeholders of this research are university administrators and policy makers (Rothaermel *et al*., 2007). In this regard, authors such as Di Gregorio and Shane (2003), Lockett and Wright (2005) and O'Shea *et al*., (2005) explain the differences in the creation of spin-offs considering aspects related to the university's prestige and research activity and to its technology transfer policies.

From this standpoint the aim of the study was double. Firstly, to identify the factors that explain the relationship between research activity and the creation of spin-offs in Spain. Secondly, to determine which factors can be linked to the level of technology used by these companies. There are prior studies in this regard, but most of them have focused on the English-speaking world and many of them have used secondary data or primary data referring to a sample of spin-offs. The main contribution is the use of primary data referring to the population of Spanish university spin-offs, which will make it possible to overcome the principal limitations of previous research (Beraza and Rodríguez, 2010) and to contribute to further understanding of the factors determining the constitution of USOs in Spain. Moreover, the results achieved may serve to guide the establishment of policies encouraging their creation, particularly in Latin America where the creation of technology-based companies is still a challenge for universities in the region (Morales *et al.,* 2012).

Following this introduction, in which we have described our approach and justified our research, we will identify the variables that make it possible to estimate the research potential of Spanish universities. In the next section, we will describe the methodology used in our study. In the fourth section we will present the results obtained, and finally, the discussion and conclusions.

2. MEASUREMENT OF UNIVERSITY RESEARCH POTENTIAL

As has been pointed out, universities are organisations that perform a key role within society by educating large proportions of the population and generating knowledge (Perkmann *et al*., 2013). But do we have any indicators enabling us to outline a university's capacity to generate knowledge? How can Spanish universities' research potential be measured? For Beraza and Rodríguez (2009), analysing universities' research activity requires the use of diverse indicators, both of the resources used and of the outcomes achieved, because there is no single variable that can reflect universities' potential to generate knowledge. Accordingly, a variety of indicators are usually used in estimating it.

One of the major resources of universities is their human capital, especially their faculty. The faculty's activities include those involving teaching, their own training and, as the case may be, participation in management. Moreover, their work includes carrying out activities involving research, innovation and knowledge transfer. Thus, the number of faculty should determine the research potential of these organisations, and therefore, this variable is often used in weighting the data on production, in order to monitor the effect of the university's size (Buela-Casal *et al*., 2012). In this regard, it may be argued that greater availability of human capital will improve the university's skills and knowledge generation, thus expecting a positive relationship with its technology transfer activity (O'Shea *et al*., 2005).

The impact and visibility of Spanish universities' scientific research is usually measured by their position on rankings of production and productivity in research, and in this regard, the rankings produced annually by Buela-Casal *et al*., which follow the Berlin

Principles on Ranking of Higher Education Institutions (International Ranking Expert Group, 2006), are a national reference. One of the concepts taken into account in producing this ranking is related to the number of publications within the university. This indicator is used to measure the outcomes of scientific activity, and it is important to know the impact factor of these publications, because it makes it possible to estimate the scientific usefulness of the research (Beraza and Rodríguez, 2009). In this regard, previous papers have evaluated research by analysing the publication of articles in journals included in the Journal Citation Reports (Buela-Casal *et al*., 2012), and have even measured the excellence of academic staff through constructs resulting from comparing the number of faculty and the number of publications in the Science Citation Index (Gómez *et al.*, 2008). To produce this ranking, other variables are also taken into account, such as research tranches, doctoral dissertations, university teacher training (FPU) grants, and doctorate programmes awarded the "Mention towards Excellence" distinction. Thus, being in the top positions on rankings of production and productivity in research can be expected to be positively associated with universities' technology transfer activity and, consequently, on the number of USOs created and on their level of technology (Di Gregorio and Shane, 2003; Gómez *et al.*, 2008).

Furthermore, the number of USOs and their technological level could be expected to be determined by activities related to innovation and knowledge transfer, which can be estimated by the number of patents, the number of inventions reported, and the number of licences and agreements signed (Di Gregorio and Shane, 2003; O'Shea *et al*., 2005).

In order to consider human capital's exposure to the industrial environment, previous literature has measured the proportion of academic staff involved in research contracts (Gómez *et al*., 2008). From this standpoint, we consider that participation in research projects could be an even more relevant aspect, because research contracts usually have a specific purpose for existing companies, whereas projects make it possible to conduct basic research which, if successful, could lead to the creation of a new company. Moreover, patents are linked to universities' knowledge stock and could help companies obtain new outputs (Berbegal-Mirabent *et al.*, 2013). Therefore, participation in research contracts, number of public grants the university has successfully competed for, and the number of patents registered in a university can be expected to be positively related with the creation of USOs and their technological level.

3. METHODOLOGY

To meet our goal in this paper, we needed to identify, on the one hand, the spin-offs stemming from Spanish universities and the level of technology that they use, and on the other, the features that make it possible to measure the research potential of each university.

Academic literature refers to spin-offs when a new firm is formed from a university research group, when an employee leaves his or her company to start a new firm, or when a firm is split up in independent parts (Wallin, 2012); therefore, the term has a wide range of possibilities as regards its defining features. In this paper, spin-offs will refer to those companies promoted by academics in order to commercially exploit the outcomes of their research, either for industrial purposes, or with the aim of providing services.

In the absence of official lists, it was necessary to conduct a search for the USOs that are currently operating in our country. For this purpose, in early 2013 we looked up the websites of Spain's 61 universities and their respective Research Results Transfer Offices (OTRIs). In this process we found a total of 904 companies, but in many cases the information came from lists of companies that are in some way related to the university, because USOs were not clearly identified. Therefore, the next step consisted in cleaning up this database and selecting only those companies that met the requirements to be considered university spin-offs. Specifically, an individualised search was carried out for all companies located in technological parks or business incubators. Those which did not refer expressly to their university origin were deleted, as were those that, having stemmed from a university, had been created by university graduates and not by researchers. Also excluded were those companies whose formal existence could not be verified, and those that were being liquidated. Finally, comprised a total of 499 USOs linked to 45 universities. For each one of these companies, information is available on its corporate name, the university it stemmed from, the activity it carries out, identified by the National Classification of Economic Activities code (2009). In addition, we have taken into account the manufacturing and services sectors that use a higher level of technology than the rest, according to the criteria established by Spain's National Statistics Institute. The technological level of university spin-offs was measured using the variable TECHNOLOGY-USO.

Once the spin-offs created by each university were known, measured using the variable NUMBER-USOs, the basic features of the universities were identified, as well as certain aspects linked to their research and transfer activity. The definition of the variables considered in this paper and the sources from which they were obtained can be found in Appendix 1. Specifically, the variable (SIZE), based on the number of teachers, was taken into consideration to measure the size of each university. To quantify research activity, four variables have been taken into account: the number of research projects achieved (PROJECTS); the number of contracts for research, development, technical support and consultancy services (CONTRACTS); the number of patents registered (PATENTS); and each university's position on the overall ranking of Spanish universities' research activity in 2011 (RANKING).

Our main goal was to identify the relationship between research activity and the creation of spin-offs; however, in the existing literature diverse factors relating to the context in which spin-offs emerge have been identified. These have been taken into account in determining the model, and three control variables have been introduced. The first two are related to the economic potential of the region in which the university is located, because the level of economic development and growth of the university's surroundings can be expected to be positively correlated with the creation of companies in general, and of USOs in particular. In this regard, the variables considered were the average per capita GDP as compared with Spain's index during the 2006-2010 period (GDP), and the average accumulative growth rate of per capita GDP during the 2006-2010 period (GDP-GROWTH).

The third control variable sought to measure the average assistance provided by universities, which was also expected to be positively correlated with the creation of USOs. This variable (ASSISTANCE) was calculated as the arithmetic mean of three others which categorized universities according to whether they provided economic assistance for creating USOs; whether they provided physical premises for their establishment; and whether they gave advice on setting them up.

The data on the dependent variables refer to 2013, whereas for some of the independent variables, prior periods have been considered. This is so because the period of time when research activity is being conducted and the moment when, as the case may be, a USO is set up do not normally coincide; the setting up of a USO can be expected to occur after the generation of knowledge (Lockett and Wright, 2005).

In view of the characteristics of the data obtained, and in order to identify which aspects of universities' research activity affect the creation and type of USOs, the decision was made to perform a stepwise discriminant analysis (Sánchez and Luque, 2012). This analysis option was chosen for two reasons. Firstly, the basic purpose of this study was to determine the relationship between the performance of a dependent variable (assessed using a dichotomous variable) and a set of indicators under the assumption that the latter are a possible cause of the former. This configuration of the variables makes the use of this technique especially appropriate; in addition, it will enable us to assess the relative importance or weight of each value of the independent magnitudes in determining the performance of the dependent variable. Secondly, having eight independent measurements makes it especially necessary to reduce the dimension of the problem and develop a model consisting of the fewest possible independent variables. In line with this, the stepwise estimation procedure of discriminant functions enables us to create a model consisting exclusively of the independent variables that offer the greatest discrimination and prediction capabilities, and even eliminating possible redundancies among them.

Our goal was to determine, firstly, which factors determine the fact that certain universities are especially prolific in creating USOs, and, secondly, which factors can be linked to these companies' level of technology; therefore, we applied the discriminant analysis twice. In both cases, the independent variables considered were the above-mentioned eight: SIZE, PROJECTS, CONTRACTS, PATENTS, RANKING, GDP, GDP-GROWTH and ASSISTANCE. However, in the first case the dependent variable was the number of spin-offs created by each university (NUMBER-USOs), and in the second case the dependent variable was the technological level of the university spin-offs (TECHNOLOGY-USO).

In both cases, we considered the arithmetic mean of the recorded values as the cut-off value. The average number of spin-offs created by Spanish universities is 11. Thus, in the first discriminant analysis, the dependent variable (NUMBER-USOs) took value 1 if the number of spin-offs created was 11 or more, and 0 if it was fewer than 11. For its part, the average number of university spin-offs operating in high-tech or medium-high-tech sectors is 5. Thus, in the second discriminant analysis, the dependent variable (TECHNOLOGY-USO) took value 1 if the number of technological spin-offs was 5 or more, and 0 if it was fewer than 5.

4. RESULTS

As noted above, the first phase of our research was aimed at determining whether there is a relationship between university research activity and the number of spin-offs stemming from the university. To this end, we firstly identified the differences between the two groups defined by the dependent variable with regard to the measurements corresponding to the values of the independent variables considered. Table 1 shows the statistics of the group. However, as can be observed in Table 2, only three of the eight independent variables (PROJECTS, CONTRACTS and RANKING) show significant difference between the two groups considered.

TABLE 1. STATISTICS OF THE GROUP

TABLE 2. TEST FOR EQUALITY OF MEANS

Specifically, it can be seen that group 1, comprising the most active universities in terms of creating USOs, has higher values for the three variables, achieving, on average, a higher number of research projects and a larger amount for research contracts, and accordingly being in higher positions on the ranking of universities' research activity.

In general, the existence of these significant differences between the two groups as regards this set of variables suggests the possibility of developing an explanatory model which would make it possible to predict assignation to said groups on the basis of assessment of individuals in relation to these variables. Given that the dependent variable divides the sample into two groups, discriminant analysis will offer a single discriminant function, which will be the basis of the classification and prediction criteria. The corresponding Box's test confirms the appropriateness of applying discriminant analysis (Box's M 1.487; p=0.229).

In this case, the discriminant function has a canonical correlation of 0.403, which indicates that said function has a medium association with the dependent variable that is to be predicted. However, the results of the analyses carried out reveal the clear existence of significant differences in the mean discriminant scores of both groups (Wilks' Lambda = 0.837; significance = 0.009), which shows that said function has a certain discriminant capability among the groups defined by the dependent variable.

The stepwise introduction procedure resulted in including in the discriminant function only one of the eight independent variables considered. Table 3 shows the values of said variable's standardised coefficients in the discriminant function.

TABLE 3. STANDARDISED COEFFICIENTS OF THE DISCRIMINANT FUNCTION

These values allow us to conclude that with a single variable, which measures the average of the total number of research projects obtained by universities in public competitive tenders during the 2006-2010 period, we can explain the creation of more or fewer USOs by Spanish universities. Specifically, we can conclude that the number of research projects obtained by the university will be positively correlated with the creation of USOs.

TABLE 4. FUNCTIONS IN THE CENTROIDS OF THE GROUPS

As regards the model's predictive capability (Table 5), the results show that the discriminant function is capable of accurately predicting a total of 73.3% of the cases.

Moreover, it can be seen that this predictive capability as regards the group of universities that create the most USOs reaches rates of 55.6%, a percentage that is considerably lower than that for the group of universities that create the fewest USOs (85.2%). In general, the solution leads to significant improvement in the classification of cases, because the hit ratio is higher than the percentage of cases that could be classified accurately by chance (50%). Furthermore, Press's Q statistic corroborates the model's predictive capability (Q=9.8).

TABLE 5. CLASSIFICATION RESULTS

The second phase of our research was aimed at verifying whether there is a relationship between universities' research activity and the technological level of the spin-offs. In this regard, we once again conducted a discriminant analysis, with the results described below. It did not meet Box's test. However, the balanced size of the groups means that non-compliance with this requirement is not critical in carrying out the discriminant analysis (Box's M 11.877; p=0.001).

Table 6 shows the statistics of the group. As for the test for equality of the means of the independent variables (Table 7), significant differences have been found in four of the eight variables considered in the analysis: PROJECTS, CONTRACTS, PATENTS and RANKING. In all four cases, the mean scores obtained are higher in the group of universities that have 5 or more technological USOs. Thus, we can conclude that universities that create a greater number of technological spin-offs are those that achieve a greater number of research projects, which obtain a larger amount for research contracts, that register and exploit a greater number of patents, and that are in the highest positions on rankings of universities' research activity.

TABLE 6. STATISTICS OF THE GROUP

TABLE 7. TEST FOR EQUALITY OF MEANS

TABLE 8. STANDARDISED COEFFICIENTS OF THE DISCRIMINANT FUNCTION

Once again, the result of the procedure applied meant that only one of the seven independent variables considered was included in the discriminant function. Table 8 shows the values of said variable's standardised coefficients in the discriminant function. These values allow us to conclude that with a single variable, PATENTS, we can explain the higher or lower number of technological spin-offs at Spanish universities. More specifically, the larger the number of patents registered and exploited, the larger the number of technological spin-offs at that university.

TABLE 9. FUNCTIONS IN THE CENTROIDS OF THE GROUPS

As regards the model's predictive capability, the results show that the discriminant function is capable of accurately predicting a total of 66.7% of the cases. Moreover, it can be seen that this predictive capability as regards group 2, which includes universities that have the fewest technological spin-offs, reaches rates of 84%, a percentage that is considerably higher than that of group 1 (45%). But, in general, the solution leads to significant improvement in the classification of cases, because the hit ratio is higher than the percentage of cases that could be classified accurately by chance (50%). Furthermore, Press's Q statistic corroborates the model's predictive capability (Q=5.00).

TABLE 10. CLASSIFICATION RESULTS

5. DISCUSSION AND CONCLUSIONS

In the early 21st century, academia can be seen to be playing a more active role in developing and exploiting the outcomes of its research. This has led certain authors to speak of a new pattern in the functioning of modern universities, a pattern that they call the "entrepreneurial paradigm" (Etzkowitz, 2003). In this context, university spin-offs, companies stemming from research carried out at universities, have become an important mechanism for knowledge transfer to the private sector, given their potential for the economic and social development of a territory, and have attracted great interest among academics and public institutions. In the current debate, it is particularly relevant to understand their nature and describe the environment in which they are born, because this will make it possible to implement policies aimed at encouraging their creation.

The aim of this paper has been to show the relationship between the university research carried out in Spain and its commercialisation through the creation of spin-offs, by identifying the factors which can be associated with the number and technological nature of these firms. To this end, we have considered all of Spain's universities and all the spin-offs stemming from them. In line with the results obtained in the USA (O'Shea *et al.*, 2005) and in some European countries (Gómez , *et al.*, 2008), we can conclude that there is a relationship between the number of spin-offs created, together with their level of technology, and the research activity of the university of origin. Specifically, the results of our study show that Spanish universities that achieve a greater number of research projects in competitive public tenders are usually those that create a greater number of spin-offs. Moreover, on the basis of their technological level, it has been seen that those spin-offs that use a higher level of technology stem, to a greater degree, from universities that have registered and exploited a greater number of patents.

It seems logical for the technological level of university spin-offs to be determined by the number of patents obtained within the university. However, it is surprising to find that the only positive relationship detected is that between the creation of university spin-offs and the achievement of research projects. And this is because, contrary to what was the case in previous research in US (O'Shea *et al*., 2005; Di Gregorio and Shane, 2003) and Europe (Gómez *et al.*, 2008; Algieri *et al.*, 2013), variables such as the size of the university, the amount for investigation contracts, the university's position on the research rankings and the economic development of the region in which the university is located are not linked to the creation of more or fewer spin-offs.

This leads us to conclude that basic research, that which is carried out through research projects, is actually the factor with decisive impact on the creation of spin-offs, and, therefore, on the development of a region's entrepreneurial fabric. Research contracts are usually formalised between university staff and companies that already exist; thus, the outcomes achieved will be applied in those companies and will not usually lead to the creation of new companies. Moreover, university rankings are designed on the basis of considering certain variables, such as patents, articles published in journals included in the JCR or number of doctoral dissertations, which do not necessarily lead to the creation of USOs.

Furthermore, as is the case of the study by Sternberg (2014) in Germany, neither has obtaining assistance turned out to be a determining factor in the creation of university spin-offs. This suggests that when university research generates business opportunities, business occurs regardless of the wealth of the region in question and of the economic and/or technical advantages that may be found.

In view of the relationship between generating university knowledge and creating spin-offs, the importance of continuing to support public research is clear, especially in these times when economic growth depends on continuous innovation and increasing technology. Moreover, we can expect the constraints on public spending which have occurred in recent times to have a significant influence on the generation of university knowledge in the near future and, consequently, on the future generation of economic growth through the creation of companies. Therefore, and especially at times of crisis like these, when the need to properly manage resources is even more obvious, we suggest the need to channel resources towards promoting research that effectively reverts back to society.

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Table 1. Statistics of the Group

	Group 1 (11 or more spin-offs)		*Group 2 (10 or fewer spin-offs)*	
	Mean	***Standard deviation***	***Mean***	***Standard deviation***
SIZE	**1514.73**	**781.87**	**1041.28**	**793.43**
PROJECTS	**83.94**	**46.24**	**49.01**	**35.05**
CONTRACTS	**21.89**	**21.57**	**8.86**	**7.52**
PATENTS	**26.31**	**20.20**	**16.98**	**21.20**
RANKING	**44.21**	**25.27**	**25.43**	**19.60**
GDP	**100.96**	**21.01**	**100.18**	**21.26**
GDP GROWTH	**.114**	**.883**	**.605**	**.960**
ASSISTANCE	**.648**	**.213**	**.579**	**.206**

Table 2. Test for Equality of Means

	Wilks' Lambda	F	df1	df2	Sig.
SIZE	**.915**	**3.641**	**1**	**39**	**.064**
PROJECTS	**.837**	**7.579**	**1**	**39**	**.009**
CONTRACTS	**.842**	**7.299**	**1**	**39**	**.010**
PATENTS	**.950**	**2.039**	**1**	**39**	**.161**
RANKING	**.844**	**7.198**	**1**	**39**	**.011**
GDP	**1.000**	**.013**	**1**	**39**	**.908**
GDP GROWTH	**.932**	**2.832**	**1**	**39**	**.100**
ASSISTANCE	**.973**	**1.079**	**1**	**39**	**.305**

Table 3. Standardised Coefficients of the Discriminant Function

Variable	Coefficient
PROJECTS	1.000

Table 4. Functions in the Centroids of the Groups

Creation of spin-offs	Function
	1
Group 1 (11 or more spin-*offs)*	**.574**
Group 2 (10 or fewer spin-offs)	**-.397**
Unstandardised canonical discriminant functions evaluated at group means	

Table 5. Classification Results

			Predicted group assignment		Total
			Group 1	**Group 2**	
Original	**Count**	**Group 1**	**10**	**8**	**18**

group		Group 2	4	23	27
	%	Group 1	55.6	44.4	100.0
		Group 2	14.8	85.2	100.0

Table 6. Statistics of the Group

	Group 1 (5 or more technological spin-offs)		Group 2 (4 or fewer technological spin-offs)	
	Mean	***Standard deviation***	***Mean***	***Standard deviation***
SIZE	**1470.11**	**762.42**	**1038.68**	**823.24**
PROJECTS	**80.08**	**45.05**	**49.37**	**37.06**
CONTRACTS	**20.53**	**21.12**	**8.92**	**7.14**
PATENTS	**28.97**	**25.81**	**13.56**	**11.42**
RANKING	**42.57**	**24.65**	**25.20**	**20.28**
GDP	**101.31**	**22.16**	**99.77**	**20.14**
GDP GROWTH	**.203**	**.821**	**.566**	**1.044**
ASSISTANCE	**.583**	**.212**	**.634**	**.208**

Table 7. Test for Equality of Means

	Wilks' Lambda	F	df1	df2	Sig.
SIZE	**.928**	**3.023**	**1**	**39**	**.090**
PROJECTS	**.872**	**5.704**	**1**	**39**	**.022**
CONTRACTS	**.873**	**5.673**	**1**	**39**	**.022**
PATENTS	**.863**	**6.214**	**1**	**39**	**.017**
RANKING	**.865**	**6.092**	**1**	**39**	**.018**

GDP	**.999**	**.055**	**1**	**39**	**.817**
GDP GROWTH	**.963**	**1.516**	**1**	**39**	**.226**
ASSISTANCE	**.984**	**.615**	**1**	**39**	**.438**

Table 8. Standardised Coefficients of the Discriminant Function

Variable	**Coefficient**
PATENTS	1.000

Table 9. Functions in the Centroids of the Groups

Technological level	**Function**
	1
Group 1 (5 or more technological spin-offs)	**.399**
Group 2 (4 or fewer technological spin-offs)	**-.380**
Unstandardised canonical discriminant functions evaluated at group means	

Table 10. Classification Results

			Predicted group assignment		Total
			Group 1	**Group 2**	
Original group	**Count**	**Group 1**	**9**	**11**	**20**
		Group 2	**4**	**21**	**25**
	%	**Group 1**	**45.0**	**55.0**	**100.0**
		Group 2	**16.0**	**84.0**	**100.0**

APPENDIX 1. VARIABLES CONSIDERED

VARIABLE	**DESCRIPTION / SOURCE / VALUES**	
NUMBER-USOs	Number of spin-offs created by the university *Source:* Websites of each university	1: More than 11 2: 10 or fewer

	and/or their respective TTOs	
TECHNOLOGY-USO	Level of technology used by the spin-off in the performance of its activity. *Source:* National Statistics Institute.	1: If it operates in high-tech or medium-high-tech sectors 0: If not
SIZE	Average number of faculty (professors, associate professors and lecturers). 2006-2010 period *Source:* Observatory of Spain's University Institute of Specialised Education (http://www.iune.es)	
PROJECTS	Average of the total number of research projects obtained by universities in competitive public tenders (National Plan or European Union Framework Programme). 2006-2010 period *Source:* Observatory of Spain's University Institute of Specialised Education (http://www.iune.es)	
CONTRACTS	Average of the amount obtained by universities for activities involving research, development and regulated technical support through a contract between parties, as well as for consultancy services that do not generate scientific or technological knowledge. 2006-2010 period *Source:* Observatory of Spain's University Institute of Specialised Education (http://www.iune.es)	
PATENTS	Number of patents registered in the 2006-2010 period and exploited in the 2004-2008 period. Weighted values (base 100) *Source:* Buela-Casal *et al.* (2012)	
RANKING	Ranking of universities' research potential. Variables considered: articles in journals included in the JCR, research tranches, R&D projects, doctoral dissertations, grants for research training, doctorate programmes of excellence, and patents. Weighted ranking values (base 100). *Source:* Buela-Casal *et al.* (2012)	
GDP	Provincial per capita GDP (average over Spain's 2006-2010 index) *Source:* National Statistics Institute	
GDP GROWTH	Average accumulative growth rate of provincial per capita GDP (2010-2006) *Source:* National Statistics Institute	
ASSISTANCE	Average assistance provided by universities. The values were obtained by assigning a 1 to each of the following possibilities: advice, physical premises and funding *Source:* Websites of each university and/or their respective TTOs	