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Do universities affect firms' location decisions? Evidence from Spain

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Do universities affect firms' location decisions? Evidence from Spain *

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Abstract

By exploiting the changes from introduction of the university reform act of 1983, which fostered the foundation of universities and faculties, this paper examines whether the presence of a university (or faculty) affects the creation of new firms. Largely, the literature of university spillovers has considered only heterogeneous spillovers. It is also interesting to identify the underlying heterogeneity in the different types of knowledge generated by universities. This work contributes to identifying more accurately modes for knowledge spillovers mechanisms by distinguishing the academic fields through which the university could influence their regional milieu. The conclusion that can be drawn is that the foundation of Sciences and Social Sciences faculties has a strong influence in the creation of new firms.

Keywords: universities, regional economic growth
JEL Codes: I23; O31; R12; R39; C23.

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1. Introduction

Universities have long been recognized as important actors in technological change and economic development. In recent decades many countries have increased the incentives and pressures on universities to become more involved with their regions. Most universities have responded by offering new programs and building branch operations closer to commercial activity. In addition, a key issue in the relationship between universities and regional government has been to foster entrepreneurship and firm formation. To do that, typically the regional policy has tried to lever the presence of local research universities, increase the availability of venture capital, encourage a culture of risk taking, and create strong local informational and business development networks (Feldman, 2001).

The relationship between university and regional development has been analyzed from several perspectives [See Goldstein and Drucker (2007) for an overview]. Few studies, however, have analyzed the role of universities as attractor, educator and retainer of students, shaping them into knowledge-based graduates for firms in the region (Boucher et al. 2003; Bramwell and Wolfe, 2008). According to these studies, the presence of a university affects the local labour market and contributes to the stock of tacit knowledge to provide formal and informal technical support. Some studies have addressed the important issue of analyzing the effects that the R&D activities have on the rise of productivity and economic growth. Goldstein and Drucker (2006) found out that the university activities of research, teaching, and technology development help to raise the economic development measured by average annual earnings. Sterlacchini (2008) confirmed the existence of a positive and significant relationship between the economic growth of European regions, and their knowledge base and human capital endowments, captured respectively, by the R&D expenditures and the proportion of adults with tertiary education. However, the impact of R&D is significant only for the regions that are above a given threshold of per capita GDP. Andersson et al. (2009) investigated the economic effects of the Swedish decentralization policy of post-secondary education on the level of productivity and innovation, and their spatial distribution in the national economy. Their model estimated the effects of university-based researchers on the productivity and innovation activity (award of patents) of local areas. They found a link between the number of university researchers in a community and the per worker output in that community.

Another important approach which has devoted considerable effort to understanding the contributions of universities is the generation of knowledge spillovers. Varga (2000) characterized three different kinds of university spillovers: information transmission through

personal networks of university and industry professionals, technology transfers via formal business relations, and spillovers promoted by universities' physical facilities. Audretsch et al. (2004) provided strong evidence about the generation of knowledge spillovers from the German university system. They tested the hypothesis whether knowledge spillovers generated by universities are homogeneous with respect to different scientific fields. By distinguishing research and education in two different fields, natural sciences and social sciences, they confirmed the influence of knowledge spillovers in the strategic decisions of firms location. Audretsch et al. (2005b) corroborated that new knowledge and technological-based firms have a high propensity to locate close to universities. According to this work, the two main types of spillovers are research and human capital, namely, the scientific research published in scholarly journals and the human capital embodied in students graduating from university. Also, it has been demonstrated that university spillovers occur through both geographically localized mechanisms being significantly larger for firms that are technologically closer to research universities (Kantor and Whalley, 2009), and collaborative research over longer distances (Ponds et al. 2009).

Some studies of knowledge spillovers have tackled more directly the analysis of the links between HEIs and new firm formations. In these studies, it has also been important to analyze the fundamental factors in the formation of an entrepreneurial culture that Feldman (2001) synthesized as; supportive social capital, venture capital, entrepreneurial support services and actively engaged research universities. Thus, new firm start-ups should be positively associated both with higher levels of educational attainment (Acs and Armington, 2002), and university research (Colombo et al. 2010). Woodward et al. (2006) pointed out a potential relationship between local university R&D expenditures (mainly science and engineering) and the total number of newly created high-technology plants by county. Kirchhoff et al. (2007) found that university R&D expenditures are positively related to new firm formations, and consequently, it stimulates employment growth. More recently for the Spanish case, Acosta et al. (2009) found out that the main source of university spillovers explaining High-Tech new business location close to universities, is the number of graduates.

Largely, the literature has considered only heterogeneous spillovers. However, the universities carry out activities (research and teaching) in several scientific disciplines with a very different degree of industrial and commercial applicability. Therefore, it would also be interesting to identify the underlying heterogeneity in the different types of knowledge generated by universities. The purpose of this paper is twofold. First, we contribute to the empirical literature on the relationship between universities and regional economic development. More precisely, we analyze the effect that the university presence has on the creation of new firms. Second, we contribute to identifying more accurate modes for knowledge spillovers mechanisms by distinguishing the academic fields through which the

university influences their regional milieu more significantly. We address the following research questions:

- Does the creation of faculties affect the firm formations in the closest regions?
- Does the kind of science matter in order to explain the creation of firms?
- Does the foundation of faculties explain the creation of High-Tech firms?

The study of the university's presence effects on the regional entrepreneurial activity have been an important topic in the literature. Our study contributes to the literature on universities and firm formations (Kirchhoff, 2006; Feldman, 2001; Audretsch, 2005a; Acosta et al. 2009), adding new evidence but also identifying more precise modes for knowledge spillovers mechanisms. To do that, first, we take a period of analysis during of which an important university reform was introduced. The University Reform Act encouraged to Spanish regions to create its own universities, therefore, the Spanish public university system experienced a significant territorial expansion. This Act represents a natural experiment that can be used to estimate the effects of university spillovers on the creation of new firms. Moreover, using the Difference in Difference Approach is possible to compare changes in the entrepreneurial activity before and after to law adoption. Second, by distinguishing the faculty foundations in main academic fields, we can identify more specific knowledge spillovers mechanisms. Next to identifying causal effects of faculty creation, we are also interested observing which industrial sectors are influenced. More precisely, we analyze whether the creation of faculties has an effect on firm formations in high and medium technology sectors.

The main findings can be summarized as follows. The creation of faculties in academic fields such as the sciences and social sciences has had a positive effect on the formations of new firms. We find no evidence that the foundation of faculties has some effect on the creation of firms in High-Tech industrial sectors. The remainder of the paper is organized in the following manner; Section 2 describes the main features of the university reform act of 1983 and their principal implications on the creation of new universities or faculties. Section 3 contains the description of data and details of the empirical strategy. Section 4 shows the results, and finally, section 5 concludes.

2. The University Reform Act of the 1980s.

In the Spanish case, there exists an interesting historic fact that can be useful to analyze the linkage between universities and firm formation. This section gives a short background and description of the university reform act, the so-called LRU (by its Spanish acronym) that has been the most important university reform in recent decades. The LRU was adopted in 1983 and implied several and radical changes. However, two aspects of this reform have a specific

interest to this study. Firstly, the decentralization process from the central government to regional governments for the planning and administration of higher education. The act transferred, to regional governments, the development their own higher educational policy, it could imply the creation of new universities. Indeed, many regions created their own universities and they opened at least one faculty in every academic field over this period. Secondly, the LRU also meant University autonomy. It gave to university governments the control over planning and management, including financial autonomy. Most of the universities increased their operations, and diversified their presence into new territories after the LRU act was implemented (See Figure 2). In addition, during the 1980s, the number of university students grew rapidly. In 1970 the number of university students was 352,000, by 1980 it had reached 698,000, and in 1985 it had grown to 935,000 students (Hernández, 1983). Consequently, the university system experienced an unprecedented expansion.

3. Data and Estimation strategy

In order to analyze the effect that the university presence has on the formation of new firms, we assembled a data set for the Spanish provinces (NUTS 3) during the period 1980 - 1994. This section starts by describing the data collection and the definition of variables, it continues with details about the estimation strategy, including a brief explanation about empirical approach, and finally, it presents the specification adopted in order to carry out the econometric analysis.

In Spain there are 50 public universities located in 43 out of the 52 Spanish provinces¹. This public university system is constituted of 470 faculties across the different academic fields (INE, 2009). It has been possible to get information for 224 faculties, 38% of which were founded after the LRU act. Our study exploits the differential timing of faculty foundations in each academic field across Spanish provinces, to identify how a university presence affects new firm formations.

3.1 Data

As already noted in the previous section, because our main hypothesis assumes that the relationship between universities and the creation of firms depends on the academic field, we distinguish the university presence through five knowledge fields, namely: sciences, engineering, medicine, social sciences and humanities. For every province, we took the year of faculty foundation in each academic field. We are only interested on the faculty founded over

¹ Some of the largest Spanish universities have campuses in different provinces. For instance, The Universidad de Castilla-La Mancha has four campuses across four different provinces: Albacete, Ciudad Real, Cuenca and Toledo.

the period of analysis. This data was hand-collected from each university website. This information was in most cases complemented and confirmed with faculty staff via email. Hence, our setting provides a unique opportunity to analyze the linkage between university presence and new firm formations.

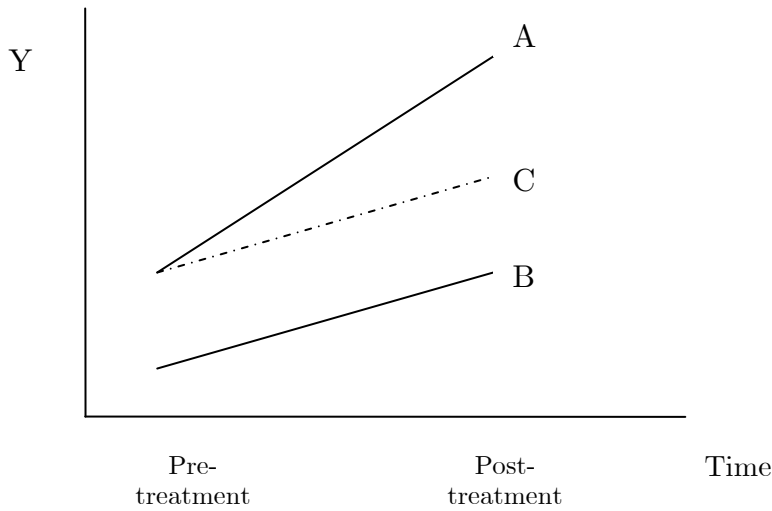
Our main outcome variable is the creation of industrial firms throughout the Spanish provinces in a given year. The database on new firm formations comes from the Register of Industrial Establishments. 124,957 new firms were created in the Spanish manufacturing sector during the period considered. We complement our panel with a control variable for the province size. A variable of extended use in the literature on the location of new firms is the population (Acs and Armington, 2002; Costa et. al, 2004). It is a good way to approximate the market potential. Hence, the logarithm of population is included. This data is obtained from the National Statistics Institute (INE).

3.2 Estimation strategy

After the LRU act, most regions founded at least one faculty in every academic field, but the starting year varies between regions, as was illustrated in Figure 2. Exploiting the geographic and temporal variation in the foundation of faculties, we can compare the creation of firms before and after the foundation of the faculty in the different regions. Hence, we use a difference-in-differences approach (DD) to estimate the effect that the foundation of faculties has had on the creation of new industrial firms in the period. This strategy allows avoiding endogeneity problems that typically arise when making comparisons between heterogeneous individuals (Bertrand, M. et. al, 2004).

The fundamental idea of the DD-estimator can be explained graphically with the help of figure 1. The DD-estimator takes the “normal” difference between the treatment and control group as the distance CB and estimates the treatment effect as the distance AC. (See graph 1). Here, the assumption that the trend in Y is the same in both treatment and control group is made. Also, the DD-estimator assumes that any differences in the change in means between treatment and control groups are the result of the treatment. Finally, the DD method is based on the idea that the unobserved provincial component does not vary over time within a group. If any of the assumptions listed above do not hold then we have no guarantee that the DD-estimator is unbiased. For example, one of the most common problems with DD estimates is the failure of the parallel trend assumption. One way to help avoid this problem is to get more data on other time periods before and after treatment to see if there are any other pre-existing differences in trends.

Figure 1: Difference in Difference Analysis.



The DD-estimator has the following form:

$$Y_{it} = \beta_0 + \beta_1 X_i + \beta_2 T_t + \beta_3 X_i * T_t + \varepsilon_{it} \quad (1)$$

Where X_i is a dummy variable taking the value 1 if the individual is in the treatment group, 0 if they are in the control group, and T_t is a dummy variable taking the value 1 in the post-treatment period and 0 in the pre-treatment period. In this specification, the DD-estimator is going to be β_3 , the coefficient on interaction between X_i and T_t . It is a dummy variable that takes the value 1 only for the treatment group in the post-treatment period. In addition, the DD approach is based on the assumption that the influence of other factors can be controlled for by a comparison with a province which is similar in every aspect that affects firm formation, but that has not created a faculty. The description above assumed only two provinces and two time periods. However, in this study there are several provinces, and they created their faculties in different years. Indeed, the idea behind the DD-estimator for our data is the same as for the two-period case, that is, it controls for time-varying factors that affect all provinces and industrial sectors similarly, and it controls for fixed province and industrial sector characteristics.

In our econometric framework only the foundation year of faculty is assumed to be exogenous. The estimations consider the provinces where any faculty was founded. Moreover, according to Varga (2000), Audretsch (2005b) and Acosta (2010) the main source of university spillovers is the number of graduates, hence, it is fair to assume that the effects of university presence on regional economy occur five years after its foundation. Therefore, the provinces with faculties founded from 1975 onwards are included in the DD analysis.

The DD-estimation equation, for our panel data for the creation of firms in 50 provinces over fifteen years, is given in equation (2)

$$Y_{ijt} = \alpha_{ij} + \beta_1 Fac_{it} + \beta_2 Pop_{i,t-1} + \gamma_{jt} + \varepsilon_{ijt} \quad (2)$$

The dependent variable is the number of new industrial establishments in province i , year t and industrial sector j . The main explanatory variable is the dummy variable Fac_{it} , which equals one since year t in the province i it has had a faculty foundation, and is zero otherwise. As an objective of this study is to analyze whether in order to produce knowledge spillovers the kind of science matters, the variable Fac alternates between five academic fields, namely; sciences, engineering, medicine, social sciences and humanities. It is also interesting to examine whether the kind of faculty founded has specific effect on a particular industrial sector. Specifically, we are interested in testing the existence of a relationship between the creation of faculties and High-Tech firm formations. Therefore, the interactive term between the kind of science and the industrial sector is included.

We define 34 industry sectors to better control for aggregation effects in regions with a different distribution of industries. Industry codes are based on the two-digit National Classification of Economic Activities (NACE 93 Rev.1). In order to absorb both industrial sector and years shocks, an interactive term between time dummies and industrial sector dummies is included. The introduction of both a time dummy and an industrial sector dummy, in a separate way, implies that to assume that the different economic booms have the same effect on every industrial sector. To avoid this, an interactive dummy (γ_{jt}) between industrial sector and year is included. This is a more flexible alternative and thus allows each sector and year to have a specific shock. As for the control variable, we introduce a lag of the log of province population ($\ln Pop_{i,t-1}$). Finally, in order to control for unobserved regional heterogeneity, province and industrial fixed effects (α_{ij}) are also included in the model.

From a statistical viewpoint, given the dependent variable has the features of count data, it can be assume that this variable followed a Poisson distribution. That is, that has large numbers of the smallest observation and remaining observations taking the form of small positive numbers. In this case, Poisson model seems to be more appropriate for count data. In addition, the Poisson model, as compared to other count models (i.e., negative binomial or zero-inflated models), is assumed the appropriate model. In other words, we assume that the dependent variable is not over-dispersed and does not have an excessive number of zeros.

The following section presents the results of the estimations of equation (2).

4. Results

The results of the estimation of equation (2) are shown in table 1. The results come from separate regressions for each academic field. The specification in column (1) includes the creation of science faculties' dummy together with fixed province specific effect and time and industrial sector effects. Also, in order to test the linkage between the foundation of science faculties and the creation of High-Tech firms, the variable 'science and High-Technology industries' is included. Similarly, in columns (2) to (6) the specifications alternate the variable for each academic field. As discussed in the previous sections, we expect that the creation of new firms will be affected by the faculty foundation. The direction of the expected effect is positive.

The DD-results in table 1 column (1) show that our coefficient of interest on science faculties' dummy is approximately, and statistically significant at the 1% level. That is, there exists a significant positive effect of the creation of Sciences faculties on firm formations. In column (2), our variable of interest *Fac* alternates to the dummy for the creation of social science faculties. This last coefficient is positive and also statistically significant. The column (3) shows the results for the foundation of engineering faculties. We expected a positive and significant coefficient for engineering dummy's coefficient, given the existence of strong links with the industrial sector. However, our results do not corroborate this hypothesis. Although previous literature have only distinguished between natural sciences and social sciences, Audretsch (2005) introduced a dummy to identify if the type of university corresponded to a technical university. He found out that the technical universities play as an important variable for location decision in older firms case, but not for younger firms.

In columns (4) and (5), the dummy *Fac* changes between medical and humanities, respectively. In both cases seem to have no statistically significant impact on new firm formations. On the other hand, as mentioned before, we are particularly interested to capturing the effect of faculty foundation on the creation of firms in High-Tech sectors, that by definition are knowledge intensive. To do that, we include a interactive term between every academic fields and the High-Tech industrial sectors. Nevertheless, we find no evidence that the foundation of faculties has some effect on the creation of firms in this type of industrial sectors. One possible explanation for this result is that in the sample, the High-Tech firms only represent the 5.2% of the total firms. Finally, it is interesting to note that in all regressions that the log of population's coefficient is positive and statistically significant.

Table 1: Does the foundation of faculties affect the creation of firms?
 Count model. Poisson regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)
Faculty of Sciences	0.074*** (0.02)				
Science and High-Technology industries	-0.042 (0.05)				
Faculty of Social Sciences		0.111*** (0.02)			
Social and High-Technology industries		0.008 (0.06)			
Faculty of Engineering			-0.011 (0.02)		
Engineering and High-Technology industries			0.028 (0.06)		
Faculty of Medical Sciences				-0.024 (0.02)	
Medicine and High-Technology industries				-0.049 (0.07)	
Faculty of Humanities					-0.001 (0.03)
Humanities and High-Technology industries					-0.065 (0.07)
ln(Population t-1)	1.214*** (0.21)	1.885*** (0.28)	2.207*** (0.30)	1.425*** (0.21)	1.821*** (0.29)
Time and industrial sectors Fixed Effects	Yes	Yes	Yes	Yes	Yes
Province and industrial sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	11858	9324	5390	10780	8526
Number of industrial sectors in every regions	847	666	385	770	609

Notes: 1) The endogenous variable is the number of new firm formations. 2) The faculty variable for every academic field is a dummy equals one since year t in the province i it has had a faculty foundation, and is zero otherwise. 3) An interactive term between faculty foundations at every academic fields and the high-technology industries is included. 4) Standard errors (in parentheses) are clustered at the (two-digit) industry and province level. 5) Statistical significances reported by *** p<0.01, ** p<0.05, * p<0.10.

5. Concluding comments.

Universities have long been recognized as a key element to regional economic development. Over the recent years, the universities have increased its actions and engagement to raise the entrepreneurial culture in their regions. The generation of knowledge spillovers is an important channel through which the university influences their regional milieu. The previous literature has only taken into account heterogeneous spillovers. The objective of this paper is to go further in this research field, adding new evidence but also by analyzing in a more precise manner the spillovers mechanisms generated by universities. Hence, this work has tried to contribute by delineating academic disciplines in a more specific way. In fact, this paper has analyzed the linkage between university presence and new firm formations. By using data from the register of new industrial establishments and the faculty foundation dates after the adoption of the University Reform Act of 1983, it was possible to examine the effect of knowledge spillovers on the creation of new firms.

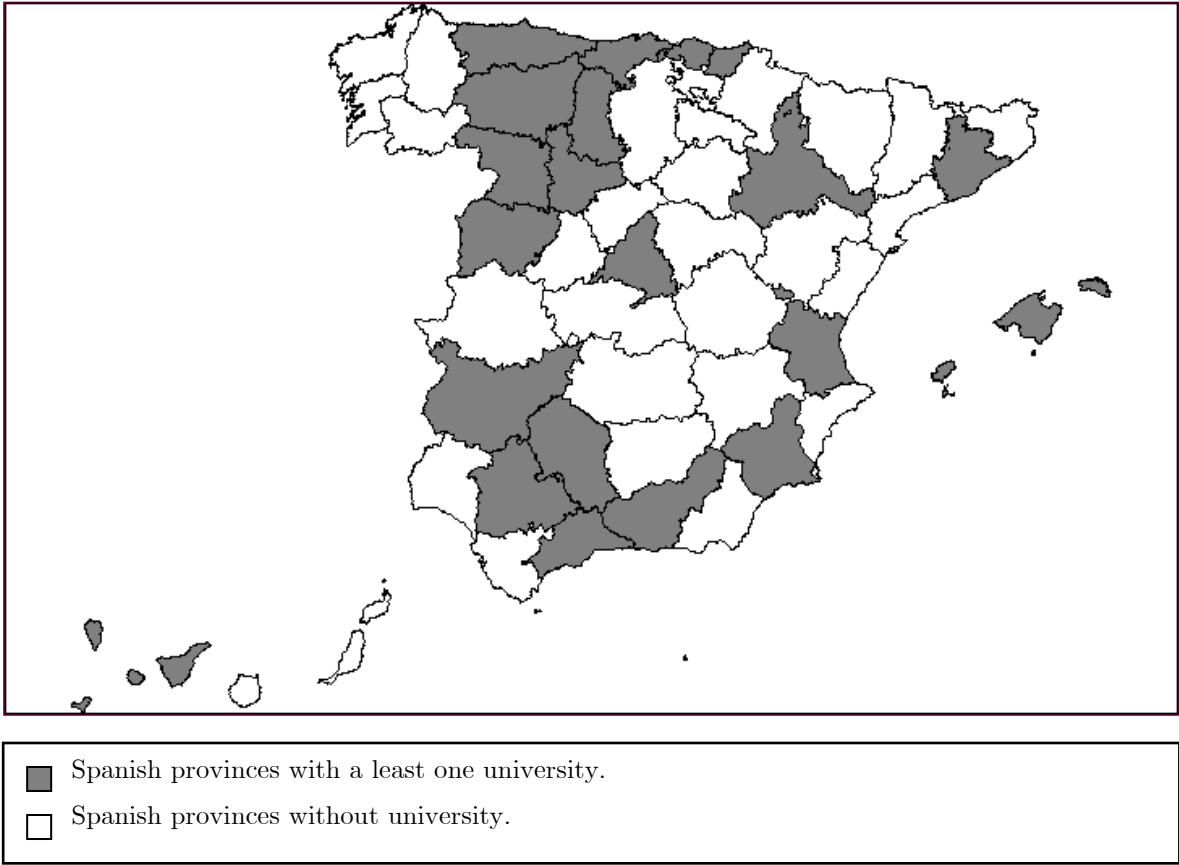
The mentioned Act encouraged to Spanish regions to create their own universities. Thus, it is very interesting to studying if this Act had an effect on the entrepreneurial activity. In fact, the existence of the effect mentioned was analyzed for every academic field. Thus, an important finding of this paper is that the foundation of Sciences and Social Sciences faculties has a strong influence in the creation of new firms.

It was not possible to determine whether or not there is a relationship between the foundation of faculties and the creation of High-Tech firms. Three arguments can help to understand this result. First, our data only includes firms from the industrial sector, and perhaps this linkage is stronger in service sector firms. Second, the period under analysis could be characterized for a lower dynamic in the creation of high tech industries. In fact, during the period 6.495 firms in high technology sectors was founded. This only represented the 5.2% of the total firms. Third, it has only been in recent years that the creation of scientific parks or the increase in the volume of contracts of the Offices for the Transfer of Research Results (OTRI) has shown an expansion of the relationship between the universities and the firms in the transmission of knowledge (Del Barrio-Castro and Garcia-Quevedo, 2005).

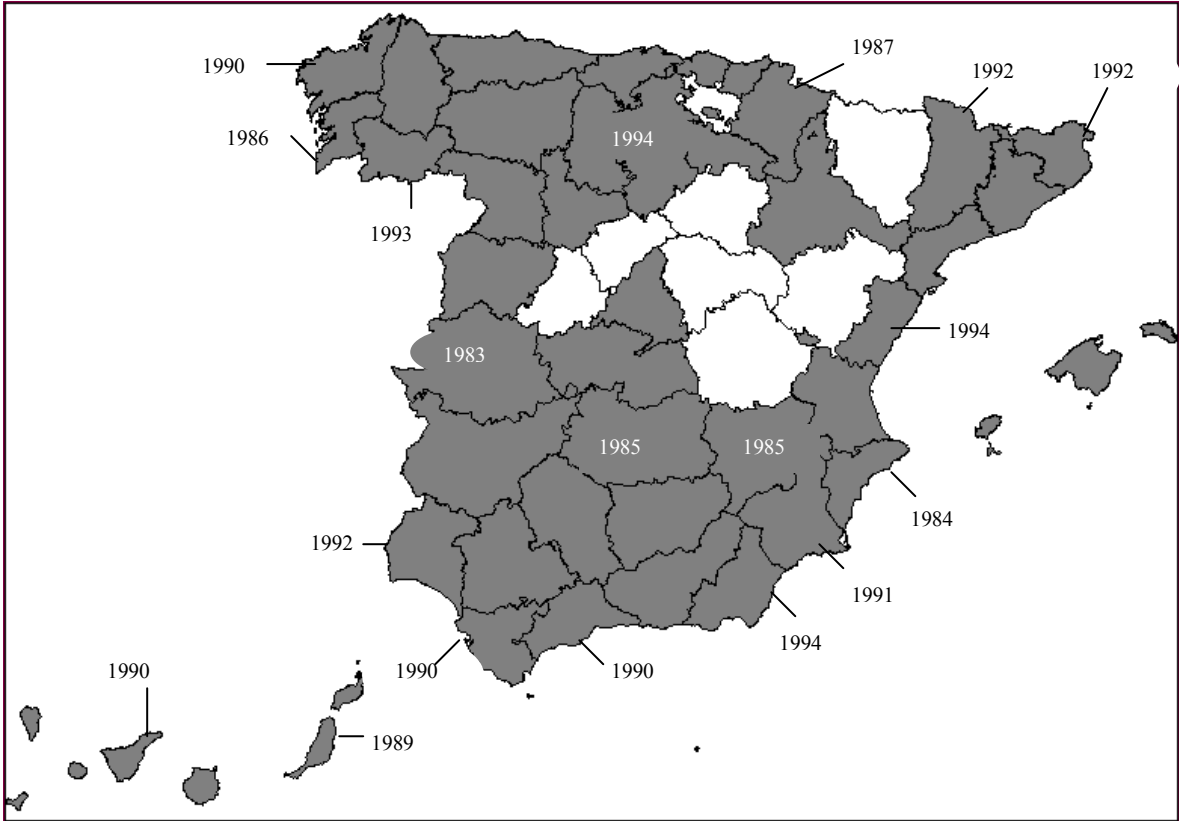
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Figure 2. Geographic distribution of Spanish Public University System. Provinces with university before LRU Act of 1983.



Provinces with University after LRU Act of 1983.



Appendix 1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of firms	19365	6.646631	19.1718	0	408
Fac. of Sciences	19365	.5433514	.49813	0	1
Science and High-Technology industries	19365	.1864704	.3894959	0	1
Fac. of Medical Sciences	19365	.5414924	.4982883	0	1
Medicine and High-Technology industries	19365	.1833721	.3869812	0	1
Fac. of Social Sciences	19365	.5802221	.4935352	0	1
Social and High-Technology industries	19365	.1971598	.3978643	0	1
Fac. of Engineering	19365	.6050607	.4888503	0	1
Engineering and High-Technology industries	19365	.1723212	.3776691	0	1
Fac. of Humanities	19365	.6269558	.4836262	0	1
Humanities and High-Technology industries	19365	.2130648	.4094836	0	1
ln Population	19365	13.24086	.817252	11.45558	15.45459