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THE ECONOMIC IMPACT OF THE SPANISH PUBLIC UNIVERSITY SYSTEM. AN ANALYSIS FOR THE PERIOD 1998 - 2004

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CENTRE DE RECERCA EN FEDERALISME FISCAL I ECONOMIA REGIONAL

THE ECONOMIC IMPACT OF THE SPANISH PUBLIC UNIVERSITY SYSTEM. AN ANALYSIS FOR THE PERIOD 1998 - 2004[a]

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ABSTRACT: In recent decades the contribution made by higher education institutions to regional development has attracted increasing attention. Considering the university as an economic agent with its own budget and expenditure, then the activities it engages in, as well as those of the groups from which it is comprised (students, professors and staff), will have an impact that is transmitted to the rest of the economy through its inter-sectoral relations. On this premise, the multiplier effects within the economy are analyzed, specifically at the level of income and employment. This study analyses the economic impact of the Spanish public university system, it examines the stability of the impact and seeks to account for the changes that occurred between 1998 and 2004. The method adopted is based on the use of input-output tables. The Gross Added Value (GAV) and employment generated by the Spanish public university system as shares of Spain's total GAV and employment presented an average annual growth rate of 4.7% and 3.8% respectively.

Keywords: Regional development; universities; higher education, economic impact.
JEL Classification: R15; I23; O18

RESUMEN: En las últimas décadas, el análisis de la contribución de la universidad al desarrollo regional ha tomado inusitada relevancia. Al considerar la universidad como un agente económico poseedor de un presupuesto y ejecutor de gasto, la actividad de la propia institución y los colectivos que la forman (alumnos, profesores y personal administrativo y servicios) tiene un impacto que se transmite al resto de la economía a través de las relaciones intersectoriales. A partir de ello, se analizan los efectos multiplicadores en la economía, específicamente en el nivel de renta y ocupación. El presente estudio realiza un análisis del impacto económico generado por el sistema público universitario español. Así mismo, examina la estabilidad del impacto y establece que cambios tienen lugar para el periodo 1998 - 2004. El método utilizado es el basado en las tablas input-output. Los resultados señalan que la participación del VAB y del empleo universitario sobre el total del VAB y empleo español registraron una tasa de crecimiento media anual de 4.7% y 3.8% respectivamente.

Palabras clave: Desarrollo regional, universidades, impacto económico.
Clasificación JEL: R15; I23; O18

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1. Introduction

In the current economic order where knowledge, science and innovation constitute the engine for development, universities have extended their classical mission as the natural space for the creation and sharing of knowledge to perform other functions that today play an important role, namely, the creation of knowledge and human capital, innovation and technology transfer, regional leadership and influence on the regional "milieu".

Recently, the analysis of the universities' contribution to regional economic development has acquired great relevance. In general, this analysis has been undertaken from two different perspectives: first, considering the impact of university in terms of knowledge, whose effects materialize in the medium and long term; second, defining the university as an economic agent, the owner of a budget and an expenditure executor. From this last perspective, the multiplier effects on the economy are analyzed, specifically at the level of income and employment.

Indeed, in several regions universities are an important economic agent, due to both the employment and the added value they generate in direct and indirect forms. In this way, employment and income levels are positively affected by the presence of the universities and as a result of their own activity they constitute a relevant economic sector in their territorial areas of influence.

This article picks up the thread of this second perspective. Here, we present a number of estimates of the economic impact generated by the Spanish public university system by means of the input-output impact methodology. Thus, the aim of our paper is to calculate the effects on output, gross added value and employment attributable to the Spanish public universities in their respective regions.

We propose undertaking this analysis at the regional level. However, the non availability of homogenous regional input-output tables (IOT) for each Spanish region means we are obliged to follow a two-stage procedure. First, the Spanish IOT for the year 2000 is adopted, which implies the assumption that the structure of inter-sectoral relations is identical in all the regions. This phase of the analysis is reinforced with pertinent variables of regional accounting such as employment, added value and production published by the National Statistics Institute (INE) in its regional accounts. In the second stage, the impacts are estimated from the regional IOT for Andalusia, Catalonia and Madrid, and compared to the previous estimates, in order to assess the bias of the assumption of an identical inter-sectoral relationship implicit in the use of the national table.

The paper is organized as follows. The literature review is presented in the next section, referring principally to analyses of universities' contributions to regional economic development. Section 3 presents our methodology and results. First, we compute the regional economic impact of the different university systems in Spain using the national IOT. Second, in order to determine the bias, we compute the impact again for three regions - Catalonia, Madrid, and Andalusia, for which regional IOTs exist. The conclusions are presented in Section 4.

2. Literature Review

According to Goldstein and Renault (2004), there is a consensus in the literature regarding the main outputs of modern universities. These are knowledge, human capital, know-how transfer, technological innovation, capital investment, provision of regional leadership, co-production of knowledge infrastructure and contributing to the generation of a particular type of regional milieu. The potential impacts of these outputs are productivity gains, business innovation, new business start-ups, increases in regional economic development capacity (for sustained, long-term development), regional creativity, and direct and indirect spending impacts.

It is no easy task to study the causal link between university outputs and their causal effects on the rest of the economy. The literature that has studied the links between universities and regional economic development can be classified in three groups according to the methodology used: i) single-university impact studies and surveys, ii) econometric models of knowledge-production and spillovers, and iii) cross-sectional and quasiexperimental designs (Drucker and Goldstein 2007, Salter and Martin 2001). This section critically reviews the available literature on the impacts of universities on regional economic development. Table 1 summarizes the main studies available.

Table 1. Theoretical and methodological literature and surveys

Author(s) and Year	Key Findings
Brown and Heaney 1997	Reviews different approaches to economic impact of higher education
Karlsson and Zhang 2001	Dynamic interdependence between knowledge creation, human capital accumulation, the regional division of labor, the spatial price structure (under perfect competition), government intervention in R&D and Higher education.
Ehrenberg 2004	Surveys the various strands of the literature on the econometrics of Higher Education (HE): 1) estimation of rates of return to HE, 2) academic labor market, 3) Institutional behavior, 4) HE as an industry.
Goldstein and Drucker 2007	Surveys the three major approaches taken in the literature to examining and assessing the impacts of universities on regional economic development
Siegfried et al. 2007	Summarizes findings of the economic impact studies, describes their common pitfalls and offers suggestions as to how to improve them.

Single-case impact studies

These studies refer to economic impact as the difference between existing economic activity in a region given the presence of the institution and the level that would have been present if the institution did not exist. The basic procedure of this methodology is to sum the expenditures of the university community (students, faculty and staff) attributable to the presence of the institution and apply multipliers to account for the interdependency of economic activity in a defined economic area. Thus, this approach measures economic impact stemming from two fundamental areas of economic activity: the first of these involves spending associated with the activity of the academic institution that arises from nonlocal sources. The second is based on spending from local sources that would have occurred outside the area had the academic institution not operated (Blackwell, et al. 2002).

These studies estimate the direct and indirect (economic) effects of university spending, investment, and employment in a region, through the use of growth accounting, regional input-output modeling, and estimation of Keynesian multipliers. The main attraction of this approach is that it offers a disaggregated perspective of the impact of Higher Education Institutions (HEI), showing the sectors for which demand and, hence, employment will be increased (Thanki 1999).

Since the 1970s, American universities have regularly conducted impact studies based on Caffrey and Isaacs' (1972) approach. In recent years, case studies have also been published in Spain. For instance, it is possible to find studies for the University of Lleida (Enciso 2001), University Rovira i Virgili (Segarra 2003), University of Vic (Parellada and Duch 2005), and the University of Alcalá (Garrido 2006). The CYD Foundation (2004, 2005, and 2007) has examined the economic impact of the Spanish university system both at national and regional levels.

Table 2. Summary of selected university economic impact studies in Spain

Author(s) and Year	Case, Design	Key Findings
Enciso et al. 2001	University of Lleida Input-Output Model Keynesian Multipliers	Output multiplier of 2.3145 Income Multiplier of 1.6399 Employment multiplier = 0.7822
Segarra 2003	University of Rovira and Virgili Input-Output Model	Income Multiplier of 1.96 0.8% and 1% of output and employment in Tarragona Province.
CYD foundation 2004	Spanish public university system Input Output Model	Output multiplier of 1.304 Direct Impact = € 4.199 millions 5.5% and 0.7% of Spanish Employment and added value, respectively.
Parellada and Duch 2005	University of Vic Input-Output Model Catalonia Input-output table	Output multiplier of 1.4306 Employment multiplier of 1.67 Income Multiplier of 1.38
CYD foundation 2005	Spanish public university system CCAA level Input Output Model	Output multiplier of 1.64 Income and Employment Multipliers to Autonomous Community (CCAA) level
Garrido 2006	University of Alcalá Input Output Model Ryan Short-Cut Method	Output multiplier of 1.12 Employment multiplier of 1.5166

Single-case impact studies have been subject to a number of criticisms. Thanki (1999) argues that the main disadvantage of this approach is that it takes little or no account of the distinctive character of higher education, namely, the value of education and its external benefits. Drucker and Goldstein (2007) find two major drawbacks in this approach. The first one is known as the "attribution problem" which is the difficulty to determine the causal link between university activities and regional outcomes of interest, for instance, to assess indirect impacts such as regional productivity gains or increases in regional innovative activity. The second one is the

lack of generalizability of the results to other universities, other regions, or even different economic situations.

In order to avoid the pitfalls of the input-output model, impact studies have resolved to incorporate diverse variables and analytical techniques so as to consider a wider range of economic effects. For example, the number of spin-offs arising from research centers of the universities, university-industry linkages (Bania et al. 1993) and income from patents and licenses (Jaffe 1989) are some of the variables that have been included. Other studies have considered the impacts of human capital produced by the universities on the region, observing the percentage of students that has remained and has been employed in the region over time (Bleaney, et al., 1992; Blackwell, et al. 2002).

Econometric models of knowledge-production and spillovers

Ehrenberg (2004) carries out a survey of econometric studies of higher education conducted over the last 40 years. He finds that econometric developments have pursued three main goals: estimating the rates of return to higher education, studying the graduate labor market and analyzing institutional behavior.

Furthermore, economists have tried to assess the economic impact of new innovation produced at universities by using econometric models (Goldstein & Renault, 2004). Frequently, these studies adopt the Griliches-Jaffe proposal. This methodology describes a Cobb-Douglas production function for knowledge, with patents as the measure of innovation constituting the dependent variable and industry and university research and development expenditures as the independent variables.

Several studies confirm the importance of spatial proximity in facilitating the economic impacts of university knowledge production. Jaffe (1989) finds that the effects of university research on corporate patents are mediated by spatial location—proximity to university research matters to corporate patents. He finds a significant effect in the areas of drugs and medical technology, electronics, optics and nuclear technology. Martin (1998) calculates the dynamic impact of Canadian university research upon GDP. Karlsson and Zhang (2001) create a dynamic two-region growth model with endogenous knowledge and human capital accumulation to describe dynamic interdependence between knowledge creation, human capital accumulation, the regional division of labor, the spatial price structure (under perfect competition), government intervention in R&D and higher education. Details of the most relevant recent studies on the impacts of universities on regional economic development are shown in table 3.

Table 3. Summary of selected literature on the impacts of universities on regional economic development

Author(s) and Year	Design, Case or Data Source	Key Findings
Jaffe 1989	KPF. U.S.: States R&D expenditures	University R&D directly affects private-sector patenting Magnitude of effect positively related to proximity
Bleaney et al. 1992	Case: Nottingham Univ.	Impact estimate including student, faculty and staff migration
Bania, Eberts, and Fogarty 1993	CSS. U.S.: metro areas. R&D expenditures count of institutions scientists/ engineers in workforce	University R&D linked to new firm births in electrical and electronic equipment industry No such linkage in instruments industry
Martin 1998	KPF. Canada: nation R&D expenditures	Substantial growth in GDP and employment attributable to university R&D and enhanced productivity of graduates
Keane and Allison 1999	Case: Univ. of Sunshine Coast	Qualitative impact analysis; Impacts of knowledge production and knowledge infrastructure may outweigh expenditure impacts
Blackwell, Cobb, and Weinberg 2002	Case: Xavier Univ.	Impact estimate including student migration and import substitution
Steinacker 2005	Case: Claremont Graduate Univ.	Local (municipal) impact estimate
Goldstein and Drucker 2006	CSS U.S.: metro areas. Separating the effects of different university functions.	The greatest impacts occur in small- and medium-sized regions Universities may act as a substitute for agglomeration economies
Universities UK (2006)	Case. Universities United Kingdom	Output multiplier of 2.52 Employment multiplier of 1.99 The university sector generated over £45 billion of output. 330,000 people were directly employed by higher education institutions (equivalent to 1.2% of total UK employment)

KPF = Knowledge production function, Case = Single-case studies, CSS = Cross Sectional Studies

Cross-Sectional and Quasiexperimental Designs

More recent impact studies of institutions of higher education have begun to employ measures that serve to isolate the traditional functions of knowledge and human capital creation from the newer university mission of technology transfer, concluding that the entrepreneurial activities of

universities are more important for economic development than the traditional functions (Goldstein & Renault, 2004).

Goldstein & Drucker (2006) investigate the possibility that university activities depend on regional agglomeration economies. In addition, they analyze the impacts of spatial spillovers arising from universities and other economic activities in nearby regions. They find some evidence that the university activities of research, teaching, and technology development help to raise regional average earnings and that knowledge and other spillovers across regional boundaries are influential as well. They also find that the greatest impacts occur in small- and medium-sized regions, suggesting that universities may act as a substitute for agglomeration economies.

3. The economic impact of the Spanish university system: Methodology and results

The economic impact of the Spanish public university system is estimated through an input-output model. The time span of the analysis is from 1998 to 2004, and the exercise is conducted at the national as well as the regional level. The main statistical source used is the bi-annual publication of the Conference of Directors of the Spanish Universities (CRUE), offering detailed information of the university budgets for 1998, 2000, 2002 and 2004.

The IO approach constitutes a linear and short-term model that assumes a stable productive structure, therefore, the structural coefficients are also stable for the years analyzed. It does not take into consideration economies of scale or factor substitution. The IO method is also a general equilibrium model in a static context. This model departs from the information registered in the input-output tables and constitutes one of the most important instruments for the analysis of economic activity, given its huge utility for the study of inter-sectoral linkages[1].

3.1. Estimation of economic impact from Spanish IOT.

In this section, the Spanish IO table 2000 is adopted, which means assuming that the structure of inter-sectoral relations throughout the territory is undifferentiated. However, in order to make this analysis more rigorous, a number of relevant variables from the regional accounts are

[1] The matrix estimation details of the model and the construction of the Leontief matrix are included as appendix 1.

incorporated, including employment, gross added value and a production account published by the INE.

The methodology provides an initial quantification of the demand generated by university institutions. In particular, it seeks to establish the final demand (in the form of investment or consumption) associated with the universities' activities, taking into consideration only that demand which would not have been registered had a specific university not existed. This demand comprises the universities' investments and consumption that can be attributed to both students and university staff[2] (faculty and officials).

At the same time, the consumption and investment generated by the particular presence of a university suppose enhancing the demand in a large number of economic sectors to the extent that they have to increase their output. Thus, our methodology manages to separate the direct impact attributable to the demand associated with the universities from the total impact that this incremental demand has on the economy. This differentiation between direct and total impact enables us to deduce the indirect impact, i.e., the impact produced in a range of economic sectors as a result of the increasing output generated to meet university demand. Similarly, the effects of direct impact can be considered on overall gross added value and employment levels.

The data describing university expenditure are drawn from information published by CDSU. Although the investment impact measurement should incorporate this ordinary characteristic exclusively, the statistical information available means that this could not be undertaken in sufficient detail and, therefore, total expenditure has been considered. Thus, in the case of the investment carried out by the university, it has included all real investments. This item essentially includes the expansion of physical infrastructure and equipment. As such, university investment has been allocated to these sectors.

Staff expenditure was calculated using the university payroll. The implicit assumption here is that consumption derived from this income is part of the demand attributable to the university's presence. In this way, the payroll value, discounted to include taxes[3] and social security, is adopted. Subsequently, the marginal propensity to consumption is calculated, and finally, the number thus obtained is distributed according to the expenditure structure of NSI's family budget survey.

[2] University staff comprises faculty and research staff (FRS) and officials and services staff (OSS).

[3] This calculation was based on the wage structure survey published by the INE.

In calculating student expenditure we distinguish between resident and nonresident students (those who have changed their place of residence in order to study). In the first instance, consumption associated with university activities is considered as a derivate of registration fees, expenses in education-related materials and transport expenses incurred in transferring to the institution[4]. Furthermore, for nonresidents we add to these costs those of rent payment and food expenditure. The distinction between residents and nonresident students is obtained from CDSU information. Next, the structure and the average expenditure level for age groups (below the age of 26) is considered, and then, the aforementioned expenditure groups are added. This information is extracted from the household budget continuous survey.

Table 4 shows the final demand behavior derived from the activity of the public universities between 1998 and 2004 for the Spanish regions. We see that the final overall demand of the Spanish university system registered sustained growth, rising from 3,570 €[5] in 1998 to 4,509 million € in 2004. This represents an average annual growth of 3.4%

An examination of final demand at the regional level shows that Canarias (7.5%), Extremadura (5.3%), Comunidad Valenciana (4.6%), Navarra (4.4%), Galicia (4%), Aragón (3.6%) and Catalonia (3.6%) registered average annual growth rates above the national average. By contrast, La Rioja recorded a slight fall in demand (-0.4%). In table 4 it is also possible to observe that the region with the greatest relative weight in the final demand generated by the Spanish university system is Madrid (18.7%), followed by Andalusia (16.7%), Catalonia (15.2%) and, finally, the Comunidad Valenciana (11.6%). It is of some significance that these four regions account for 63% of the total final demand generated by the Spanish universities[6].

[4] Here, the implicit hypothesis is that other costs (i.e., clothes and leisure) would be incurred regardless of their condition as university students.

[5] All prices in this study are constant based on the value of the euro as of 2001.

[6] Appendix 2 presents the university system profile by individual regions.

Table 4. Final demand associated with university activity, by region.

	1998	2000	2002	2004	Variation 04/ 98	Average annual growth
Andalucía	601.5	672.5	715.8	753.7	1.2	3.2
Aragón	109.1	122.6	123.8	139.7	1.3	3.6
Asturias	108.3	132.6	120.5	112.2	1.0	0.5
Baleares	36.6	38.5	46.1	45.3	1.2	3.1
Canarias	102.9	132.1	156.7	170.9	1.7	7.5
Cantabria	47.5	55.0	48.9	55.3	1.2	2.2
C. León	264.1	264.4	283.0	291.6	1.1	1.4
C. La Mancha	77.9	97.6	100.0	94.5	1.2	2.8
Cataluña	537.7	607.1	653.4	687.2	1.3	3.6
C. Valenciana	417.1	379.4	541.3	570. 8	1.4	4.6
Extremadura	50.7	67.7	69.8	72.6	1.4	5.3
Galicia	216.1	269.6	276.3	285.6	1.3	4.0
Madrid	683.3	728.7	806.8	851.9	1.2	3.2
Murcia	106.2	127.7	120.9	129.6	1.2	2.9
Navarra	30.6	31.2	38.9	41.4	1.3	4.4
País Vasco	159.5	167.5	189.1	186.1	1.2	2.2
La Rioja	21.6	25.0	19.0	21.0	1.0	-0.4
Total España	**3570.9**	**3919.31**	**4310.54**	**4509.5**	**1.3**	**3.4**

Millions of euros (2001)
Source: Authors' own based on CRUE data.

As discussed above, university demand drives production in its receiving sectors, which have to increase their input purchases accordingly so as to meet the rise in demand. This represents an indirect impact on the economy (also known as a diffusion or multiplier effect), the average value of which was 1.63 during the period analyzed. Thus, for each Euro increase in the final demand associated with university activity, production in the economy increased 0.63 of a Euro. Across the regions, we see that the region with the greatest multiplier effect is Navarra with a diffusion effect of 1.71, whereas the region with the lowest multiplier is Aragon (1.59). Table 5 shows this multiplier effect and reports the total impact on production in each of the four years under review.

Table 5. Total impact on the economy output

	1998	2000	2002	2004	Multiplier effect
Andalucía	1000.1	1104.9	1149.9	1216.2	1.63
Aragón	173.0	197.1	198.3	219.4	1.59
Asturias	176.4	221.6	196.4	181.6	1.64
Baleares	60.4	62.7	74.7	72.1	1.62
Canarias	171.8	219.6	257.6	282.4	1.66
Cantabria	76.9	88.9	77.5	86.3	1.60
C. León	441.7	451.9	468.0	480.3	1.67
C. La Mancha	132.4	160.5	172.6	156.6	1.68
Cataluña	872.6	1000.0	1050.4	1095.4	1.62
C. Valenciana	702.9	637.0	887.2	936.3	1.66
Extremadura	87.0	110.8	111.2	116.7	1.64
Galicia	360.1	454.1	455.7	471.6	1.66
Madrid	1106.3	1185.8	1285.0	1355.7	1.61
Murcia	173.6	214.0	195.5	209.6	1.64
Navarra	51.0	53.6	67.0	71.1	1.71
País Vasco	266.1	273.5	309.9	303.8	1.64
La Rioja	36.4	42.8	31.4	33.6	1.66
Total	**5888.9**	**6478.8**	**6988.1**	**7288.8**	**1.63**

Millions of euros (2001)
Source: Authors' own based on CRUE and INE data.

Next we evaluate the impact university activity has on employment and gross added value (GAV) across the regions. Table 6 shows the total impact behavior on employment, revealing that in 2004 university final demand represented 118,653 jobs, which is equivalent to 0.7% of Spain's total employment. Furthermore, the impact of university final demand on regional employment represented a half-yearly growth rate of 3.8% between 1998 and 2004.

The total amount of employment generated by the presence of the university system in the Spanish economy rose from 91,563 to 118,653 jobs during the period. Canarias (7.3%), Extremadura (5.7%) and the Comunidad Valenciana (4.8%) were the regions that showed the greatest growth in employment generated by the final demand associated with their system of universities. By contrast, Asturias (- 0.5%) registered a slight fall.

Table 6. Total impact on employment[7]

	1998		2000		2002		2004		Var. 04/ 98	Annual growth
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)		
Andalucía	15729	0.7	15943	0.7	18944	0.7	20668	0.8	1.3	4.0
Aragón	2929	0.6	3002	0.6	3363	0.7	3786	0.7	1.3	3.7
Asturias	3279	0.9	3487	0.9	3521	0.9	3172	0.8	1.0	-0.5
Baleares	994	0.3	917	0.3	1130	0.3	1183	0.3	1.2	2.5
Canarias	2687	0.4	3130	0.5	3830	0.5	4398	0.6	1.6	7.3
Cantabria	1400	0.8	1413	0.7	1333	0.6	1556	0.7	1.1	1.5
C. León	6362	0.7	5450	0.6	6993	0.7	7083	0.7	1.1	1.5
C. La Mancha	2046	0.3	2395	0.4	2565	0.4	2304	0.4	1.1	1.7
Cataluña	13552	0.5	13647	0.5	15902	0.6	18221	0.6	1.3	4.3
C. Valenciana	10608	0.7	9394	0.6	14154	0.8	14743	0.8	1.4	4.8
Extremadura	1454	0.5	1729	0.5	1958	0.5	2139	0.6	1.5	5.7
Galicia	6393	0.6	6961	0.7	7863	0.7	8348	0.8	1.3	3.9
Madrid	16664	0.8	15505	0.7	19404	0.8	22015	0.9	1.3	4.1
Murcia	2886	0.7	2989	0.7	3144	0.7	3482	0.7	1.2	2.7
Navarra	735	0.3	592	0.2	886	0.3	878	0.3	1.2	2.6
País Vasco	3346	0.4	3330	0.4	4113	0.4	4152	0.4	1.2	3.1
Rioja	497	0.5	532	0.5	443	0.4	524	0.4	1.1	0.8
Total	**91563**	**0.6**	**90416**	**0.6**	**109546**	**0.7**	**118653**	**0.7**	**1.3**	**3.8**

(1) Number of jobs
(2) Percentage of participation in the total employment generated by the university system as a proportion of the total employment of each Spanish region
Source: Authors' own based on CRUE and INE data

In the case of the impact on Gross Added Value (GAV), in 2004 demand associated with the public universities gave rise to a total increase in GAV of 4,050 million euros, equivalent to 0.6% of Spain's overall GAV for the same year. In line with the previous results, table 7 presents the regional variations in the total impact on GAV derived from the university final demand.

Table 7 also shows that the regions with the greatest annual average growth in total impact on GAV were Canarias (8.6%), Extremadura (7.2%) and the Comunidad Valenciana (6.2%). By contrast, those with the smallest rates of growth were Asturias (1.6%) and La Rioja (1.3%).

[7] A recent study published by the CYD Foundation (2008) reports largely similar results. The differences that occur reflect the fact that this study conducts its analysis using current prices.

Table 7. Total Impact on gross added value (GAV)

	1998		2000		2002		2004		Variation 04/ 98	Average annual growth
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)		
Andalucía	486.2	0.7	513.7	0.7	589.8	0.7	672.2	0.7	1.4	4.7
Aragón	92.0	0.6	97.1	0.5	104.9	0.6	126.8	0.6	1.4	4.7
Asturias	91.0	0.7	103.8	0.8	100.3	0.7	101.4	0.7	1.1	1.6
Baleares	31.4	0.2	30.7	0.2	38.1	0.2	41.5	0.3	1.3	4.1
Canarias	83.7	0.4	99.8	0.4	126.4	0.5	148.9	0.5	1.8	8.6
Cantabria	40.1	0.6	43.6	0.6	42.1	0.5	49.9	0.6	1.2	3.2
Castilla y León	215.4	0.7	201.7	0.6	231.6	0.7	259.0	0.7	1.2	2.7
C. La Mancha	63.7	0.3	77.4	0.4	80.1	0.4	81.7	0.4	1.3	3.6
Cataluña	451.6	0.5	478.3	0.5	547.5	0.5	621.4	0.5	1.4	4.7
C. Valenciana	337.0	0.7	302.9	0.5	453.5	0.8	513.4	0.8	1.5	6.2
Extremadura	40.1	0.5	52.6	0.5	57.8	0.5	65.1	0.6	1.6	7.2
Galicia	177.9	0.6	208.2	0.7	225.8	0.7	249.9	0.7	1.4	5.0
Madrid	559.8	0.6	560.1	0.6	668.9	0.6	776.2	0.7	1.4	4.8
Murcia	86.3	0.7	99.5	0.7	100.2	0.7	116.1	0.7	1.3	4.3
Navarra	26.1	0.3	24.4	0.3	31.9	0.3	36.6	0.3	1.4	5.0
País Vasco	131.6	0.4	132.4	0.4	157.4	0.4	168.6	0.4	1.3	3.6
La Rioja	17.5	0.4	19.3	0.4	16.1	0.4	19.2	0.4	1.1	1.3
España	2933.4	0.6	3047.7	0.5	3574.4	0.6	4050.1	0.6	1.4	4.7

(1) Millions of euros (2001)
(2) Participation percentage of total GAV generated by the university system, like proportion of total GAV of each region
Source: Authors' own based on CRUE and INE data

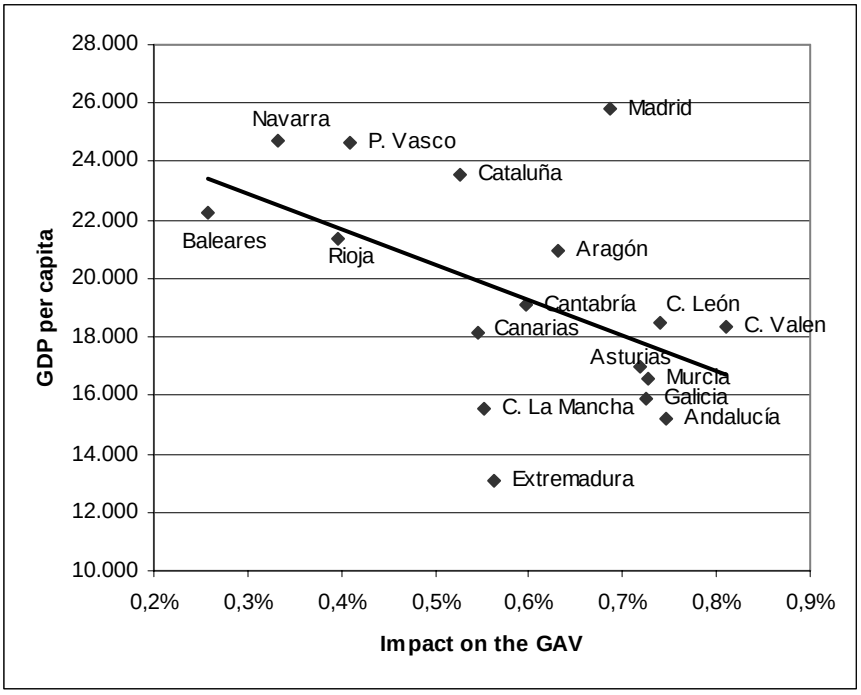
The results obtained here indicate that the variation registered in the respective impacts of the university systems around the regions, measured both in terms of GAV and employment, tend to increase most noticeably in those regions which in 1998 started from positions of greatest advantage. Thus, it becomes evident that regions with a high impact in 1998 exhibited the greatest growth in this impact over the period analyzed. Exceptions to this trend are found in Canarias and Extremadura, which although presenting the lowest impacts in GAV and regional employment at the start of this study, presented the highest rates of variation in the period analyzed in both cases.

If we relate regional per capita GDP to the impact that the final demand associated with the university system in each region has on the latter's GAV, we observe, with the obvious exceptions of Madrid and Aragon, that the regions with a GDP per capita below the Spanish average in 2004 present a final demand impact that is greater than the average for that same year. In this group of regions are to be found Andalusia, Galicia, Murcia, Asturias, Comunidad Valenciana, Castilla and Leon, Canarias, Castilla-La Mancha, Extremadura and Aragon.

Contrary to this, regions with a per capita GDP above the national average in 2004 registered impacts of final demand generated by their universities inferior to the average. They include

Baleares, Navarra, País Vasco, La Rioja and Catalonia. However, we should stress the great differences to be found in terms of per capita regional GDP and the impact of university regional systems as a proportion of regional GAV. Graph 1 shows that regions with marked differences in terms of their per capita GDP can, at the same time, register similar impacts in their regional GAV derived from the final demand generated by their universities, as is the case of the group of regions formed by Catalonia, Canarias, Castilla-La Mancha and Extremadura.

Graph 1. GDP per capita and the ratio between the total GAV generated by the university system and the total GAV of the Spanish regions



Source: Authors' own based on CRUE and INE data

As discussed in the introduction, we need to distinguish between the impacts that the university systems have in terms of their participation in the economic activities from those which they cause through their contribution to knowledge creation. Although the latter are difficult to measure, and while the methodology adopted in this study means that any conclusions we might draw on this matter are somewhat contentious, we still need to emphasize that the size of the economic impact of the university systems seems play a prominent role. Such a role is evident given the greater intensity of the inter-sectoral linkages derived from the relative size of the university systems in the territories in which they are located. Thus, we can expect a positive relation between per capita GDP and the impacts that the regional university systems have on knowledge and, additionally, on the universities' so-called "third mission".

3.2. Estimation of economic impact from regional IOTs.

Although the use of the Spanish input output table (IOT) allows us to provide an idea of the magnitude of the university impact at the regional level, it is necessary to further our analysis by using the regional IOTs which include specific features of the diverse productive structure to be found within each region.

In this section we present the results of the university's regional system of economic impacts obtained from the corresponding regional IOT. The analysis is conducted in two directions. On the one hand, we are interested in determining the temporal evolution; on the other hand, we wish to determine the effects of introducing an IOT that includes specific features of the regional productive structure. In both cases, a comparative analysis is conducted with the results presented above for the Spanish IOT.

For the analysis, we chose three regions based on their high number of higher education institutions and students. These regions are Andalusia, Catalonia and Madrid. By choosing to do so we ensured that the analysis includes 50% of the Spanish University system in terms of the number of institutions and 53% in terms of the total number of students registered.

The OIT adopted in each case corresponds to the latest table published. Thus, in the case of Andalusia we use the IOT for 2000, for Catalonia the table corresponding to 2001 and for Madrid we use the IOT for 2003.

First, we present our analysis of the temporal dimension. We only analyzed total impacts as direct impacts (university final demand) are the same as in the previous section. Consequently, the variations in the results obtained respond to the fact that we introduced different structural coefficients matrixes and Leontief inverse matrixes for each region (See appendix 1). Thus we identify the total impact on output, GAV and employment based on calculations obtained with regional IOTs and these are then compared with the results derived from the Spanish IOT.
We also decided to verify the dissimilarities in magnitude between the Leontief inverse regional matrixes and the Spanish matrix. For this, three dissimilarity indexes[8] were calculated (see table 8). The higher the index value is the greater the dissimilarity between the components in each matrix. At the same time, we expect that significant dissimilarities between Leontief inverse matrixes will lead to greater differences in the impact results.

[8] Appendix 3 shows the calculation formulae for the dissimilarity index.

Table 8. Dissimilarity index between Leontief inverse matrixes

	Coefficient of correlation S	1- S	Euclidian Distance	Manhattan Distance
Spanish – Andalusian 2000	0.991	0.009	0.82	9.94
Spanish – Catalonian 2001	0.985	0.015	1.04	11.8
Spanish – Madrid 2003	0.982	0.018	1.21	13.92

The indexes consistently show greater dissimilarity for the case of the Madrid table and less dissimilarity in the case of the Andalusian table, which provides us with the hypothesis of the existence of a directly proportional relationship between a table's temporality and its dissimilarity. It can be observed, for instance, that the measures of distance between the Spanish matrix and that of Madrid expands as the reference year of the regional table moves away from the base year of the Spanish matrix.

In order to confirm the hypothesis presented above, the Euclidian distances between the three regional Leontief matrixes are presented in table 9, where we see that distance increases with time.

Table 9. Euclidian distance between several Leontief inverse regional matrixes

	Andalusia 2000	Catalonia 2001	Madrid 2003
Spain 2000	0.82	1.04	1.2
Andalusia 2000	-	0.9	1.047
Catalonia 2001	-	-	0.83

However, the temporal analysis shows that in all three regional cases, the impacts estimated from the IOTs were smaller than those obtained when using the Spanish table. This is due to the fact that the Leontief inverse matrix coefficients are smaller in the case of the regional IOTs. In other words, the use of the Spanish table tends to overestimate the technical coefficients, which affects the construction of the Leontief inverse matrix and, in the last instance, the results obtained in the impact study. It is also possible that our assumption of equal technical coefficients for all regions means that differences in production technology, R+D, degree of opening and the demand patterns derived from variations in the relative prices are not taken into account.

Our comparative analysis produced the following results. Specifically this involved an examination of the annual average growth, variation, multiplier effect, the employment

generated by the university system as a proportion of total regional employment and the participation of the GAV generated by universities within the overall regional GAV.

In the case of Andalusia, the two tables - Spanish and Andalusian – largely explain the evolution in the different impacts over the period. Thus, the variation and annual average growth obtained with the regional table are slightly greater than the corresponding results for the Spanish table, as is shown in table 10. The multiplier effect is 8% lower in the case of the regional table (1.50) compared to the Spanish table (1.61). On the other hand, the ratio between university employment and regional employment obtained with the Andalusian table is 0.72, while the corresponding figure for the Spanish table is 0.77, which implies a difference of 6%. In terms of the participation of university GAV within the regional GAV the result obtained with the regional IOT (0.72) is 4% lower than that derived from the Spanish IOT (0.77).

Table 10.
Comparison of results: Andalusia table 2000 and Spanish table 2000
Total Impacts

	1998		2000		2002		2004		Variation 2004/ 1998		Average annual growth		Multiplier effect 2004		Total employment Univ / Total employment of Andalusia 2004		GAV total Univ / Total GAV Andalusia 2004	
	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST
Output	908.7	1000.1	1023.0	1104.9	1058.5	1149.9	1127.3	1216.2	1.24	1.22	3.13	2.83	1.50	1.61				
GAV	453.2	486.2	485.0	513.7	557.9	589.8	641.4	672.2	1.42	1.38	5.09	4.74					0.72%	0.75%
Employment	14.378	15.729	14.831	15.943	17.697	19.404	19.468	20.668	1.35	1.31	4.43	3.98			0.72%	0.77%		

AT = Andalusia Table

ST = Spanish Table

Millions of euros (2001)

Source: Authors' own based on CRUE and INE data

Table 11.
Comparison of results: Catalonian table 2001 and Spanish table 2000
Total Impacts

	1998		**2000**		**2002**		**2004**		**Variation 2004/ 1998**		**Average annual growth**		**Multiplier effect** 2004		Total employment Univ / Total employment of CAT 2004		GAV total Univ / Total GAV of CAT 2004	
	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST
Output	766.5	872.6	889.6	1000.0	925.6	1050.4	974.3	1095.4	1.27	1.26	3.5	3.3	1.42	1.59				
GAV	410.1	451.6	436.9	478.3	499.7	547.5	575.8	621.4	1.40	1.38	5.0	4.7					0.49%	0.53%
Employment	12.006	13.552	12.254	13.647	14.294	15.902	16.674	18.221	1.39	1.34	4.8	4.3			0.57%	0.62%		

CT = Catalonian Table

ST = Spanish Table

Millions of euros (2001)

Source: Authors' own based on CRUE and INE data

The estimation conducted with the Catalan table provides similar results to those for Andalusia. Indeed, as can be seen in table 11, the variation and average annual growth obtained with the Catalan table are slightly higher than the corresponding results for the Spanish table. The multiplier effect, in this case, is 12% lower in the Catalan table (i.e., 1.42 compared to 1.59 for the Spanish table). Similarly, the ratio between university employment and regional employment obtained with the regional IOT (0.57) is 9% lower than the corresponding result for the Spanish IOT (0.62). The participation of university GAV within the regional total based on the regional IOT (0.49) is 8% lower than that calculated when using the Spanish IOT (0.53).

In contrast to the findings for Andalusia and Catalonia, the results obtained when using the Madrid IOT, in terms of the evolution in the impact on production and employment, are slightly lower than those derived from the Spanish IOT. Yet, as in the above cases, the two tables provide a good explanation of the evolution in the different impacts in the period analyzed. Table 12 provides detailed results from the estimations made using the Madrid table.

The differences in the results provided by the Madrid IOT and the Spanish IOT reach 20% in the case of the multiplier effect and 24% in the case of the ratio between university and regional employment levels. Thus, the regional table provides a multiplier effect of 1.33 compared to that of 1.59 with the Spanish table, while the ratio between university and regional employment levels derived from the regional IOT is 0.69, again lower than that obtained with the Spanish IOT (0.86).

Likewise, the participation of university GAV within the regional GAV registers a difference of 13%. Using the regional IOT the ratio value stands at 0.61, whereas with the Spanish IOT it rises to 0.69.

These calculations were followed by an analysis of the structural order, i.e., a verification of the impact of final university demand and its different components (investment, payroll expenditure and student expenditure) on the main sectors in the economy. In this section, also, we undertake a comparative static exercise between the years 1998 and 2004, emphasizing the economic sectors in which the main variations in terms of the economic impact of universities were recorded.

Table 12.
Comparison of results: Madrid table 2003 and Spanish table 2000
Total impacts

	1998		**2000**		**2002**		**2004**		**Variation 2004/ 1998**		**Average annual growth**		**Multiplier effect** 2004		Total employment Univ / Total employment of Madrid 2004		GAV total Univ / Total GAV of Madrid 2004	
	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST
Output	928.3	1106.29	971.3	1185.76	1066.06	1285.0	1133.57	1355.73	1.22	1.23	2.9	2.9	1.33	1.59				
GAV	488.0	559.8	475.0	560.1	578.5	668.9	684.5	776.2	1.40	1.39	4.9	4.8					0.61%	0.69%
Employment	13.665	16.664	12.160	15.505	15.335	19.404	17.778	22.015	1.30	1.32	3.8	4.1			0.69%	0.86%		

MT = Madrid Table

ST = Spanish Table

Millions of euros (2001)

Source: Authors' own based on CRUE and INE data

In the case of Andalusia, the total impact on production is 7.9% smaller when estimated with the regional IOT as opposed to using the Spanish table. Given that the regional tables present a more approximate nature of the characteristics of the region's economic structure, we need to analyze the changes in the sectoral impacts of university demand[9]. In table A.4.1., when observing the sectoral structure of impact on production for years 1998 and 2004, we find that with the regional IOT certain sectors are assigned a greater relative weight, for example, agriculture (4.2%), energy (3.2%), construction (6.6%) and services (56%), whereas with the Spanish IOT the respective participation of these sectors is 3.7%, 2.7%, 5.7% and 53%. By contrast, the weight of the industrial sector when using the Andalusian IOT is 5% lower (30% compared to 35% when applying the Spanish IOT).

Similarly, table A.4.1 shows that the impact on production in sectors such as construction and services (non-sale) registered the most marked increases. The impact of the industrial sector, on the other hand, remained constant between 1998 and 2004. Similar findings are seen when the total impact on the GAV is analyzed.

In terms of total impact on employment, we see that the most marked variations took place in the construction and services sector (non-sale). By contrast, in the industrial sector a 16% reduction was recorded in the impact on employment.

In the case of Catalonia, the estimation conducted with the regional table presents a total impact on production that is 12% smaller than that calculated with the Spanish IOT. If we then examine the sectoral structure of impact on production, the estimation with the Catalan IOT reveals that the sectors of agriculture (1.3%), energy (2%) and industry (32%) are assigned a lower relative weight with respect to estimates with the Spanish IOT, where the corresponding percentages are 3.3%, 3%, 35%. By contrast, the services sector accounts for a larger participation in the estimation with the Catalan IOT (62.4%) compared to its share with respect to the Spanish IOT (55.6%). This distinction is also present in the total impacts on GAV and employment. These results can be consulted in table A.4.2.

Between 1998 and 2004, the greatest variations were registered by the construction and services (non-sale) sectors. The impact on production in the agricultural sector remained constant throughout the period analyzed. A similar situation was found in the cases of impacts

[9] The detailed results of the different impacts (output, employment and GAV) derived from regional IOT are presented in appendix 4.

on GAV and employment, although in the case of the latter there was a 24% reduction in the impact on employment in the agricultural sector.

Table A.4.3 presents the main impacts of the university sector in Madrid based on the regional IOT. The total impact on production in this case is 19% lower than the figure derived from using the Spanish table. As mentioned above, the Spanish table corresponds to the year 2000 while the regional table for Madrid corresponds to 2003. Again, this difference would seem to reflect the fact that the further we move away from the Spanish table's year of reference, the greater the differences in the estimated impacts. Thus, while the total impact on production obtained with the Andalusian table (year 2000) is 7.9% smaller than that obtained with the Spanish table (2000), this percentage difference stands at 12.4% in the case of the Catalonia table (2001). These results are robust compared to the findings provided by the dissimilarity indices.

The sectoral structure of impact on production presents the following characteristics: on the one hand, the estimation with the Madrid IOT attributes a lower relative weight to sectors that include agriculture (0.3%, compared to 3% with the Spanish IOT), energy (2%, compared to 3% with the Spanish IOT), construction (26% compared to 31% with the Spanish IOT); on the other hand, the services sector accounts for a larger participation in the regional IOTs (63.8) compared to 55.2% with the Spanish IOT.

4. Conclusions

This study analyses the economic impact of the Spanish public university system using an input-output model. First, it reports the results of a temporal analysis, examining the evolution recorded by various impacts (output, employment and gross added value) between 1998 and 2004. Then, it reports the findings from a spatial analysis conducted at the regional level. This is the first time a study of these characteristics has been attempted in Spain, but its relevance and the need for an exhaustive study of this nature go parallel with the increasing importance of the public university system.

The study has been conducted in two phases: first, it focused its outcomes on the impacts estimate derived from the Spanish IOT, which involved assuming a homogeneous productive structure for the whole of Spain. In the second phase, in seeking to eliminate the estimate bias generated by this prior assumption, the study adopted regional IOTs so as to provide a more accurate picture of the special features of the inter-sectoral relations of each territory.

The main results emphasize the increasing importance of the universities as economic agents. Thus, between 1998 and 2004, the direct impact of university activity (a derivate of its investment and consumption) rose from €3571 million to €4509 million, that is, a variation in real terms of 26%. At the same time, each monetary unity of final demand generated by the university system increased economic production by 1.63 units.

In 2004, final university demand represented a total impact on employment of around 118,653 jobs while the final demand impact on regional employment recorded an average annual growth of 3.8% between 1998 and 2004.

Moreover, we conclude that the total impact of university activity on Spanish GAV represented an average annual growth of 4.7%, while the participation of both the GAV and induced employment in the respective regional totals represented 0.6% of GAV and 0.7% of total employment.

The estimation of the economic impacts of the university system based on Input-Output regional tables and their subsequent comparison with the results derived earlier from the Spanish IOT allows us to conclude that the estimated impacts, both temporal and sectoral, are robust, albeit that they present some slight variations. Furthermore, the differences between the total impacts

might reflect temporary differences, as we deduce to be the case with the calculation of the dissimilarity index.

The main contribution from calculating the economic impacts from the regional tables is the possibility it affords us of explaining more appropriately the magnitude of the main sectoral and territorial effects. In this way, we have been able to verify in the three regions analyzed (Andalusia, Catalonia and Madrid) that the most important impact has been recorded in service sectors destined for sale (42%) followed by the industry sector (29%).

The results obtained in this study suggest a range of future lines of investigation for the on-going examination of the regional economic impact of the universities. These include, among others, the international comparison of economic impacts, the individual analysis of university institutions (single-case impact studies), knowledge impact analyses using IOTs and, finally, the construction of a satellite account of the higher education sector.

Appendix 1. Creating the Leontief matrix

The production of a sector in terms of inter-sectoral links can be expressed as follows:

$$X_i = x_{i1} + x_{i2} + ... + x_{in} + y_i \qquad i = 1,2,...,n$$

X_i = Effective production of branch i.

x_{i1} = Branch 1's intermediate product consumption of Branch i's products.

y_i = Exogenous final demand of products of the sector i.

1. We estimate the technical coefficients

$$a_{ij} = \frac{x_{ij}}{X_j}$$

This indicates the proportion of the production of the corresponding sector that comes from each of the other sectors. In other words, what j buys from i with respect to j's production. At the same time, it indicates the number of units of i that j needs to buy so as to produce a unit of output.

2. In matrix terms, the output is expressed as follows:

X = AX + Y

X= Vector of effective production

A= Matrix vertical technical coefficients

Y= Components of the final demand

3. From the previous expression we can obtain the "Leontief inverse matrix"[10]. This shows how much of each industry's output is required, in terms of direct and indirect requirements, to produce one unit of a given industry's output:

$L = \{ I - A \}^{-1}$

4. The economic impact is obtained by multiplying the Leontief inverse matrix (L) by the new vector of final demand, in our case, the expenditure associated with the university activity (Y^U).

$X^U = \{ I - A \}^{-1} * Y^U$

[10] Or the matrix of interdependence coefficients (direct and indirect requirements) by final demand unity.

Appendix 2. University system profile by Spanish regions. Academic year 2004/2005

	Nº Universities		Nº students		% over total Spain students	Staff (Full time equivalent)			(4) Incomes R&D (€) / FRS (FTE)
	Pub.	Priv.	1º y 2º cycle (1)	3º cycle		FRS (2)	OSS (3)	OSS / FRS	
Andalucía	10	0	279.826	17.759	18,7	13.791	8.199	0,59	7.908,4
Aragón	1	1	39.362	3.350	2,7	2.676	1.560	0,58	12.330
Asturias	1	0	37.440	1.912	2,5	1.912	1.000	0,52	6.297
Baleares	1	0	17.227	1.375	1,2	868	437	0,5	8.243
Canarias	2	0	55.198	3.945	3,7	3.093	1.573	0,51	4.992,5
Cantabria	1	0	13.654	1.025	0,9	902	528	0,59	17.319
Cast. y León	4	3	33.879	2.134	2,3	5.572	2.917	0,52	6.902
C. La Mancha	1	0	95.455	7.452	6,5	1.687	982	0,58	11.501
Cataluña	7	5	208.429	63.812	17,1	11.325	7.115	0,63	19.199,7
C. Valenciana	5	2	157.677	15.525	10,9	8.549	5.512	0,64	11.315,4
Extremadura	1	0	30.296	976	2,0	1.603	812	0,51	5.683
Galicia	3	0	94.020	6.199	6,3	4.601	2.558	0,56	9.855,3
Madrid	8	8	244.427	35.350	17,6	13.743	8.471	0,62	11.349,8
Murcia	2	1	40.204	1.966	2,7	2.174	1.302	0,60	5.958
Navarra	1	1	9.237	870	0,6	691	391	0,57	8.267
País Vasco	1	2	57.700	3.238	3,8	3.722	1.486	0,4	7.625
Rioja (La)	1	0	8.566	668	0,6	413	236	0,57	5.018
Total Spain	**50**	**23**	**1.422.597**	**167.556**	**100**	**77.322**	**45.079**	**0,58**	**9.851**

Source: Own elaboration with CRUE and CYD Foundation data.

(1) It includes students new entrance, academic year 2004/2005

(2) FRS: Faculty and researcher staff

(3) OSS: Officials and services staff

(4) School fees, of public and private origin, recognized in the universities.

Appendix 3. Dissimilarity measures

1. Euclidian distance:

$$d(i,j) = \sqrt{|x_{i1} - x_{j1}|^2 + |x_{i2} - x_{j2}|^2 + \ldots + |x_{in} - x_{jn}|^2}$$

d(i,j) = Distance between matrix i and matrix j.

x_{i1} = Element 1 of the matrix i.

x_{j1} = Element 1 of the matrix j.

2. Manhattan distance:

$$d(i,j) = |x_{i1} - x_{j1}| + |x_{i2} - x_{j2}| + \ldots + |x_{in} - x_{jn}|$$

3. Canberra Distance

$$d_{ij}^2 = \sum_{k=1}^{p} \frac{|x_{ik} - x_{jk}|}{|x_{ik} + x_{jk}|}$$

Properties of distances:

(i) $d(i, j) \geq 0$, (ii) $d(i, i) = 0$, (iii) $d(i, j) = d(j, i)$, y (iv) $d(i, j) \leq d(i, h) + d(h, j)$

Appendix 4. Results of regional tables.

Table A.4.1. Main sectorial impacts of the Andalusian university system.
Comparative analysis estimations Andalusian IOT and Spanish IOT

Total impact on the economy output

	INVESTMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST	AT	ST
Agriculture	1,0	2,6	0,5	1,1	39,0	36,1	44,5	41,3	1,8	2,5	2,2	3,1	41,8	41,2	47,2	45,5
Energy	7,0	8,6	10,5	10,9	13,6	12,2	16,8	14,9	7,0	6,2	8,5	7,5	27,6	27,0	35,9	33,3
Industry	128,5	153,6	95,8	113,3	157,7	203,8	182,0	236,8	43,3	54,0	56,9	70,9	329,4	411,4	334,7	421,0
Construction	31,4	30,1	51,8	48,5	14,6	13,1	18,4	16,4	3,2	3,4	3,8	4,1	49,2	46,7	74,0	69,0
SS. sale	25,2	35,9	27,5	37,9	281,9	285,5	367,4	369,9	48,3	49,1	61,8	63,0	355,4	370,5	456,6	470,8
SS no sale	33,5	33,2	102,6	102,3	2,0	0,6	2,5	0,7	69,8	69,6	73,9	73,6	105,3	103,4	179,0	176,7
Total	226,5	264,0	288,7	314,0	508,8	551,3	631,4	680,0	173,4	184,8	207,1	222,2	908,7	1000,1	1127,3	1216,2

Euros millions of 2001

AT = Andalusia Table ST = Spanish Table

Total impact on gross added value (GAV)

	INVESTMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE
Agriculture	0,6	1,5	0,3	0,6	23,2	21,5	24,7	23,0	1,1	1,5	1,2	1,7	24,9	24,5	26,3	25,3
Energy	3,3	4,8	4,9	5,5	6,3	6,6	7,5	7,7	3,3	3,3	3,8	3,8	12,8	14,7	16,3	17,0
Industry	41,8	49,9	31,3	37,1	41,0	54,0	50,0	65,7	14,2	17,6	18,0	22,4	97,1	121,5	99,3	125,3
Construction	12,2	11,7	20,8	19,4	5,7	5,1	7,4	6,6	1,3	1,3	1,5	1,6	19,2	18,2	29,6	27,6
SS. sale	15,1	21,6	18,8	26,0	168,2	170,2	249,1	249,7	28,4	29,0	40,0	40,7	211,7	220,9	307,9	316,5
SS no sale	28,0	27,8	93,2	93,0	1,3	0,5	1,8	0,7	58,4	58,2	67,1	66,9	87,6	86,5	162,0	160,5
Total	101,0	117,4	169,3	181,7	245,7	257,9	340,4	353,3	106,6	111,0	131,7	137,2	453,2	486,2	641,4	672,2

Euros millions of 2001

Table A.4.1. (continuation). Main sectorial impacts of the Andalusian university system.
Comparative analysis estimations Andalusian IOT and Spanish IOT

Total impact on employment

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE	TA	TE
Agriculture	21	56	15	29	845	782	1185	1101	40	54	58	82	906	892	1258	1212
Energy	55	61	70	63	108	87	120	84	56	45	62	43	219	193	252	190
Industry	1925	2259	898	1076	800	1152	921	1360	774	920	1130	1340	3499	4331	2949	3776
Construction	290	278	606	567	134	121	215	192	30	31	45	48	454	430	865	807
SS. sale	471	781	504	758	4383	4621	5892	6137	981	1054	1340	1429	5834	6456	7736	8324
SS no sale	1108	1102	3693	3687	43	16	58	21	2314	2309	2657	2651	3465	3427	6408	6359
Agriculture	3870	4537	5785	6180	6314	6779	8391	8895	4193	4414	5292	5594	14378	15729	19468	20668

Number of jobs

Source: Own elaboration from of CRUE and INE data.

Table A.4.2. Main sectorial impacts of the Catalonian university system.
Comparative analysis estimations Catalonian IOT and Spanish IOT

Total impact on the economy output

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST	CT	ST
Agriculture	0,3	2,7	0,4	2,0	11,2	29,6	12,1	31,9	0,6	2,4	0,6	2,6	12,1	34,7	13,1	36,4
Energy	4,6	8,0	7,5	12,7	4,9	10,3	5,9	12,0	5,4	7,3	5,9	8,0	14,9	25,6	19,3	32,7
Industry	89,9	110,8	124,9	150,7	126,4	159,6	140,0	177,4	39,8	50,2	44,7	56,4	256,1	320,7	309,6	384,5
Construction	4,3	5,1	12,6	13,1	6,6	11,5	8,4	14,9	3,4	4,1	3,7	4,5	14,2	20,7	24,7	32,5
SS. sale	20,4	27,8	31,2	40,5	259,1	256,6	324,7	320,4	51,0	48,9	56,1	54,0	330,5	333,3	412,0	414,9
SS no sale	61,3	61,1	113,5	113,2	1,2	0,5	1,4	0,6	76,2	76,0	80,7	80,5	138,7	137,7	195,6	194,3
Total	180,7	215,6	290,1	332,2	409,3	468,0	492,5	557,2	176,4	189,0	191,7	206,1	766,5	872,6	974,3	1095,4

Euros millions of 2001

CT = Catalonian Table ST = Spanish Table

Total Impact on gross added value (GAV)

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE
Agriculture	0,2	1,6	0,2	1,1	6,7	17,6	6,7	17,8	0,4	1,4	0,4	1,4	7,2	20,6	7,3	20,3
Energy	2,6	4,5	4,0	6,6	2,7	5,6	3,0	6,1	2,9	4,0	3,0	4,1	8,2	14,0	10,0	16,9
Industry	30,1	36,9	38,2	46,9	32,8	42,0	38,1	49,0	13,0	16,3	14,1	17,8	75,9	95,3	90,5	113,8
Construction	1,7	2,0	5,0	5,2	2,6	4,5	3,4	6,0	1,3	1,6	1,5	1,8	5,5	8,1	9,9	13,0
SS. sale	12,4	16,7	22,0	27,9	154,9	152,9	222,0	217,8	30,1	28,9	36,6	35,2	197,4	198,5	280,6	280,9
SS no sale	51,3	51,1	103,1	102,9	0,8	0,4	1,1	0,5	63,7	63,6	73,3	73,2	115,8	115,2	177,5	176,6
Total	98,2	112,9	172,5	190,6	200,4	222,9	274,4	297,2	111,5	115,8	128,9	133,6	410,1	451,6	575,8	621,4

Euros millions of 2001

Table A.4.2. (continuation). Main sectorial impacts of the Catalonian university system.
Comparative analysis estimations Catalonian IOT and Spanish IOT

Total impact on employment

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE	TC	TE
Agriculture	8	85	9	43	354	930	266	702	19	75	14	57	381	1090	289	802
Energy	25	44	36	64	28	59	30	63	31	42	31	43	83	145	97	170
Industry	1189	1425	1265	1529	534	723	779	1073	497	606	577	711	2220	2753	2621	3313
Construction	36	43	150	156	55	97	101	177	28	34	44	54	119	174	294	388
SS. sale	277	448	534	722	3480	3536	4784	4812	857	840	1026	1018	4614	4825	6344	6552
SS no sale	2032	2028	4086	4078	29	14	38	18	2527	2523	2905	2900	4588	4565	7029	6997
Total	3567	4073	6079	6593	4479	5359	5998	6846	3959	4120	4597	4783	12006	13552	16674	18222

Number of jobs

Source: Own elaboration from of CRUE and INE data.

Table A.4.3. Main sectorial impacts of the Madrid region university system.
Comparative analysis estimations Madrid IOT and Spanish IOT

Total Impact on the economy output

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST
Agriculture	0,0	5,2	0,1	2,0	0,1	27,4	0,1	35,4	0,0	2,6	0,1	3,0	0,1	35,2	0,4	40,4
Energy	4,5	12,7	7,6	14,9	5,0	11,1	6,3	14,2	3,7	7,6	6,8	9,6	13,2	31,4	20,7	38,7
Industry	182,4	237,1	101,5	153,8	114,0	159,1	147,2	204,5	46,5	57,6	47,4	64,1	343,0	453,8	296,1	422,5
Construction	3,3	5,1	74,0	80,4	11,0	14,5	15,5	20,3	3,4	4,2	4,5	5,5	17,8	23,8	94,0	106,2
SS. sale	32,6	50,0	33,7	54,1	305,2	307,4	404,2	406,6	56,1	52,9	52,7	55,9	393,9	410,2	490,6	516,5
SS no sale	65,6	63,4	112,5	112,4	3,9	0,6	1,0	0,8	90,9	87,9	118,4	118,3	160,3	151,9	231,8	231,5
Total	288,5	373,5	329,5	417,6	439,2	520,1	574,3	681,8	200,6	212,7	229,8	256,4	928,3	1106,3	1133,6	1355,7

Millones de euros de 2001

MT = Madrid Table

ST = Spanish Table

Total Impact on gross added value (GAV)

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	TM	TE	TM	TE	TM	TE	TM	TE	TM	TE	TM	TE	TM	TE	TM	TE
Agriculture	0,0	3,1	0,1	1,1	0,0	16,3	0,1	19,7	0,0	1,5	0,1	1,7	0,1	20,9	0,2	22,5
Energy	1,7	7,2	3,8	7,5	1,7	6,0	2,2	7,3	1,2	4,1	3,2	4,9	4,6	17,3	9,3	19,8
Industry	61,1	78,9	34,1	51,7	30,0	42,5	40,2	57,0	15,1	18,8	15,0	20,3	106,2	140,3	89,3	129,0
Construction	1,3	2,0	29,6	32,2	4,3	5,6	6,2	8,1	1,3	1,6	1,8	2,2	6,9	9,3	37,7	42,5
SS. sale	19,9	30,1	23,6	37,0	182,6	183,7	278,7	278,2	33,4	31,2	35,2	36,8	235,9	245,0	337,5	352,1
SS no sale	54,9	53,1	102,2	102,2	3,3	0,5	0,8	0,7	76,1	73,6	107,5	107,5	134,4	127,1	210,5	210,3
Total	138,9	174,3	193,5	231,8	221,9	254,6	328,1	371,0	127,2	130,8	162,9	173,4	488,0	559,8	684,5	776,2

Euros millions of 2001

Table A.4.3. (continuation). Main sectorial impacts of the Madrid region university system.
Comparative analysis estimations Madrid IOT and Spanish IOT

Total impact on employment

	INVESMENT				STAFF				STUDENTS				TOTAL			
	1998		2004		1998		2004		1998		2004		1998		2004	
	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST	MT	ST
Agriculture	0	282	8	118	4	1485	6	2048	0	140	8	173	5	1907	23	2338
Energy	32	76	40	78	37	69	47	73	27	47	38	49	96	191	126	200
Industry	2249	2846	998	1457	508	740	741	1072	541	674	800	1023	3298	4261	2538	3552
Construction	28	43	814	884	92	121	171	223	29	35	49	60	149	199	1034	1168
SS. sale	455	778	419	795	3307	3523	4546	4785	743	769	753	845	4505	5069	5719	6425
SS no sale	2232	2104	4052	4050	290	15	24	21	3091	2918	4263	4262	5613	5037	8339	8333
Total	4996	6129	6331	7381	4238	5953	5535	8221	4431	4583	5912	6413	13665	16664	17778	22015

Number of jobs

Source: Own elaboration from of CRUE and INE data.

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