38TH CONGRESS OF THE EUROPEAN REGIONAL SCIENCE ASSOCIATION

28 AUGUST-1 SEPTEMBER 1998 IN VIENNA

Europe quo vadis? - Regional Questions at the Turn of the Century

Coronado Guerrero, Daniel

Acosta Seró, Manuel

Departamento de Economía General

Universidad de Cádiz

Cádiz

SPAIN

e-mail: daniel.coronado@uca.es

manuel.acosta@uca.es

Fax: 56 299636

THE INFLUENCE OF REGIONAL LOCATION ON THE INNOVATION ACTIVITY OF SPANISH FIRMS: A LOGIT ANALYSIS .

Abstract: In this paper we deal with three questions that we believe to be crucial in terms of the technology-regional development relation: firstly, how can regional innovation and technological capacity be quantified; secondly, which are the main factors determining innovation; and thirdly, what can be done to increase the technological capacity of the least favoured regions, thereby in turn boosting competitiveness and regional growth. We deal with these questions in terms of Spanish regions. The working plan we propose is based on a diagnosis of regional imbalances and technological capacities from the twofold outlook of inputs and outputs. We then give what we believe to be the most noteworthy original contribution of this paper: an examination of the microeconomic determining factors of innovation and, fundamentally, the role played by business location. Lastly, we give some reflections on the results obtained and their implications in drawing up and applying regional policies of technological innovation in Spain.

1. Introduction

There has recently been a spate of works analysing the relationship between technological innovation and regional development. We also see the importance this matter is now being given in the sundry reports and communications on economic cohesion issued by the European Commission. The idea is steadily gaining ground that research and development (R&D) can boost the growth of industrial regions in decline and serve as a driving force for getting the poorer regions off the ground. In our opinion, from a scientific point of view there are three key features in the territorial development-technology relation: firstly, how can regional technological capacities and innovation be quantified; secondly, which are the main determining factors behind innovation; and thirdly, what can be done to increase the technological capacity of the least favoured regions, thereby in turn boosting competitiveness and regional growth.

As regards the first question, there are several indicators that are normally used to reveal the imbalances and technological capacities in the business resources and results of R&D activities between regions. From the input side widespread use has been made of technological effort (R&D as a percentage of gross added value, GAV), personnel skilled in R&D activities, etc, both by individual researchers and in institutional reports. Suitable processing of this data would seem to be essential for assessing the differences in territorial technological activity. But this should not be the only criterion taken into account to establish regional innovating capacities, since the same inputs are often associated with very different outputs. It is therefore necessary to take into account the technological results aspect to gain a complete overview of the process. From this viewpoint, the use of patents as an indicator has always been the object of widespread controversy in the various reference works (see, for example, Basberg, 1987, Pavitt, 1985, Mansfield, 1986, Levin et al., 1987, Griliches, 1990; Buesa and Molero, 1992). The existence of other innovation protection measures and the different patenting tendencies amongst industrial, business, national and regional sectors, etc, are the main drawbacks involved. Against this, these same studies point out that the regularity and uniformity of patent statistics make them a good instrument for estimating the differences in innovation activity between sectors and countries. Such are the conclusions, in a strictly regional context, of, amongst others, the empirical studies of Fischer et al. (1994) and Coronado and Acosta (1997).

As regards the second question – the determining factors behind regional innovation capacity – the conciliatory attempts of the network paradigm try to marry up regional studies and technological innovation theories with no specific geographical content (Camagni, 1991; Cooke and Morgan, 1993; Illeris and Jakobsen, 1990: Morgan, 1992, 1997; Storper, 1995). Put simply, the basic argument of this approach centres on the fact that low technological capacities (of competitiveness, for example) are due not only to the lack of suitable infrastructure or the workforce's lack of instruction (Cappellin,1988; Cappellin, 1992; Garofoli, 1992; Cuadrado, 1988; Vázquez Barquero, 1990; Caramés, 1990; Utrilla, 1991; Wadley, 1988), but also to the shortfalls in social capital. This last concept refers to the characteristics of organisations (company associations or networks, governmental institutions, etc.) that facilitate coordination and cooperation to their mutual benefit (Putnam, 1993). In this context, the location in the central area of a metropolitan region or functional zone can help to set up or maintain company networks permitting the individual companies' access to technological "learning". Nonetheless, despite the importance given in theoretical approaches to territory in the innovation-regional development relation, in practice it is traditionally the Schumpeterian hypotheses that most effort has been concentrated on (see, for example, Soete, 1979; Link, 1980; Loeb, 1983; Meisel and Lin, 1983; Levin et. al., 1987; Cohen and Levin, 1989; and, for the Spanish case, Gumbau, 1994). The emphasis on location aspects in relation to innovation is more recent (see, amongst others, Bania et. al., 1992, Kleinknecht and Poot, 1992; Fischer et al., 1994; Suarez-Villa and Walrod, 1997). In Spain, very little attention has been paid to the role played by location; in most cases it has been relegated to a secondary level or simply left out of the practical analysis altogether; in this respect, the work of Suarez-Villa and Rama (1996) is a notable exception.

Finally, as regards the third question – what can be done to boost regional technological development – unlike the traditional strategy centred on granting R&D aid in the form of subsidies or loans, or other strategies geared towards the creation of the necessary conditions in the environment where companies do business, action proposed from the network approach is basically geared towards increasing social capital by cutting down the technological and organisational imbalances between the strongest and weakest regions. The aim is that the least developed economies should become what has come to be known as “learning economies” (Lundvall and Johnson, 1994; Gregersen and Johnson, 1997). It is therefore proposed that there be a complete shift from a supply strategy based on furnishing R&D resources to another, bottom-up, demand-type strategy wherein companies play a more active part.

In this paper we aim to analyse these three matters in practice in the context of Spanish regions. The working plan we propose starts with a diagnosis of regional imbalances and potentialities from the twofold perspective of inputs and outputs. Secondly, we will undertake an examination of the microeconomic determining factors of innovation and, fundamentally, the role played by business location. Lastly, some reflections are offered on the results obtained and their implications in drawing up and applying regional technological innovation policies in Spain.

2. Identification of potentialities: Technologically advanced regions and technologically peripheral regions

As we argued in the introduction of this work, identification of regional technological capacities should be based not only on resources but also on results. This twofold approach is the subject of this section. The figures we work with correspond to an average of the years running from 1989 to 1995, both inclusive. This is a brief space of time, limited by a shortage of data, but nonetheless sufficiently long to illustrate the recent situation of the main indicators.[1] We would also point out that the figures and results herein presented are mainly based on business R&D, since, as pointed out by Barceló et. al. (1992) on the basis of several studies, universities and public research centres as a whole represent less than 1% of innovation sources.

From the input side, the regional breakdown of total and business R&D spending shows an asymmetrical distribution (Table 1). Two regions (Autonomous Communities, ACs) - Madrid and Catalunya – accounted in 1995 for 55% of national R&D activities, this figure rising to 63,17% in the case of business research. These same ACs represented 35,12% of total GAV and 37% of industrial GAV, showing that the regional distribution of R&D activities is much more uneven than that of economic activity as a whole.

The total average technology effort (R&D spending as a percentage of GAV) of Spain comes out as 0,92%, a very low figure, bearing in mind that the average for the European Union is about 2%. When we come down to regional detail, we find that La Rioja and Extremadura, at the bottom end, do not reach even one half of the Spanish average (neither do the Balearic islands, but this region is less representative since it has little industrial structure and its development is firmly based on a thriving tourism sector). At the upper end, some ACs - Madrid, the Basque Country and Catalunya – top this figure; but it must be borne in mind that, with the exception of the AC of Madrid, all are below the European average levels. The differences in pure business technological effort, without the offsetting effect of the public sector in total R&D activity, are even more marked. This is particularly worrying since the increase in competitiveness of companies located in the least developed areas can have a direct influence on boosting their development. As regards human capital, two indicators, full-time staff involved in R&D activities and researchers (always weighted in terms of total employment) show the regional situation of these resources. The average of the business sector for the whole set of Spanish regions in 1995 is 1,76 full-time equivalent workers for each thousand employed and 0,25 researchers in each company for each thousand employed. The unevenness shown by this indicator does not differ substantially from the above ones.

On the output side (Table 2), a marked polarisation is again noticeable. Catalunya and Madrid accounted in 1995 for slightly over half of the patents, and this figure rises to 63,39% if we add the Community of Valencia. They are followed in importance by the innovating nucleus of the north – Basque Country and Navarre – both Communities together accounting for almost ten per cent of patent applications. At the lower end of the scale, the patent applications of seven ACs together (Asturias, Balearic Islands, Canary Islands, Cantabria, Extremadura, Murcia and La Rioja) barely add up to 8% of the total.

- Table 1-

Summary of regional technological characteristics (inputs)
Average values 1989-95

Regions	Concentration of R&D resources		Technological effort (1)		Company R&D / Total R&D	R&D staff/ Thousand employed		Researchers/ Thou. employed	
	Total	Comp.	Total	Comp.		Total	Comp.	Total	Comp.
Andalucía	8.25	4.47	0.58	0.98	28.42	2.64	0.57	1.67	0.19
Aragón	2.39	1.93	0.65	0.95	42.28	3.94	1.27	2.40	0.35
Asturias	1.62	1.12	0.57	0.63	36.12	2.99	0.78	1.87	0.26
Balearic isl.	0.32	0.06	0.13	0.12	9.69	0.89	0.08	0.63	0.03
Canary isl.	1.72	0.15	0.45	0.22	4.64	2.38	0.08	1.67	0.03
Cantabria	0.72	0.40	0.52	0.55	29.92	2.70	0.57	1.86	0.25
Castilla-leon	4.04	3.62	0.64	1.06	47.03	3.27	1.09	1.94	0.26
Cast-La M.	0.90	1.09	0.24	0.61	60.93	1.01	0.41	0.55	0.12
Catalunya	19.57	24.98	0.97	1.98	66.18	5.09	2.97	2.63	1.04
Com. Valencia	5.26	3.29	0.52	0.60	33.10	2.43	0.66	1.62	0.25
Extremadura	0.66	0.13	0.32	0.19	10.38	1.63	0.16	0.97	0.03
Galicia	2.59	1.40	0.46	0.55	27.85	1.91	0.45	1.15	0.11
Madrid	39.41	41.92	2.30	6.56	55.23	12.96	5.26	6.94	2.49
Murcia	1.34	0.65	0.52	0.63	24.67	2.82	0.57	1.72	0.16
Navarra	1.56	1.62	0.90	1.28	55.93	6.29	2.71	3.85	0.79
Basque country	8.38	12.91	1.22	2.62	79.81	5.90	4.32	3.13	1.84
Rioja (la)	0.21	0.25	0.27	0.50	64.79	1.57	0.65	0.90	0.18
Spanish average	100	100	0.93	1.96	51.92	4.47	1.83	2.53	0.72

(1) Total technological effort = total R&D /Gross added value (G.A.V.) on total factor costs; Business technological effort = company sector R&D / G.A.V. industrial factor costs.
SOURCE: I.N.E (National Statistics Institute) and drawn up from own figures.

From the output viewpoint, we can break down the analysis to the more detailed level of sectors by regions.[2] Table 3 shows the technological specialisation levels by activity for each of the seventeen Spanish regions. Two clear conclusions can be drawn therefrom: the most technologically advanced regions (with the greatest concentration of recourses and results) specialise in technology with a high or very high difficulty. The second conclusion to be drawn is that regions like the Community of Valencia, and even Catalunya, which show a notable imbalance between the relatively low level of resources in relation to results (many patents), specialise more in technology of a low difficulty: patents obtained with relatively few resources.

-Table 2-
Regional technological characteristics (outputs*)
Average values 1989-95

Autonomous Community	Percentage of patents (%)	RICI (1) Av.=100	Patents/ million inhabitants Av. =100	Patents/FTE staff companies (2) Av. =100	Patents/ employed Av. =100
Andalucía	6.60	74.60	37.34	130.54	46.93
Aragón	2.90	70.40	93.21	131.87	85.16
Asturias	1.48	42.71	51.98	134.56	54.04
Balearic Islands	1.03	110.16	56.14	1343.79	54.18
Canary Islands	1.10	77.45	28.06	749.47	29.80
Cantabria	0.75	52.74	56.05	192.80	57.58
Castilla-león	2.45	37.35	38.33	67.50	38.18
Castilla-la mancha	1.54	43.17	36.39	183.30	38.09
Catalunya	32.22	127.51	202.95	115.25	179.62
Com. of Valencia	11.13	103.64	113.23	301.47	108.31
Extremadura	0.57	42.12	20.27	248.99	23.62
Galicia	2.00	40.44	28.81	115.23	25.85
Madrid	23.39	188.29	184.48	64.80	177.65
Murcia	1.42	69.61	52.77	173.67	55.55
Navarra	2.52	99.49	185.96	124.30	168.73
Basque Country	8.27	85.50	153.65	61.12	146.84
Rioja (la)	0.63	65.69	98.16	288.22	92.87

(*) The number of patents includes applications in each region via national, European and P.C.T (Patent Cooperation Treaty) channels.
(1) RICI: Regional innovation capacity index: (Nº of Patents region i/ total nº of patents)/(region i industrial G.A.V. /total industrial G.A.V).
(2) F.T.E..: Full time equivalent R&D personnel.
SOURCE: INE, OEPM (Spanish Patents Office) and self-produced.

The joint analysis of resources and results shows that, in terms of innovation capacity, there are several types of regions in Spain. In the interests of simplicity we can separate the technological regions (those with average or above-average resources and results) from the technologically peripheral regions. Within the first group, the most important technological region is Madrid; Catalunya, the Basque Country, Navarre and the Community of Valencia are regions that, in terms of the Spanish average, can be said to reach an acceptable level. Remaining regions are on the technological periphery. Obviously, as the indicators themselves show, there are grey areas within these two groups. Be that as it may, it should be stressed that all Spanish regions except Madrid show levels well below the average of the European Union.

-Table 3-

Patents granted broken down by level of complexity 1989-95(*)

Regions	Very high		High		Intermediate		Low		Total
	Nº	%	Nº	%	Nº	%	Nº	%	
Andalucía	153	35,83	163	38,17	47	11,01	64	14,99	427
Aragón	69	28,75	98	40,83	46	19,17	27	11,25	240
Asturias	43	43,88	28	28,57	15	15,31	12	12,24	98
Balearic Islands	24	41,38	12	20,69	12	20,69	10	17,24	58
Canary Islands	29	36,71	21	26,58	20	25,32	9	11,39	79
Cantabria	11	26,19	14	33,33	13	30,95	4	9,52	42
Castilla-León	48	24,49	88	44,90	31	15,82	29	14,80	196
Castilla-la Mancha	22	24,18	26	28,57	21	23,08	22	24,18	91
Catalunya	1.067	33,20	1.214	37,77	506	15,74	427	13,29	3.214
Community of Valen.	249	26,80	292	31,43	171	18,41	217	23,36	929
Extremadura	12	33,33	13	36,11	6	16,67	5	13,89	36
Galicia	41	29,93	51	37,23	25	18,25	20	14,60	137
Madrid	996	47,11	514	24,31	365	17,27	239	11,31	2.114
Murcia	23	22,33	40	38,84	25	24,27	15	14,56	103
Navarra	99	37,79	103	39,31	32	12,21	28	10,69	262
Basque Country	231	30,47	303	39,97	165	21,77	59	7,78	758
Rioja (la)	12	20,34	20	33,90	8	13,56	19	32,20	59
Total	3.129	35,38	3.000	33,93	1.508	17,05	1.206	13,64	8.843

(*) Classification taken from Buesa and Molero (1988, pp. 49 and 50). These authors effected the classification from the assessment made by a panel of experts of the complexity of the processes and products of each branch. The sector breakdown is as follows: VERY HIGH: Machinery and electrical and electronic material; Office machinery, computers, precision instruments; pharmaceutical products; base chemical industry; oil industry. HIGH: Aeronautical industry; Car industry and its components; construction of other transport material; construction of industrial and agricultural machinery; railway stock; electricity; final consumption chemical products. INTERMEDIATE: Rubber and plastic products; Other manufactures; furniture industry; ship building; metal products; Cement, bricks, tiles and other construction material; glass products; basic industry of non-ferrous metals; chemical products for agriculture and industry; iron and steel industry. LOW: Bakery, cake making; footwear; wood and cork industries; meat industry; publishing and printing; tailoring; tanning and leather articles; carpets and other textile products; food industry not included elsewhere.; textile industry; paper industry; gas, steam and water; sugar Industry; alcoholic drinks; Mining (energy and non-energy, except oil and gas); tobacco industry.
SOURCE: Drawn up from figures of the Spanish Patents Office (OEPM).

3. An examination of the microeconomic determining factors of business innovation. The influence of location.

In theory there are many factors that could influence a business decision to introduce a process or product innovation. Accepting patents as a useful innovation indicator, with the advantages and drawbacks outlined above, we obtain a set of four elements that influence in business innovation (Fischer et al., 1994): a) Internal factors related to business characteristics: size, innovation resources, cultural characteristics of the company, etc. b) The industrial sector in which the company trades and the market structure. c) Action of public sector through technology policy. d) Location: access to scientific-technological knowledge, availability of relevant infrastructure, access to information and innovation networks, etc. While the first two factors are related to Schumpeterian approaches to innovation, regardless of geographical area, the last concept links up directly with the regional concept of social capital that we referred to in the introduction.

In this section we aim to bring together the above four aspects as explanatory factors of innovation in Spanish firms, although restrictions on statistical information have prevented us from considering more explanatory variables. The regressors used in the empirical contrast are the following:

PAT: Endogenous variable. Takes the value 1 if the firm has patented at least once in the period 1989-1995. Otherwise its value is 0. This variable represents the indicator of business innovation; it is the variable that the procedure aims to explain.
LEMP and LEMP2: Explanatory variables representing the company size. This factor is introduced with the natural logarithm and the squared logarithm of the number of employees in the firm.
MALTA, ALTA, INTERM: Dummy variables expressing whether firm i belongs to a sector of very high, high, intermediate or low technological complexity (see table 4). The base category

we have defined is "low". As is well known, not all patents have the same technological significance; the differences in quality and the difficulty of obtaining them are taken into account in this variable.

LOC, ZONAU, RETEC, PARQUE: Dummy variables indicating the location characteristics. LOC takes the value 1 if firm i is located in a provincial capital or city with more a population of more than one hundred thousand. Otherwise its value is 0. ZONAU takes the value 1 if firm i is located in a great conurbation or functional urban zone, defined by the European Union as an area of more than one million inhabitants with a urban centre and a surrounding area from where the labour force commutes daily to the urban centre; Spain has five great cities with these characteristics: Barcelona, Madrid, Valencia, Bilbao and Seville. RETEC is a variable representing the regional technological potentialities from the input side; it takes the value 1 if the region in which company i is located is a "Technological Region", i.e., if it has an above-average research personnel and technological effort (see above section). Otherwise it takes the value 0. PARQUE is a variable representing the proximity of a technological park and access to the corresponding services. It takes the value 1 if the region in which the firm is located has one or more technological parks; 0 otherwise.

PN and PUE: Dummy variables representing public aid for technological innovation. PN takes the value 1 if firm i has been included in a national R&D project before taking out a patent; 0 otherwise. PUE takes the value 1 if firm i has been included in a European project before taking out a patent; 0 otherwise.

The basic equation to be estimated is:

PAT=f(LEMP, LEMP2, MALTA, ALTA, INTERM, LOC, ZONAU, RETEC, PARQUE, PN, PUE)

The variable to be explained is binary, so the most fitting is to specify a discrete choice model. In this case we have opted for the logit model. With this type of specification we can estimate the parameters by the maximum likelihood model. As is well known, the first-order conditions are non-linear, so the estimated parameters are obtained using iterative procedures.[3]

The observation sample for the estimation is made up by 1.342 firms. The data on business characteristics are taken from the population contained in the database of the Industrial Technology Development Centre (Centro para el Desarrollo Tecnológico Industrial: CDTI). The firms involved, therefore, have all contacted this body in one way or another, usually to apply for some sort of aid to subsidise their technological activity. These figures have in turn been cross checked against the patent registers of the Spanish Patents Office (Oficina Española de Patentes y Marcas: OEPM), contained in its database CIBEPAT. Consideration has hence been given to whether or not the firm in question has obtained any aid in the form of a subsidy or loan and whether this was prior to obtaining the patent. Indicators of regional technological characteristics have been calculated from data furnished by the National Statistics Institute (Instituto Nacional de Estadística, INE) (see Tables 1, 2 and 3). The period considered runs from 1989 to 1995. The lower limit is determined by the date when R&D information in Spain was homogeneously and consistently regionalised. The construction of the sample could therefore influence in the results, which need to be interpreted with due caution. The reason for this is, firstly, that all these firms are in one way or another bound up with technological activity and are therefore included in the CDTI database; secondly, the period considered ends in 1995, so there could be some firms whose patent application refers to this date but which as yet (first quarter of 1998) is not included in the CIBEPAT database because it is still in process of being granted – this database does not include patents with all information (application date, date granted, applicant, summary, etc) until the granting procedure has run its full course, and this could take several years.

Descriptive statistics for the set of variables are shown in Table 4. As may be seen, 244 of the total sample of 1.342 have taken out a patent. Table 5 shows the results obtained from two estimation models: it shows the estimated parameters, variances, the asymptotic values of the "t"s and the remaining statistics for assessing the goodness of fit of the model. The difference between them lies in the fact that Model 1 includes as an explanatory variable the location of the firm in a provincial capital or city with a population of more than one hundred thousand. Model 2 attempts to discriminate the effect of location in great conurbations or functional urban zones.

The size variable (LEMP) is significant and positive, from which it follows that the likelihood of a firm taking out a patent grows in direct proportion with size, thereby conforming to the Schumpeterian hypothesis. As indicated by the negative sign of variable LEMP2, however, there is a maximum size, after which the likelihood of a firm taking out a patent falls.

An analysis of the MALTA, ALTA, INTERM variables shows that innovation is more likely in those companies trading in technological sectors of high and very high complexity. There is no appreciable difference, however, between sectors of intermediate and low complexity. Mention must also be made of the significant effect of government aid, as indicated by the positive signs of the variables PN and PUE.

-Table 4-

Descriptive statistics for explanatory variables

Variable	Dep=0		Dep=1		All	
	Mean	Std. Desv.	Mean	Std.Desv.	Mean	Std.Desv.
LEMP	4.2683	1.5137	4.9373	1.4404	4.3900	1.5222
LEMP2	20.5080	14.0878	26.4428	14.9839	21.5871	14.4320
PN	0.6056	0.4889	0.8279	0.3783	0.6461	0.4784
PUE	0.2231	0.4165	0.2951	0.4570	0.2362	0.4249
MALTA	0.2468	0.4314	0.3443	0.4761	0.2645	0.4412
ALTA	0.1831	0.3869	0.2951	0.4570	0.2034	0.4027
INTERM	0.2714	0.4449	0.2008	0.4014	0.2586	0.4380
LOC	0.3042	0.4603	0.4303	0.4961	0.3271	0.4693
ZONAU	0.1940	0.3956	0.3074	0.4624	0.2146	0.4107
RETEC	0.6275	0.4837	0.7992	0.4014	0.6587	0.4743
PARQUE	0.8333	0.3728	0.8975	0.3039	0.8450	0.3620
Observations		1098		244		1342

Variables: LEMP: log. of number of employees: LEMP2: LEMP*LEMP; PN (dummy): value 1 if the firm is included in a national R&D project; PUE (dummy): value 1 if the firm is included in a European Union R&D project; MALTA (dummy): value 1 if the firm belongs to a sector of very high technical complexity; ALTA (dummy): value 1 if the firm belongs to a sector of high technical complexity; INTERM (dummy): value 1 if the firm belongs to a sector of intermediate technical complexity; LOC (dummy): value 1 if the firm is located in a provincial capital or city with a population of over one hundred thousand. ZONAU (dummy): value 1 if the firm is located in a functional urban zone with a population of over one million (defined by the EU as a zone with an urban centre with a surrounding area from where the labourforce commutes in daily to the centre); RETEC (dummy): value 1 if the firm belongs to a region with above-average research personnel and technological effort; PARQUE (dummy): value 1 if the firm is located in a region with one or more technological parks. (Dummy variables take the value 0 whenever the above does not hold true).

As for location, Model 1 shows that the LOC variable is positive and significant. It therefore follows that a firm is more likely to take out a patent if it is located in a conurbation, in this case provincial capitals or cities with a population of over one hundred thousand. A similar conclusion can be drawn from an analysis of the RETEC variable: firms located in what we have called technological regions (with an above-average availability of resources and specialised R&D personnel) are more likely to innovate. In Model 2 the LOC variable has been replaced by ZONAU with the aim of discriminating whether conurbations or functional urban zones offer location advantages when adopting an innovation. The results show that there are no appreciable differences between the two models. The PARQUE variable, moreover, is not explanatory in either of the two models. This should not surprise us, however; most technological parks – especially those in the least developed regions – have been set up very recently and, as is generally acknowledged, the technopolis effect on business innovation and regional development is felt only in the long term.

-Table 5-
Results of logit analysis

Variable	MODEL 1				MODEL 2			
	Coeff.	StdError	t-Stat	Prob.	Coeff	StdError	t-Stat	Prob.
CONS	-3.4262	0.3736	-9.1715	0.0000	-3.3310	0.3699	-9.0059	0.0000
LEMP	0.4681	0.1363	3.4337	0.0006	0.4694	0.1374	3.4154	0.0006
LEMP2	-0.0372	0.0136	-2.7335	0.0063	-0.0367	0.0138	-2.6616	0.0078
PN	0.6570	0.1045	6.2863	0.0000	0.6447	0.1039	6.2078	0.0000
PUE	0.3427	0.1049	3.2662	0.0011	0.3303	0.1045	3.1603	0.0016
MALTA	0.4286	0.1224	3.5019	0.0005	0.4435	0.1221	3.6309	0.0003
ALTA	0.6126	0.1277	4.7964	0.0000	0.6256	0.1285	4.8671	0.0000
INTERM	0.1913	0.1276	1.4995	0.1337	0.1883	0.1275	1.4764	0.1398
LOC	0.2753	0.0927	2.9697	0.0030				
ZONAU					0.2218	0.1101	2.0143	0.0440
RETEC	0.2310	0.1044	2.2126	0.0269	0.1813	0.1062	1.7079	0.0877
PARQUE	0.1190	0.1351	0.8810	0.3783	0.0871	0.1359	0.6406	0.5218

Log likelihood:	-564.5023	Log likelihood:	-566.8694
Restr. log likelihood:	-636.2950	Restr. log likelihood:	-636.2950
LR statistic (10 df):	143.5853	LR statistic (10 df):	138.8512
Probability(LR stat):	0.0000	Probability(LR stat):	0.0000
McFadden R-squared:	0.1128	McFadden R-squared:	0.1091
Obs with Dep=0:	1098	Obs with Dep=0:	1098
Obs with Dep=1:	244	Obs with Dep=1:	244
Total obs:	1342	Total obs:	1342

Variables: LEMP: log. of number of employees: LEMP2: LEMP*LEMP; PN (dummy): value 1 if the firm is included in a national R&D project; PUE (dummy): value 1 if the firm is included in a European Union R&D project; MALTA (dummy): value 1 if the firm belongs to a sector of very high technical complexity; ALTA (dummy): value 1 if the firm belongs to a sector of high technical complexity; INTERM (dummy): value 1 if the firm belongs to a sector of intermediate technical complexity; LOC (dummy): value 1 if the firm is located in a provincial capital or city with a population of over one hundred thousand. ZONAU (dummy): value 1 if the firm is located in a functional urban zone with a population of over one million (defined by the EU as a zone with an urban centre with a surrounding area from where the labourforce commutes in daily to the centre); RETEC (dummy): value 1 if the firm belongs to a region with above-average research personnel and technological effort; PARQUE (dummy): value 1 if the firm is located in a region with one or more technological parks. (Dummy variables take the value 0 whenever the above does not hold true).

-Tabla 6-

Resuls of logit analysis

Variable	MODEL 3 Technologically Peripheral Regions				MODEL 4 Technological Regions			
	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.
CONS	-3.5290	0.7184	-4.9123	0.0000	-3.2156	0.4765	-6.7478	0.0000
LEMP	0.5919	0.3062	1.9333	0.0532	0.4423	0.1592	2.7781	0.0055
LEMP2	-0.0494	0.0335	-1.4742	0.1404	-0.0350	0.0156	-2.2448	0.0248
PN	0.5388	0.1944	2.7718	0.0056	0.7009	0.1239	5.6570	0.0000
PUE	0.2989	0.2169	1.3784	0.1681	0.3563	0.1206	2.9535	0.0031
MALTA	0.4663	0.2354	1.9810	0.0476	0.4540	0.1468	3.0933	0.0020
ALTA	0.3458	0.2515	1.3752	0.1691	0.7093	0.1537	4.6148	0.0000
INTERM	0.0649	0.2111	0.3073	0.7586	0.2667	0.1611	1.6561	0.0977
LOC	0.2335	0.1800	1.2971	0.1946	0.2988	0.1098	2.7207	0.0065
PARQUE	0.1237	0.1838	0.6729	0.5010	0.1087	0.2014	0.5398	0.5893
Log likelihood	-140.7446				Log likelihood:		-422.3169	
Restr. log likelihood	-155.7974				Restr. log likelihood:		-466.4439	
LR statistic (9 df)	30.1056				LR statistic (9 df)		88.2539	
Probability(LR stat)	0.0004				Probability(LR stat)		0.0000	
McFadden R-squared	0.0966				McFadden R-squared		0.0946	
Obs with Dep=0	409				Obs with Dep=0		689	
Obs with Dep=1	49				Obs with Dep=1		195	
Total obs	458				Total obs		884	

Variables: LEMP: log. of number of employees: LEMP2: LEMP*LEMP; PN (dummy): value 1 if the firm is included in a national R&D project; PUE (dummy): value 1 if the firm is included in a European Union R&D project; MALTA (dummy): value 1 if the firm belongs to a sector of very high technical complexity; ALTA (dummy): value 1 if the firm belongs to a sector of high technical complexity; INTERM (dummy): value 1 if the firm belongs to a sector of intermediate technical complexity; LOC (dummy): value 1 if the firm is located in a provincial capital or city with a population of over one hundred thousand. ZONAU (dummy): value 1 if the firm is located in a functional urban zone with a population of over one million (defined by the EU as a zone with an urban centre with a surrounding area from where the labourforce commutes in daily to the centre); RETEC (dummy): value 1 if the firm belongs to a region with above-average research personnel and technological effort; PARQUE (dummy): value 1 if the firm is located in a region with one or more technological parks. (Dummy variables take the value 0 whenever the above does not hold true).

Two additional estimation models have been used to gain a more in-depth knowledge of the effects of regional location. Table 6 shows results of the estimation for firms located in technologically peripheral areas (Model 3) and for technological regions (Model 4). The differences between them show that the determining factors of innovation vary according to the location in one or other type of region. It should be noted that in Model 3, unlike in Model 4, the PUE and ALTA variables are not important. As for location, the LOC variable, of no importance in Model 3, shows that in these peripheral regions, the fact of whether or not the firm is sited in a large city within one of these regions makes no difference: the location-innovation binomial, as opposed to what obtains in technological regions, seems not to function in these zones.

Results to date show that there are several regional innovation models in Spain. Put simply, we can speak of a first-order model (made up basically by Madrid, Catalunya, the Community of Valencia and the Basque Country together with Navarre) which is forged in the cities of the technological regions; here we do see the positive effect of urban concentrations. Within these regions, firms located in a conurbation or functional zone have greater innovation possibilities (to take out a patent). This shows the positive effect of the proximity to a pool of specialised labour, access to advanced technology services, the possibility of joining company networks facilitating mutual cooperation, etc. The existence is therefore confirmed in these areas of positive externalities, both static in character (better communications, infrastructure, etc.) and dynamic (flow of knowledge, learning and innovation). It must nonetheless be pointed out that in this category of regions there is hardly any difference according to whether we consider urban nuclei of an average or even small size as compared with the great functional zones. This shows the importance of small cities in development and access to business innovation (but it should also be stressed that, although the cities in question are small, they are all close to a great functional zone).

There is another, second-order regional model in Spain made up by the rest of the regions and characterised by the fact that the only important factors determining innovation are firm size, public aid and the fact that the activity is carried out in a sector of very high complexity. The binomial urban concentration-innovation seems not to obtain in regions that are technologically little advanced; here, empirical results show that the role of location in urban concentrations is not important. The reasons for the fact that urban concentrations have little influence on innovation have obviously to be looked for in structural deficiencies. The problem lies not only in the lack of networks to facilitate learning but in the deficiencies in the rest of the factors determining competitiveness: poor infrastructure quality, dependence on traditional productive sectors, the lack of a pool of specialised labour, etc.

4. Final Conclusions

The technological scene in Spanish regions as outlined above prompts the question of what are the solutions for boosting innovation capacity, especially in technologically peripheral areas. A fact to bear in mind when answering this question is the agreement of most observers that we are evolving from a linear innovation system to an integrated one. The linear system is characterised by the fact that innovation is mainly generated in the major companies, while low innovation capacity is nearly always explained by a lack of R&D resources; consequently, technological policy is geared towards furnishing this type of resources by means of a top-down strategy. In the integrated innovation system the medium and small firms are also important – like the major ones – in the innovation process, and differences in innovation capacity are explained not only by the lack of R&D resources but also by other invisible factors (institutional and cultural context). It therefore follows that technological policy should be directed towards encouraging the creation of networks and the joining thereof, to the mutual advantage of the firms concerned, all from a bottom-up strategy. In Madrid and the other regions that, with some reservations, can be considered as technologically more advanced, no objection can be placed against the adoption of a bottom-up type innovation policy, inter- or intra-regional, as part of a national innovation system.

In the case of Spanish regions, however, it has been clearly shown that the distribution of technological capacities is markedly polarised. The question we must answer, therefore, has to do with the possibility of applying a network policy in regions on the technology periphery. Although technological innovation has become a new holy grail, it should not be forgotten that innovation is not the only determining factor of low regional competitiveness; the development of peripheral regions must spring from several sources, an argument that seems to have been forgotten in post Fordist approaches lying behind the network approach. The emphasis on networks is useful when the region has minimum resources; regions lacking them completely need parallel technology instruments. In the absence of a suitable framework – appropriate transport and communications infrastructure, an instructed workforce, etc – it is unlikely that a network strategy implying the active participation of small and medium sized firms will work. Action on physical and human capital has to be, if not prior to, at least parallel to any attempts to increase social capital. In any case, it is obvious that the least developed regions should not be denied their possibilities of increasing their innovation capacities on the grounds that innovation policies seek above all national efficiency objectives. Up to now the offsetting role of innovation policies in the least developed regions has been carried out by the competent innovation authority on regional policy. Its work, however, has been mainly geared towards furnishing resources (in the form of flows or stocks) which in many cases has inevitably come up against the absorption capacity of the least developed zones. The network approach therefore opens up a new perspective for the least developed regions. The proposal involves the creation of regional development agencies responsible for the "learning" of the potential innovation agents. Its main responsibilities will be finding a way of integrating companies in networks that favour access to knowledge and learning for innovation and competitiveness, as well as demonstrating the path to follow for training personnel. The experience in other countries (see Morgan, 1997) shows that this strategy can work. In the case of Spanish regions on the technology periphery, we have been able to show that the effects of location in urban nuclei are not significant (neither is proximity to technological parks) and this shows, as opposed to what obtains in technologically more advanced regions, that companies located in these areas do not have the expected learning capacity. What is lacking in these regions is a bottom-up strategy favouring learning, albeit of course accompanied by a range of top-down initiatives, since it has also been shown that R&D aid generally has positive results across the board.

---

1. Although there are some statistics on regionalised R&D spending (inputs) prior to 1989, it was from this year on that figures were regularly published by the National Statistics Institute (I.N.E) with no gaps and with a homogenous presentation (the choice of the end of the period -1995- corresponds only to the fact that this is the last year for which figures are available, published in November 1997). As for patent figures (outputs), these have been directly forwarded by the

Spanish Patents Office (O.E.P.M.).
2. With resources this same approach cannot be followed, as there are no published statistics that break down R&D spending by sector and region.
3. Space fails us here to describe a procedure that in any case is already sufficiently known– model description, likelihood function, random perturbation hypothesis, iterative approximation, etc. We refer the reader to Crown (1998, pp. 99-154) or Stewart and Gill (1988, pp. 362-371). These recent works go into all these aspects in depth, with abundant bibliographical references.

References

BARCELÓ, M.; SOLÉ, F.; VALLS, J. (1992): "Tecnología y PME en Espańa". *Economía Industrial*, marzo-abril, pp. 127-136.

BANIA, N.; CALKINS, L.N.; DALENBERG, D.R. (1992): "The effects of regional science and tecnology policy on the geographic distribution of industrial R&D laboratiries". *Journal of Regional Science,* vol. 32, nş 2, pp. 209-228.

BASGERG, B. (1987): "Patents and the Measurement of Tecnological Change: A Survey of the Literature". *Research Policy,* nş 16, pp. 131-141.

BUESA, M; MOLERO, J. (1988): *Estructura Industrial de Espańa*. Fondo de Cultura Económica, Madrid.

BUESA, M; MOLERO, J. (1992): "Capacidades tecnológicas y ventajas competitivas en la industria espańola". *Ekonomiaz*, nş 22, pp. 222-247.

CAMAGNI, R. (1991): *Innovation Networks: Spatial Perspectives*. Belhaven, Londres.

CAPPELLIN, R. (1988): "Opciones de política regional en la CEE". *Papeles de Economía Española*, nº35, pp. 15-35.

CAPPELLIN, R. (1992): "Los nuevos centros de gravedad del desarrollo regional en la Europa de los 90". *Revista de Estudios Regionales*, nº 33, pp. 15-62.

CARAMES VIEITEZ, L. (1990): "Descentralización de la política regional". *Política Regional en la Europa de los años 90,* pp. 489-498. Ed. Ministerio de Economía y Hacienda, Madrid.

COHEN, W.M.; LEVIN, R.C. (1989): "Empirical studies of innovation and market structure", en Schmalensee, R. Y Willig, R.D. (Eds.), *Handbook of Industrial Organization,* vol. 2, pp. 1.059-1.110. Ed. North Holland, Amsterdam.

COOKE, P.; MORGAN, K. (1993): “The network paradigm: new departures in corporate and regional development”. *Environment and Planning*, nş 11, pp. 543-564.

CORONADO, D.; ACOSTA, M. (1997): “Spatial Distribution of Patents in Spain: Determining Factors and Consequences on Regional Development”. *Regional Studies*, Vol.31,nş4,pp.381-390.

CROWN (1998): *Statistical Models for the social and behavioral sciences.* Ed. Praeger, Westport, Connecticut.

CUADRADO ROURA, J.R.(1988): "Políticas regionales: hacia un nuevo enfoque". *Papeles de Economía Española*, nº 35, pp. 68-95.

FISCHER, M.M.; FRÖHLICH, J.; GASSLER, H. (1994): “An Exploration into the Determinants of Patent Activities: Some Empirical Evidence for Austria”. *Regional Studies,* Vol. 28, nş 1,pp.1-12.

GAROFOLI, G. (1992): "Endogenous development and Southern Europe: An introduction". En Garofoli G. (ed.): *Endogenous Development and Southern Europe*. Avebury, Aldershot, pp. 1-13.

GREGERSEN, B.; JOHNSON, B. (1997): “Learning Economies, Innovation Systems and European Integration”. *Regional Studies,* Vol. 31, nş 5, pp. 479-490.

GRILICHES, Z. (1990): “Patent statistics as economic indicators: a survey”. *Journal of Economic Literature,* Vol. XXVIII, pp. 1661-1707.

GUMBAU, M. (1994): “Los determinantes de la innovación: El papel del tamańo de la empresa”. *Información Comercial Espańola,* nş 726, pp. 117-127.

ILLERIS, S.; JAKOBSEN, L. (1990): *Networks and Regional Development*.University Press, Copenhagen.

KLEINKNECHT, A.; POOT, T.P. (1992): “Do regions matter for R&D?. *Regional Studies*, vol. 26, pp. 221-232.

LEVIN, R.; KLEVORIK, K.; NELSON, R.; WINTER, G. (1987): “Appropriating the returns from industrial R&D”. *Brooking Papers on Economics Activity,* nş 3, pp. 783-820.

LINK, A.N. (1980): “Firm Size and efficient entrepreneurial actividty: a reformulation of the Schumpeter hypotesis”. *Journal of Political Economy,* vol. 88, pp. 771-782.

LOEB, P.D. (1983): “Further evidence of the determinants of industrial research and development using single and simultaneous equation models”. *Empirical Economic*, vol. 8, pp. 203-214.

LUNDVALL, B. A.; JOHNSON, B. (1994): “The learning economy”. *Journal of Industrial Studies*, Vol. 1, nş 2, pp. 23-42

MANSFIELD, E. (1986): “Patents and innovation: an empirical study”. *Management Science*, vol. 32, nş 2, pp. 173-181.

MEISEL, J.B. AND LIN, S.A.Y. (1983): “The impact of market structure on the firm’s allocation of resources to research and development”. *Quarterly Review of Economics and Business*, vol. 23, pp. 351-374.

MORGAN, K. (1992): “Innovating by networking: new models of corporate and regional development”, en Dunford M.; Kafkalis, G. (Eds.), *Cities and regions in the New Europe*, pp. 150-169. Belhaven, Londres.

MORGAN, K. (1997): “The Learning Region: Institutions, Innovation and Regional Renewal”. *Regional Studies*, Vol. 31, nş 5, pp. 491-503.

PAVITT, K. (1985): “Patent Statistics as Indicators of Innovative Activities: Possibilities and Problems”. *Scientometrics*, Vol. 7, nş 1 y 2, pp. 77-99.

PUTNAM, R. (1993): “The prosperous community: Social capital and public life”. *Am Prospect*, nş 13, pp. 35-42.

SOETE, L. (1979): “Firm size and innovative activity: the evidence reconsidered”. *European Economic Review*, vol. 12, pp. 319-340.

STEWART, J.; GILL, L. (1998): *Econometrics*. Ed. Prentice Hall, Londres.

STORPER, M. (1995): “The resurgence of regional economics, ten years later: the region as nexus of untrades interdependencies”. *European Urban and Regional Studies*, nş 2, pp. 191-221.

SUAREZ-VILLA, L.; RAMA, R. (1996): “Outsourcing, R&D and the pattern of intra-metropolitan location: The electronics industries of Madrid”. *Urban Studies*, vol. 36, nş 3, pp. 1155-1198.

SUAREZ-VILLA, L.; WALROD, W. (1997): “Operational strategy, R&D and intra-metropolitan clustering in a policentric structure: the advanced electronics industries of the Los Angeles basin". *Urban Studies,* vol. 34, nş 9, pp. 1343-81.

UTRILLA DE LA HOZ, A. (1991): "Las nuevas estrategias del desarrollo regional". *Estudios Territoriales*, nş 36, pp. 77-92.

VAZQUEZ BARQUERO, A. (1990): "Local development initiatives under incipient regional autonomy: the Spanish experience in the 1980s", en Stöhr, W.B. (ed.), *Global challenge and local response*, pp. 354-374. Mansell, Londres.

WADLEY, D. (1988): "Estrategias de desarrollo regional". *Papeles de Economía Española*, nº35, pp. 96-114.