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Dynamic effects within a regional system: an empirical approach

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Abstract. In this paper we focus on the dynamic effects under which the regional economic growth processes are accomplished, breaking them down into two broad types: neighborhood and economy-wide effects. By means of a proposed dynamic space – time empirical model, the competition structure within a multiregional economic system is developed. Cointegration and error-correction modeling techniques are used to support the existence of this competition structure over both the short and long term. As an application, we show the dynamic effects on the evolution of the regional performance of Spanish regions over the period 1972 – 2000. Our results indicate that some macroeconomic forces are operating through time on this Spanish system because positive and negative effects are detected both at economy-wide and at neighborhood levels. Further, the findings show that a new taxonomy of the Spanish regions could provide some guidance for the development of appropriate measures for regional economic policy.

1 Introduction

How does the aggregate production of regions within a multiregional system change over time? What are the significant patterns of these evolutions? In particular, how is the gross added value (GAV) distributed among regions? In this paper, an empirical framework is proposed with which to estimate the significant macroeconomic effects that could help explain the movements that occur within a regional economic system, in an attempt to shed some light on these questions. Two principal macroeconomic effects are identified: economy-wide (aspatial) effects and neighborhood (spatially adjacent) effects. The process of interpreting these effects is quite complex, as they synthesize different forces affecting regional productive capacity.

Additionally, a competitive perspective arises; with these two sets of effects taken into account, the vertical and horizontal competition structure within a regional economic system can be outlined. The empirical strategy considers the competitive growth (Richardson, 1973) of regional economies, wherein a region increasing its share of some macroeconomic aggregate does so at the time that one or more other regions have to reduce their shares. Under these conditions the national growth process is assumed to be given or determined exogenously, and a top-down approach is adopted; the feedback effects of regional growth on the national level performance are ignored. At the same time, the notion of regional competition follows Parr (1978, page 122):

> "Broadly speaking, regional competition may be regarded as the market process by which economic activities or employed factors of production are allocated through time among the regions of a nation. Phrasing this in terms of national income, regional competition represents the process by which the gross national product (GNP) is distributed among regions. The overall competitiveness of a particular

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region can thus be measured by the region's share of the GNP, although a more useful view of a region's competitiveness might be the extent to which it is able to maintain or increase its share of the GNP through time."

However, as Krugman (1994) has noted, this concept of dynamic regional competition can be misconstrued, because though the regions compete with each other in terms of share, all the regions could be gaining in absolute terms. Although we are aware of this, the competitiveness of a regional economy and its prospects for continued prosperity should be appraised and determined in the context of the evolution of a multiregional economic system, and here is where the regional competition structure that is articulated in the empirical methodology could prove to be valuable. The region's share of GNP as an indicator of regional competitiveness is very simple, but it is also an overall competitiveness indicator that measures competition within a regional system in a very clear, albeit indirect, way; the issue of measuring regional competitiveness is a complex one (Batey and Friedrich, 2000).

In the present paper we adopt a dynamic space – time perspective wherein cointegration analysis is employed to test the hypothesis that, for a regional economic system as a whole, the regional shares behave as if they are independent against the alternative that they are determined by economy-wide and/or neighborhood forces. This approach combines a time-dynamic perspective with the typical modus operandi of spatial econometrics, in which a scheme of interaction directly related with the geographical location of the regions is specified [see, for example, Fingleton (2004), Le Gallo et al (2003), or Rey and Montouri (1999)]. In addition, the cointegration method proceeds by separating the long-term and short-term effects, thereby gaining some insights into the space – time economic development of a regional system. At the level of the region, this enables us to bring together the net effects of the economy-wide and neighborhood interactions over time. The economy-wide effects are regarded as spin-off effects that operate beyond adjacent regions (global relationships). In these national effects the geographical level of resolution is higher, because all the regions within the system are considered. On the other hand, neighborhood (local) effects provide a more bounded analysis, which takes into account the influence of geographical proximity as a relevant factor to explain the evolution of a regional economy. Although spatial proximity is not a necessary condition to admit the presence of horizontal competition, it is hypothesized that proximity may be reflective or can be considered to capture agglomeration economies or diseconomies. These local or neighborhood effects provide a complementary perspective to the more global processes associated with national-level influences.

The paper is organized as follows: section 2 provides a theoretical framework for our empirical methodology. The modeling issues are presented in section 3, in which the proposed model is estimated, using data for regions of Spain for the period 1972 – 2000, and the results are discussed. These outcomes suggest a new taxonomy of Spanish regions. In section 4 a summary interpretation is provided followed by some concluding remarks. In addition, some regional policy considerations are discussed and suggestions for further analysis are provided.

2 Conceptual background and motivation

The theoretical arguments pointing to the existence of forces that drive regional growth with the possibility of uneven regional development are embodied in many of the 'new growth theory' models and 'new economic geography' models. These models are contrary to traditional neoclassical growth models, which rest "on a much narrower vision of the dominant forces in an economy. ... Imbalances merely reflect lags in the adjustment towards equilibrium ... or imperfections in market process" (Richardson and Townroe, 1986, page 654).

The modern formulation of endogenous-growth theory from a macroeconomic-growth approach was stimulated by Romer (1986; 1990) and Lucas (1988; 1993) and was based on the existence of increasing returns and positive externalities; the models can be formulated through consideration of the existence of factor accumulation over time, which reinforces the internal pattern of development of the regional system. Most recently, regional agglomeration processes have appealed to earlier ideas centered on cumulative causation mechanisms, thereby allowing for the consideration of centripetal (agglomeration economies) and centrifugal (agglomeration diseconomies) forces. These forces were used by Krugman (1991), whose work, together with the work of Krugman and Venables (1995) and Venables (1996), contributed to the formation of the 'new economic geography' (Arthur, 1990; Grossman and Helpman, 1991), thereby establishing the basis for the growth of research in this field [see for example, Ottaviano and Puga (1998), Puga and Venables (1999), and Fujita et al (1999)]. Nevertheless, the rise of spatial external economies of agglomeration (forces of agglomeration) had been proposed previously by Myrdal (1957), Hirschman (1958), Oates et al (1971), Richardson (1973), and Dixon and Thirlwall (1975) in the context of cumulative causation, and by Friedmann (1966; 1973), whose core–periphery model extended Myrdal and Hirschman's ideas.

These viewpoints highlight the relationship between economic growth processes and spatial concentration. Further, they contemplate the possibility of divergence—that is, growth could lead to a spatial divergence in regional incomes (per capita), thereby increasing interregional welfare differences. However, there are differences in the causes and the origins of the forces under which regional economic processes evolve over time. The earlier ideas of Myrdal (1957) and Hirschman (1958) consider the role of external economies in explaining differential increases in regional growth, whereas external diseconomies and/or deficient capacity could limit these increases. The proponents of endogenous-growth theory consider endogenous factors such as technical change and human capital in order to explain the existence of technical progress and its spatial differentiating influence over time. In this environment, the mainspring behind increasing returns to human and physical capital is the presence of agglomeration effects.

On the other hand, the 'new economic geography' takes into account explicitly the geographic aspects of regional growth, thereby emphasizing the role played by economies of scale, transportation costs, and the tension between centripetal and centrifugal forces in order to explain spatial economic structure. The differences between the dynamic agglomeration economies of the 'endogenous-growth theory' and those of the 'new economic geography' may be ascribed to the fact that, although the first are based on localization or Marshall–Arrow–Romer (MAR) economies (for example, Romer, 1986), the latter find their support in urbanization or Jacobs (1969) economies. According to Henderson et al (1995), the MAR economies are dynamic localization economies in which the proximity among the same activities results in knowledge spillovers, whereas in Jacobs economies the origin of these externalities is in diversity; the close proximity among different activities over time is the source of the knowledge spillovers. Thus, we can identify Jacobs economies with dynamic urbanization economies.

These forces (dynamic agglomeration economies) could be considered as dynamic externalities, because their external character comes from the measurement of the interactions among regions as economic units within a regional system over time. These externalities could be the consequence of internal economies and/or external economies (Parr, 2002, page 152):

> "agglomeration economies or diseconomies deriving from internal economies may co-exist with agglomeration economies or diseconomies driving from external economies, these possibilities, resulting in a variety of spatial structures. ... an

agglomeration economy based on an internal economy of scope, scale or complexity can be said to have a counterpart based on a corresponding external economy."

On the other hand, Maier (2000) showed the important role played by agglomeration effects in regional growth; without agglomeration forces the regional shares converge toward a steady state under which economic homogenization takes place, but with agglomeration forces there is no balanced growth and a heterogeneous panorama unfolds, which leads to the existence of regional divergence and/or regional stagnation within the regional system. Maier (2000, page 132) yields the main implications of the agglomeration effects: "Agglomeration effects bring about spatial structure, path dependence of growth process, 'lock-in' phenomena, and long term implications of historical events."

To recapitulate, there exist different categories of forces that are widely regarded as affecting regional evolution. According to Krugman (1998) these forces are the three main categories of centripetal forces (market-size effects, thick labor markets, pure external economies) and the three main types of centrifugal forces (immobile factors, land rents, and pure external diseconomies). This classification of forces provides the basis for an evaluation of the probable causes of the origin of the forces operating within a multiregional economy. In this sense, Krugman (1998, page 8) indicates that "the menu should not be viewed as comprehensive; it is a selection of some forces that may be important in practice."

Therefore, the detection and quantification of the existence of effects among regional economies working over time and influencing the functioning of an economy could provide new insights into understanding regional growth. Consequently, it would be desirable to build new theoretical research around measures that adequately detect external effects, and it is in this domain that the contribution of this paper is placed. Besides, the empirical evidence of the way these effects work within a regional system should be interpreted in the context of packages of forces affecting regional trajectories.

As the existence of significant centripetal (agglomeration) or centrifugal (dispersion) forces (see Fujita and Thisse, 1996; 2002) in the regional evolution of economies can be detected at different levels, it is necessary to establish a framework to carry out a convenient analysis. The approach adopted here is similar to one used by Poot (2000) who considered 'local and economy-wide effects of territorial competition'. Hence, economy-wide and local effects form the bases for two types of agglomeration effects. In the presence paper the concept of 'local' will be adapted to the regional environment, being identified with the effects generated from the geographically adjacent regions that shape the neighborhood (for an alternative perspective see Márquez and Hewings, 2003).

In short, our primary framework and calculations focus on the concept of dynamic regional competition, including the comparison over time of the regional performance within a regional system. Because regional competition is a temporal phenomenon, and a time-series approach is required for its evaluation, attention has to be directed both to the short-term (transitory competition) and to the long-term (durable competition) analysis of the effects that generated the competitive structure of the regional system. The long-term economic processes in regions are generally informed by gradual and slow developments that make reference to the region's economic history (including a variety of physical and social capital endowments) and which determine the potential capacity of the region. Convergence issues are generated by these long-term implications. On the other hand, short-term changes may be generated by ephemeral events that may or may not influence long-run trajectories of growth. Hence, there is a need to employ methods that allow for the coexistence of both long-term and short-term effects that drive the evolution of the regional system.

In the next section is presented a simple empirical strategy to facilitate the identification of significant negative and positive effects within an interregional system. The empirical study is designed under the assumption of the existence of effects acting in both the long and short term. In addition, the procedure incorporates both 'localized' and 'global' competition.

3 Empirical analysis and discussion

In this section a methodology will be described to test the significance of the impact both of supraregional effects, referring to the influence of the national aggregate, and of neighborhood effects, referring to the relationship among adjacent regions.

3.1 Data

In order to illustrate our empirical approach, the Spanish economic system is investigated. Spain is a decentralized state composed of seventeen regions and Ceuta and Melilla (two Spanish North African cities), and they constitute the so-called Autonomous Communities. The Autonomous Communities have achieved the status of self-governed territories, sharing governance with the Spanish central government within their respective territories. In the present work, the analysis will use only the fifteen peninsular regions in Spain (figure 1), not taking into account the regions without geographical connection (Balearic Islands, Canary Islands, Ceuta, and Melilla). This peninsular Spanish economic system has a marked economic core–periphery pattern, with an unequal economic geography. Traditionally, the economic periphery is comprised of Castilla-León, Castilla-La Mancha, and Extremadura (regions around Madrid), whereas Madrid (in the center), País Vasco (in the north), Cataluña, and Valencia (both in the east) make up the economic core. Galicia, Andalucía, and Murcia are also considered as 'peripheral' regions, whereas Navarra, La Rioja, and Aragón may be considered as 'core' regions. Finally, Asturias and Cantabria are historical 'core' regions, but currently experiencing significant industrial restructuring processes.

Time series on GAV in the fifteen peninsular regions in Spain provide the main data source. The database of the HISPALINK project (HISPADAT) was employed in

Regional abbreviations: Andalucía (AN), Aragón (AR), Asturias (AS), Cantabria (CB), Castilla-León (CL), Castilla-La Mancha (CM), Cataluña (CT), Valencia (CV), Extremadura (EX), Galicia (GA), Madrid (MA), Murcia (MU), Navarra (NA), País Vasco (PV), and La Rioja (RI)

Figure 1. Spanish Peninsular regions.

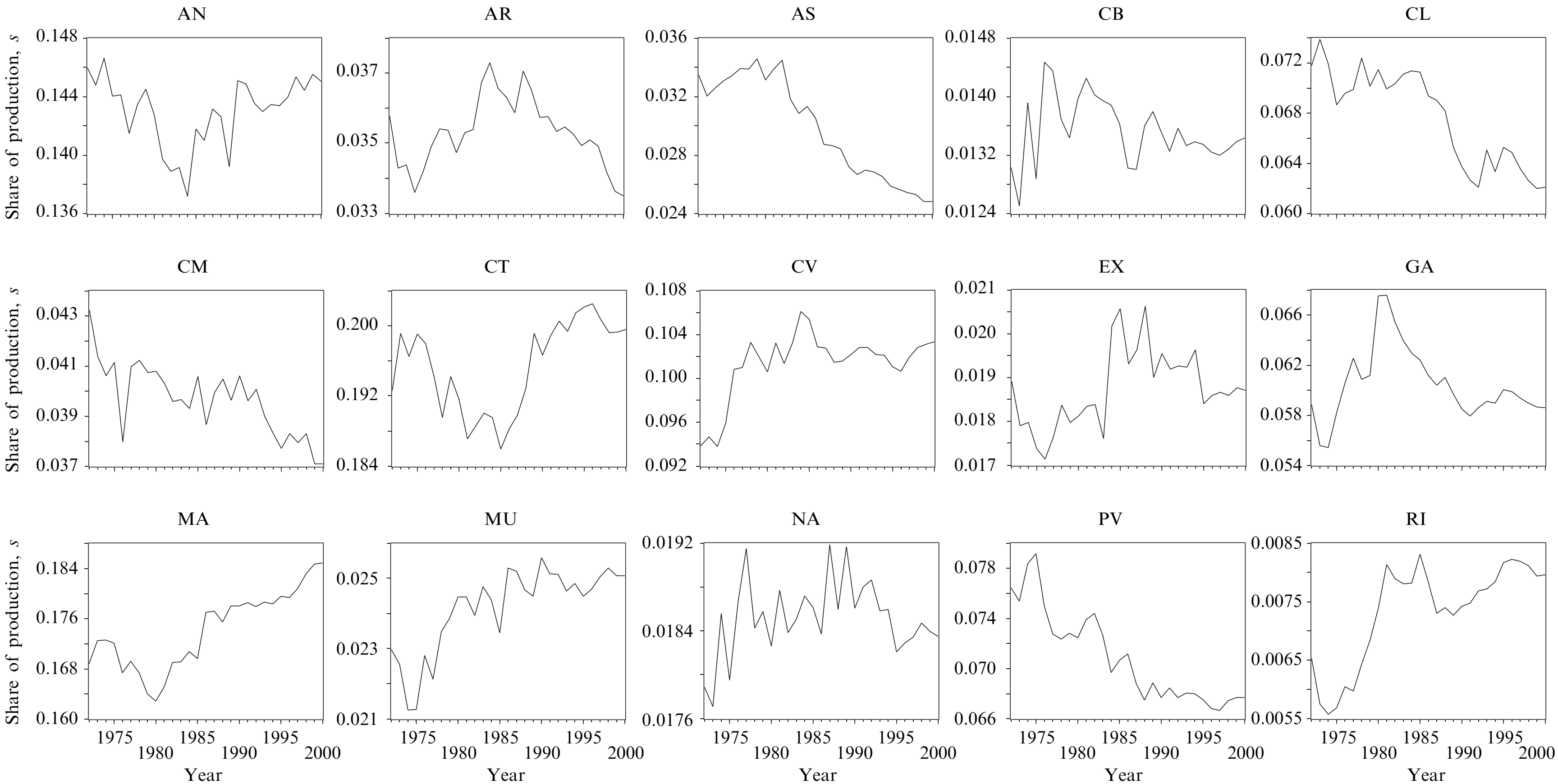


Figure 2. Evolution of the regional shares. Refer to figure 1 for an explanation of abbrevations.

this analysis; regional GAV at market prices in 1995 constant pesetas (GAV) for the period 1972 to 2000 was used [see Pulido and Cabrer (1994) and Cabrer (2001)]. The national aggregate that was used in the application was obtained as the sum of the GAVs of the fifteen Spanish regions included in the analysis.

With the location of the regions in mind (see figure 1), figure 2 represents the time evolution of every regional share over the period 1972–2000.

Regional agglomerations are reflected in the regions of Spain. For example, Madrid, which has an area corresponding to 1.63% of the peninsular area in Spain, produces 17.37% of the GAV. Conversely, Extremadura, with 8.44% of the total area accounted for 1.74% of the Spanish GAV. Relative productive capacities of the Spanish regions, measured as shares of GAV, are shown in table 1, jointly with the corresponding areas.

To enhance the analysis of spatial agglomerations of production in Spanish regions, we employ the entropy diversity index based on the entropy measure described by Theil (1967). The entropy diversity index is an inverse measure of concentration of production: when the entropy index increases, agglomeration declines. Following Attaran and Zwick (1987), the entropy index can be expressed as

$$\mathrm{D}(s) = -\sum_{i=1}^{n} s_i \ln s_i ,$$

where the variable s_i denotes region i's share of production, that is, $s_i = G_i/G$, $\sum_i s_i = 1$, and $s_i \geqslant 0$, with G the total GAV and G_i the GAV of region i. The D(s) index reaches its maximum value of ln(15), when all fifteen Spanish regions have equal shares of production. Conversely, D(s) is at its minimum value of 0 when one region's share $s_i = 1$ and all other regions' shares $s_j = 0, j \neq i$. In addition, we will use two modified versions of the above entropy diversity index (Theil and Seale, 1994;

Table 1. Indicators for Spanish regions 2000/01.

Region	AREA	POP	GAV	L	KPRIV	KPUB	R&D	INNOV	QUAL	NSL
Andalucía	17.75	18.07	13.37	15.25	13.08	17.04	8.64	6.23	69.16	47.82
Aragón	9.67	2.93	3.13	3.18	3.16	3.97	2.24	4.81	75.39	37.48
Asturias	2.15	2.62	2.34	2.29	2.43	3.32	1.59	1.51	70.32	42.05
Cantabria	1.08	1.31	1.27	1.31	1.34	1.57	0.74	1.16	77.15	42.52
Castilla-León	19.09	6.05	5.80	5.91	6.07	7.88	4.75	3.85	70.77	41.86
Castilla-La Mancha	16.10	4.28	3.44	4.08	3.94	5.49	1.16	2.50	68.92	45.99
Cataluña	6.51	15.53	18.84	16.92	19.07	13.59	21.42	27.04	78.07	33.49
Valencia	4.71	10.26	9.67	10.71	11.39	9.21	7.17	7.95	81.64	41.15
Extremadura	8.44	2.62	1.74	2.33	1.84	3.36	1.06	0.40	65.89	52.15
Galicia	5.99	6.67	5.51	6.72	5.34	7.09	3.86	4.12	66.92	48.21
Madrid	1.63	13.11	17.37	14.38	15.55	9.80	31.70	25.92	80.96	29.63
Murcia	2.29	2.91	2.32	2.84	2.60	2.40	1.62	1.50	73.90	48.88
Navarra	2.11	1.36	1.70	1.51	1.51	1.98	1.83	1.71	76.71	35.18
País Vasco	1.47	5.13	6.35	5.52	5.53	6.77	9.01	9.07	78.68	29.98
La Rioja	1.02	0.66	0.74	0.65	0.72	0.91	0.37	0.69	71.82	38.87

Note: AREA: share of geographical extension; POP: share of population; GAV: share of gross added value; L: share of employment; KPRIV: share of stock of private capita; KPUB: share of stock of public capita; R&D: share of research and development expenditures; INNOV: share of innovation expenditures; QUAL: percentage of medium-high educational attainment of employees; NSL: percentage of employment in non-specialized activities (agriculture, construction, hotels, and commerce). Shares represent the relative sizes of the regional variables in the whole system.

Theil and Sorooshian, 1979). These indices take the form

$$D_{\text{AREA}}(s) \;=\; -\sum_{i=1}^{n} s_i \ln\left(\frac{s_i}{a_i}\right),$$

and

$$D_{\text{POP}}(s) \;=\; -\sum_{i=1}^{n} s_i \ln\left(\frac{s_i}{p_i}\right),$$

where a_i represents the area share of the region i relative to the total area of the Spanish peninsular regions, p_i denotes the population share of the ith region. These additional (relative) indices have a minimum value of 0 when the production shares and the area (or population) shares are pair-wise equal. On the other hand, when the pair-wise shares diverge, the indices (now taking positive values) increase.

Figure 3 shows the evolution of the three entropy diversity indices. In all cases, we can see that the spatial concentration of production (absolute or relative to area or population) has diminished over the time period considered. These observed trajectories illustrate the decline of regional production diversity and the key question in this paper concerns which geographical dimensions are causing these trajectories.

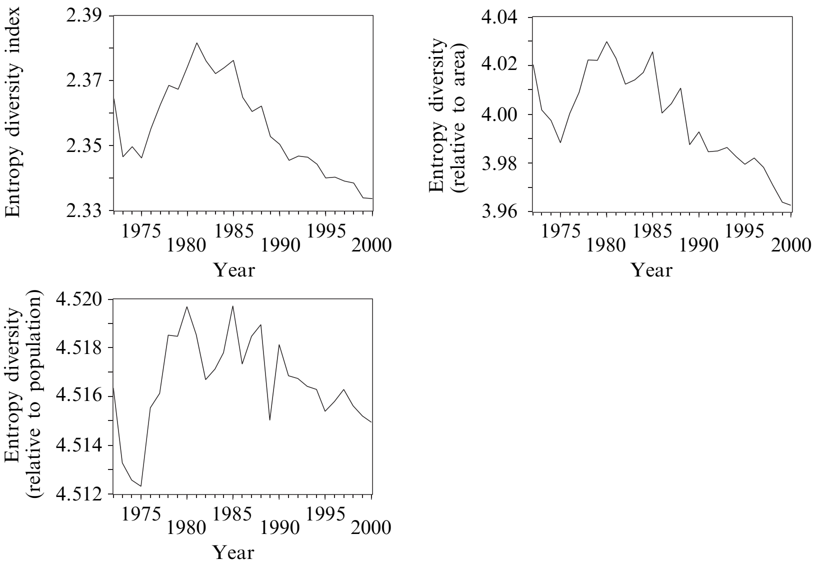


Figure 3. Spatial concentration of production in Spanish regions.

Further, all the regional shares in figure 2 appear to be nonstationary. The augmented Dickey–Fuller (Dickey and Fuller, 1979; 1981) and PP (Phillips and Perron, 1988) tests for the presence of unit roots in the regional shares and in the logarithms of the total GAV were applied. The null hypothesis of these unit root tests is that the variable analyzed has a unit root, against the alternative that it does not.

Table 2 reports results for the application of these tests; the results indicate that all of the series (except one case) display the characteristics of I(1) variables at the 5% level of significance. In addition, the null hypothesis of a unit root in each series is clearly rejected using differenced data (there is not a second unit root). The conclusion to be drawn is that the series can be considered to be generated by a unit root process, except in the case of the regional share of Cantabria, which shows a stable behavior around the mean [that is, it is integrated to order I(0)].

Table 2. Unit root tests.

Nomenclature	Definition	ADF test[a]		PP test[b]	
		level	first difference	level	first difference
*s*AN	share Andalucía	−2.66*	−7.38***	2.62	−7.63***
*s*AR	share Aragón	−1.27	−5.44***	−1.45	−5.53***
*s*AS	share Asturias	−2.09	−4.91***	−1.98	−5.55***
*s*CB	share Cantabria	−3.89***	−8.48***	−3.86***	−8.99***
*s*CL	share Castilla-León	−2.53	−6.38***	−2.61	−6.31***
*s*CM	share Castilla-La Mancha	−1.45	−9.01***	−2.93*	−10.0***
*s*CT	share Cataluña	−1.49	−6.23***	−1.54	6.22***
*s*CV	share Valencia	−2.69*	−5.03***	−2.74*	−5.03***
*s*EX	share Extremadura	−2.52	−7.01***	−2.51	−7.89***
*s*GA	share Galicia	−1.80	−4.66***	−1.70	−4.38***
*s*MA	share Madrid	−0.41	−5.50***	−0.36	−5.49***
*s*MU	share Murcia	−1.52	−6.61***	−1.51	−7.11***
*s*NA	share Navarra	−2.56	−4.72***	−2.61	−4.76***
*s*PV	share País Vasco	−1.46	−6.21***	−1.36	−4.89***
*s*RI	share La Rioja	−1.11	−4.62***	−1.25	−4.63***
log *N*	log of national GAV[c] (15 regions)	1.08	−3.34**	−0.14	−3.40**

* Significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.001 level.
[a] Augmented Dickey–Fuller test.
[b] Phillips–Perron test.
[c] Gross added value.

The regional shares are clearly bounded by construction, and this would imply that they would be stationary in the very long run. However, the regional shares display all the characteristics of I(1) processes, and so we treat them accordingly. The empirical implication of this result would be that such variables are not converging individually to a stable set of constant proportions in the long run.

3.2 Empirical framework

To estimate the influence of the national aggregate (economy-wide effect) over each of the fifteen Spanish regions, a specification referred to as a *regional curve* is used. The specification is assumed to be of the form:

$$s_{it} = \beta_{0,i} + \beta_{2,i} \ln P_t + \varepsilon_{it}, \qquad i = 1, 2, ..., 15, \qquad t = 1972, 1973, ..., 2000, \quad (1)$$

where s_{it} denotes the share of the production of the region *i* in the national economy at time period *t*, $s_{it} = G_{it}/G_t$, and P_t denotes the GNP at time *t*. This is a very simple specification that, in a context of regional competition, explores only the role of general macroeconomic factors. In equation (1), β_0 is the share that is unexplained by the increase at the national level. The sign of parameter β_2 in each regional curve indicates whether the corresponding regional share increases or diminishes when the national GAV increases. This formulation has similar objectives to the Dendrinos–Sonis model (see Dendrinos and Sonis, 1988; 1990), which also attempts to model competition through shares; however, the model in the present paper posits competition between regions as a process that explores a single region's share of the aggregate total.

Logically, as the addition poverty is verified in this zero-sum game ($\sum_i s_i = 1$ is equivalent to $\sum_i \mathrm{d}s_i = 0$, where d denotes the derivative operator), not all the regions can have positive parameters, with some regions losing share ($\beta_2 < 0$) while the shares

of others improve ($\beta_2 > 0$). These considerations address only relative changes in regional competition, as all regions could be improving in absolute terms. Different *economy-wide effects* can be distinguished:
(a) Positive effects ($\beta_2 > 0$). Here, national impulses positively change a region's share; dynamic effects are generating more positive impacts in the region than in other regions.
(b) Negative effects ($\beta_2 < 0$). Here, the national impulses negatively affect the regional share. In this case, dynamic effects are affecting the regional share in a negative form compared with other regional shares.
(c) Neutral effects ($\beta_2 = 0$). This result presents the case in which a region's competitive position is unchanged with respect to the nation.

Starting from this basic time-series specification, the spatial dimension is introduced by adding a spatial lag for the variable s, $\mathbf{W}s$, where $\mathbf{W}$ represents a spatial weights matrix (Anselin, 1988), which specific form will be described later. Then, the final long-run specification is:

$$s_{it} = \beta_{0,i} + \beta_{1,i}(\mathbf{W}s)_{it} + \beta_{2,i} \ln P_t + \varepsilon_{it} . \qquad (2)$$

In this case, at the regional level, if parameter β_1 is positive or negative, region i increases or diminishes its relative proportion (measured as its share), but now owing to the interaction with its adjacent regions. Therefore, this parameter measures the net degree of complementarity or competition between every region and its neighbor regions (*neighborhood effect*). This provides a spatial view, and the effects can be interpreted as follows:
(a) Negative effects ($\beta_1 < 0$). A region improves (diminishes) its share by receiving positive (negative) spillovers from its neighbors. The neighboring regional shares affect the regional share in a manner that is significantly negative.
(b) Positive effects ($\beta_1 > 0$). The regional share is being affected in a significantly positive manner by the neighboring regional shares. Positive spillovers could be improving the share of the region under analysis.
(c) Neutral effects ($\beta_1 = 0$). There are no significant net effects between a region and its neighbors. This null parameter should not be interpreted to mean that the neighborhood does not affect the regional share, but rather that it does so in a nonsignificant net sense. The tension between region and neighborhood under this possibility is considered to be in equilibrium.

Neighborhood effects could put regions in direct competition with their neighbors. The interaction among economy-wide and neighborhood effects is founded on territorial aspects stemming from the sharing of locational information. Interrelated forces causing these effects have in common their influence on regional economic processes, acting from above, but also from below. Needless to say, agglomeration externalities may primarily be operating within regions and may not be captured either by the neighboring region or by economy-wide effects.

The introduction of the time factor in this empirical structure is fraught with difficulties. Tests used in the investigation established that each of the series [$\ln P_t$ and regional shares (s_{it})], except in the case of the variable $s_{\mathrm{CB}t}$ (the subscript CB denotes the Cantabria region), are indeed integrated of order I(1). Accordingly, equations of type (1) have to be understood as long-term regressions, and they must be estimated with this fact taken into account. The next step is to test for the presence of cointegration relationships; if the existence of cointegration is identified, the estimated effects (β_1 and β_2) have to be interpreted as long-term estimates. Equation (1) can be most easily interpreted as identifying the extent to which regional shares are explained in the long run by factors operating at the national level and factors acting at the neighborhood level. If cointegration exists, this relation is stable in the long run.

In the presence of cointegration, short-term changes in the regional shares are a function of the level of disequilibrium in the cointegration relationship. In this sense, the empirical specification that is used in order to estimate the short-term effects associated with the proposed model takes as the basis for the corresponding error-correction model (ECM, Engle and Granger, 1987). Our original technical contribution is to generalize the standard ECM formulation, including spatial effects in the short-term equations; hence, the specification is expressed as:

$$\begin{aligned}\Delta s_{it} &= \delta_{0,i} + \delta_{1,t}\Delta s_{i,t-1} + \delta_{2,i}(\mathbf{W}\Delta s)_{i,t-1} + \delta_{3,i}\Delta\ln P_{t-1} + \delta_{4,i}\hat{e}_{i,t-1} \\ &\quad + \delta_{5,i}(\mathbf{W}\hat{e})_{i,t-1} + u_{it} \,, \end{aligned} \tag{2}$$

where $\hat{e}_{i,t-1}$ (error-correction term) denotes the residuals (lagged by one period) of the long-term relation estimated in each of the equations of type (1).

These residuals concern the short-run response of the dependent variable to the adjustment of the regional share back towards long-run equilibrium. Equation (2) is a recursive space–time model that incorporates in the specification the dependent variable with a time lag of order 1 ($\Delta s_{i,t-1}$) and a first order spatial lag [$(\mathbf{W}\Delta s)_{i,t-1}$]. The change in the share of the region i at time t is determined by variables lagged by one period (the dependent variable, the shares of the neighbors, the variable representing the whole system, the residuals, and the spatial lag of residuals). The inclusion in the basic ECM formulation of a *spatial error-correction term*, $(\mathbf{W}\hat{e})_{i,t-1}$, needs to be highlighted, because this represents the adjusting mechanism in region i resulting from the existence of a net imbalance in its neighborhood. Thus, this short-term adjustment coefficient characterizes the proportion by which the long-run disequilibrium in the regional share is being corrected in each short-term period by neighboring factors. Whereas the error-correction term, $(\hat{e}_{i,t-1})$, corrects, in each short period, long-run imbalances in a regional share caused by disequilibrium in the region itself, the spatial error-correction term, $(\boldsymbol{W}\hat{e})_{i,t-1}$, corrects, in each short period, long-run imbalances in a regional share caused by disequilibrium in adjacent regions.

The implications of the above formulation warrant some discussion. For example, if we are analyzing the trajectory of a region within a multiregional system, a historical event (for instance, some type of local political intervention) occurring in a neighboring region (which produces an unexpected distancing of the stable long-run path in this neighbor) could transfer relevant short-run impulses to the region under analysis. Therefore, our spatial error-correction model proposes that special events in adjacent regions could play a decisive role in explaining the economic development of a region.

3.3 Results and discussion

Equations (1) and (2) are estimated individually for each region. It is important to emphasize that both equations are more general than those used in standard spatial econometrics, in which parameters $\beta_{1,i}$ and $\delta_{2,t}$ are the same in all the regions. These hypotheses were tested in our work and, in both cases, the null hypotheses of equality of the spatial coefficients were clearly rejected. Equation (1) requires the specification of the 'neighbor' structure, namely, the interaction among regions as defined by a spatial weights matrix (**W**). In our case, **W** was defined by expressing for each region (row) those regions (columns) that belong to its neighborhood. Formally, $w_{ij} = 1$ if regions i and j are neighbors, and $w_{ij} = 0$ otherwise. This simple contiguity matrix ensures that interactions between regions with common borders are considered (see figure 1); alternative weight matrices were considered but the results did not change significantly. For ease of economic interpretation, a row-standardized form of the **W** matrix was used. Thus, the spatial-lag terms represent weighted averages of neighboring values.

Equations of type (1) must be estimated within the context of nonstationary variables, thereby avoiding the possibility of spurious estimates. Hence, the next step is to test for the presence of cointegrating relationships among the variables that appear in each equation by means both of the maximal eigenvalue and of the trace tests proposed by Johansen (1988; 1991). Test results for cointegration are listed in the fourth column of table 3 for each region. The null hypothesis of the absence of cointegration among the variables in each equation is rejected; results support the view that each equation of type (1) for every region represents a stable long-run relationship equilibrium.

As soon as the stability of the regional equations (1) has been confirmed, they are estimated, with the fact that they are cointegrated relationships taken into account. The estimation of equations (1) has been realized using the fully modified estimator derived

Table 3. Estimated effects in the long term [equation 1: $s_{it} = \beta_{0,i} + \beta_{1,i}(\mathbf{W}s)_{it} + \beta_{2,i} \ln P_t + \varepsilon_{it}$].

Region	Neighborhood effect, $\mathbf{W}s$	Economy-wide effect $\ln P$[a]	Results of cointegration analysis (Johansen) (maximal eigenvalue/trace)
Andalucía	−1.3361**	0.0039*	35.10/55.07
	(−1.976/0.05)	(1.901/0.07)	
Aragón	0.4424	−0.0007	35.44/51.25
	(0.676/0.51)	(−0.656/0.52)	
Asturias	0.3777***	−0.0133***	43.88/59.58
	(2.744/0.01)	(−10.016/0.00)	
Cantabria	0.1456	0.0018	44.50/62.29
	(1.353/0.188)	(0.990/0.332)	
Castilla-León	1.0976	−0.0164***	32.51/57.86
	(1.307/0.20)	(−9.634/0.00)	
Castilla-La Mancha	0.3005	−0.0058***	38.53/63.41
	(1.029/0.31)	(−4.562/0.00)	
Cataluña	−2.2600***	0.0213***	36.40/52.21
	(−7.277/0.000)	(8.210/0.00)	
Valencia	−1.9435***	0.0126***	38.31/50.82
	(−4.958/0.00)	(5.803/0.00)	
Extremadura	−0.2310	0.0002	39.40/59.23
	(−1.134/0.27)	(0.110/0.91)	
Galicia	2.2152***	0.0332***	39.21/57.64
	(5.126/0.00)	(4.397/0.00)	
Madrid	−0.8437	0.0167**	54.76/72.62
	(−1.515/0.14)	(2.549/0.02)	
Murcia	0.3815*	0.0038***	32.49/53.78
	(1.679/0.10)	(4.257/0.00)	
Navarra	−0.1932	−0.0007	37.55/64.97
	(−1.260/0.22)	(−0.959/0.35)	
País Vasco	−3.4001***	−0.0126***	41.49/55.42
	(−3.673/0.00)	(−7.553/0.00)	
La Rioja	0.8604**	0.0102***	44.93/64.31
	(2.489/0.02)	(3.450/0.00)	

Note: In parentheses, beneath the estimated coefficients, appear the t-statistics and the associated p-values, respectively. With respect to Johansen tests for the null hypothesis of absence of cointegration, the critical values are 22.04 ($\alpha = 0.05$) and 19.86 ($\alpha = 0.1$) in the case of the maximal eigenvalue test and, on the other hand, they are 34.87 ($\alpha = 0.05$) and 31.93 ($\alpha = 0.1$) in the trace test.
* Significant at the 0.1 level; ** significant at the 0.05 level; *** significant at the 0.01 level.
[a]Log of national gross added value.

in Phillips and Hansen (1990). The fully modified estimation, considering the problem of the correlation between the explanatory variables $[(\mathbf{W}s)_{it}, \ln P_t]$ and the error term in equations of type (1), provides a way to obtain inference of the estimated parameters [this is not the case with ordinary least squares (OLS)] and, in addition, it is more appropriate in finite samples (such as the one used in this work). Notwithstanding their theoretical differences, similar results were also obtained when equations of type (1) were estimated by means of OLS.

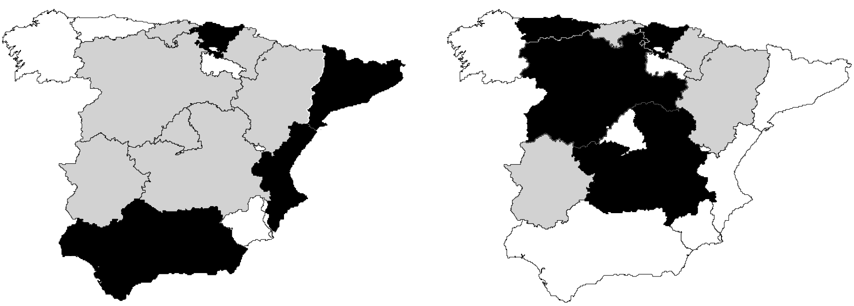
The results of the regression analysis are disclosed in columns 2 and 3 of table 3. Table 4 and figure 4 show these results from a qualitative point of view. Table 4 provides a taxonomy of the Spanish regions, highlighting the way in which economy-wide and neighborhood effects influence growth in the long term. Though it would appear that the long term is the relevant way in which to view significant changes in competitive position, short-term processes, as Johansson et al (2000) have noted, can cause outcomes that affect long-term regional competitiveness.

The results in table 3 indicate that more national growth elasticities (β_2) are significant than are neighborhood elasticities (β_1). When the total GAV increases, the regions that have positive percentage changes in their shares (see figure 4) are Galicia, Madrid, La Rioja, and the regions in the Mediterranean Arc (Cataluña, Valencia, Murcia,

Table 4. Qualitative analysis of the estimated effects in the long term.

		Neighborhood effect		
		− [a]	0 [b]	+ [c]
Economy-wide effect	− [a]	País Vasco	Castilla-León Castilla-La Mancha	Asturias
	0 [b]		Extremadura Aragón Cantabria Navarra	
	+ [c]	Andalucía Cataluña Valencia	Madrid	Galicia La Rioja Murcia

[a] Significant negative coefficient.
[b] Nonsignificant coefficient.
[c] Significant positive coefficient.



Neighborhood effect Economy-wide effect

Figure 4. Classification of the long-term effects. Black regions have a significant negative coefficient, white regions have a significant positive coefficients, gray regions have a nonsignificant coefficient.

and Andalucía). This fact could suggest that positive national effects are bounded geographically by some macroregional context (located in the Mediterranean Arc).

On the other hand, Asturias, Castilla – León, País Vasco, and Castilla-La Mancha constitute a group of regions that have a negative percentage change in shares when the total GAV increases. In addition, there is a third group of regions whose shares are neutral to the general macroeconomic circumstances, these being Extremadura, Cantabria, Navarra, and Aragón.

The initial interpretation of these results would suggest little evidence of 'convergence forces' operating in this Spanish regional system; in general, peripheral regions show negative economy-wide effects, whereas core regions are being affected by positive national effects. It might be noted at this point that our results can be regarded as complementary to, rather than competitive with, explorations of convergence properties of Spanish regions [see Sala-i-Martin (1996) and Cuadrado-Roura (2001)]; our approach concerns the growth of relative productive capacity, whereas the analysis of growth of output per capita focuses on the changes in economic welfare.

Table 5. Estimated effects in the short term [equation (2): $\Delta s_{it} = \delta_{0,i} + \delta_{1,i}\Delta s_{i,t-1} + \delta_{2,i}(\mathbf{W}\Delta s)_{i,t-1} + \delta_{3,i}\Delta \ln P_{t-1} + \delta_{4,i}\hat{e}_{i,t-1} + \delta_{5,i}(\mathbf{W}\hat{e})_{i,t-1} + u_{it}$].

Region	Neighborhood effects		Economy-wide effects	
	$(\mathbf{W}\Delta s)_{i,t-1}$	$(\mathbf{W}\hat{e})_{i,t-1}$	$\Delta \ln P_{t-1}$	$\hat{e}_{t-1}$
Andalucía	0.0104	0.2375	0.0275	−0.5990***
	(0.014/0.99)	(0.311/0.76)	(1.380/0.18)	(−3.239/0.00)
Aragón	0.9043***	−0.5654**	−0.0123**	0.0237
	(2.754/0.01)	(−2.462/0.02)	(−2.034/0.05)	(0.189/0.85)
Asturias	0.5258***	−0.3062	−0.0009	−0.3016
	(2.958/0.01)	(−1.366/0.19)	(−0.094/0.93)	(−1.552/0.14)
Cantabria	−0.2496*	−0.0725	−0.0070*	−0.9950***
	(−1.907/0.07)	(−0.517/0.61)	(−1.867/0.08)	(−5.705/0.00)
Castilla-Laeón	−0.4137	−0.3555	−0.0270**	−0.6015***
	(−0.523/0.61)	(−0.408/0.69)	(−2.034/0.05)	(−2.925/0.01)
Castilla-La Mancha	−0.0505	0.0326	0.0095	−0.8731***
	(−0.117/0.91)	(0.087/0.93)	(0.884/0.39)	(−3.856/0.00)
Cataluña	0.1216	0.7426*	0.0141	−0.7311***
	(0.226/0.82)	(1.704/0.10)	(0.570/0.58)	(−3.279/0.00)
Valencia	0.4165	1.1899	−0.0325*	−0.9337***
	(0.797/0.43)	(1.340/0.19)	(−2.008/0.06)	(−2.784/0.01)
Extremadura	0.2212	−0.2980	0.0057	−0.4796***
	(1.3184/0.20)	(−1.570/0.13)	(0.771/0.45)	(−2.775/0.01)
Galicia	−0.9984***	−0.2428	−0.0530***	−0.7586***
	(−2.851/0.01)	(−0.564/0.58)	(−3.632/0.00)	(−5.335/0.00)
Madrid	−0.3609	0.5408	0.0531*	−0.5084**
	(−0.628/0.54)	(0.692/0.50)	(1.7246/0.10)	(−2.615/0.02)
Murcia	−0.0159	−0.1313	−0.0120*	−0.4758***
	(−0.101/0.92)	(−0.846/0.41)	(−1.853/0.08)	(−2.909/0.01)
Navarra	−0.2656**	0.2510*	0.0028	−0.8330***
	(−2.157/0.04)	(1.986/0.06)	(0.888/0.39)	(−3.546/0.00)
País Vasco	1.9944*	0.1348	0.0068	−0.7516***
	(1.948/0.07)	(0.136/0.89)	(0.437/0.67)	(−3.445/0.00)
La Rioja	−0.0897	−0.0786	−0.0089***	−0.2305**
	(−0.564/0.58)	(−0.526/0.60)	(−2.808/0.01)	(−2.074/0.05)

Notes: In parentheses, beneath the estimated coefficients, appear the t-statistics and the associated p-values, respectively.
* Significant at the 0.1 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

País Vasco is the region that has the worst position in table 4; this region is facing negative effects at both economy-wide and neighborhood levels. On the other hand, Galicia, La Rioja, and Murcia are regions that have the best position in this table: they are influenced by both economy-wide and neighborhood positive effects.

With respect to the estimation of the short-term relationships, OLS can be used (as the spatial autoregressive term is lagged); the estimation results are presented in table 5. These findings can be interpreted as evidence for the fact that, in general, the regional shares are being driven by their respective long-run equilibria: most of the error-correction terms are significant, and this means that changes in the regional shares are being corrected in the short term by the deviations from the long-run equilibrium.

The significance of the lagged error-correction term in any equation of type (2) implies the existence of a long-run relationship contained in the corresponding equation of type (1). For the spatial error-correction term, only the coefficient for Aragón is significant at the 5% level (Cataluña and Navarra have significant coefficients at the 10% level), implying that long-run imbalances in the share of Aragón caused by disequilibrium in its neighborhood are being corrected in each short period. Table 5 is complemented with a graphical analysis of the results (figure 5) and the taxonomy in table 6 (over). Indeed, even though the long-term effects generally have the most relevant implications for the evolution of the regional shares, results tend to confirm the general view of external effects both over the short term and over the long term; the same is true at the economy-wide level. They are general forces that underpin the spatial structure of the Spanish economic system. The analysis of data at the economy-wide level reveals that Madrid is the only region that presents a significant positive coefficient, with positive economy-wide effects both in the long term and in the short term. On the other hand, Castilla-León has negative economy-wide effects both in the long term and in the short term whereas Extremadura does not have significant economy-wide effects.

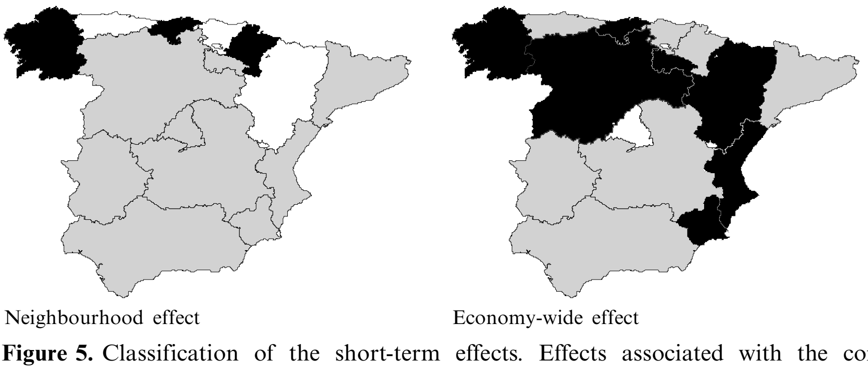


Figure 5. Classification of the short-term effects. Effects associated with the cointegration residuals are not taken into account. Black regions have a significant negative coefficient, white regions have a significant positive coefficients, gray regions have a nonsignificant coefficient.

At the neighborhood level the findings tend to support the existence of significant long-term and short-term net effects from the neighbors over the corresponding region. Asturias is the only region with a significant positive coefficient both in the long term and in the short term. Again, as the evolution of relative productive capacity is generally generated by long-term processes, this dimension will provide the focus of our interest. The results reflect the presence of neighboring regional shares affecting the corresponding regional shares (País Vasco, Anadalucía, Cataluña, and Valencia) in a significantly negative manner in the long term. On the contrary, Asturias, Galicia, La Rioja, and Murcia are regions that are being affected in a significantly positive

Table 6. Qualitative analysis of the estimated effects in the short term.

		Neighborhood effect		
		–[a]	0[b]	+[c]
Economy-wide effect	–[a]	Cantabria Galicia	Castilla-León Valencia Murcia La Rioja	Aragón
	0[b]	Navarra	Andalucía Castilla-La Mancha Cataluña Extremadura	Asturias País Vasco
	+[c]		Madrid	

Note: Effects associated with the cointegration residuals are not taken into account.
[a] Significant negative coefficient.
[b] Nonsignificant coefficient.
[c] Significant positive coefficient.

manner in the long term by the neighboring regions. In essence, the significance of neighborhood effects reveals the influence of geographical proximity as a relevant factor with which to explain the evolution of regional shares. A neighborhood effect provides a local perspective that complements the higher geographical level associated with national-level influences, because whereas the economy-wide effects consider all the regions within the system, the neighborhood effects consider only the adjacent regions.

The results suggest that there are stable trajectories over time within the Spanish regional system. Nevertheless, and owing to the nature of the empirical approach used, it is not possible to infer direct conclusions from the results regarding the factors that can explain the trajectories of the shares. The data contained in table 1 provide some indications about the latent forces that could be producing the detected macroeconomic effects. Variables such as innovation or research and development ratios, private and public stock of capital ratios, specialization of the workers, educational differences, or institutional and political factors are those which one might think could help us to develop an exploratory analysis of what the underlying causes are that could be the source of movements in the regional shares. Nevertheless, as commented previously, in this paper our concern is limited to detecting complex movements within an interrelated regional system.

3.4 Some final remarks about our results in the context of the literature

In this section attention will be directed to the contributions to the existing knowledge of Spanish regional growth and the innovations in the field of research of spatial econometrics made by this paper. The evolution of regional disparities and convergence has been analyzed by several empirical studies in terms of the evolution of per capita income (as a measure of welfare) and/or of GDP per worker (as a measure of labor productivity). Several of these studies have examined the existence of convergence within the European Union (for example, Cuadrado-Roura et al, 2001; Lopez-Bazo et al, 1999; Magrini, 1999) and within Spain (for example, Cuadrado-Roura et al, 1999; Goerlich and Mas, 2001; Mas et al, 1995, and Tortosa-Ausina et al, 2005). The attention of these papers has been focused on the analysis of the abovementioned measures, and they are not directly related with our topic (the significant changes in the evolution of relative productive capacity within a multiregional economic system). Further, their results may be seen as complementary to ours, because, as López-Bazo et al (1999) emphasize, regional convergence is not a simple process and it would be necessary to analyze different magnitudes simultaneously in order to avoid incomplete and distorted conclusions.

López-Bazo et al (1999) have employed spatial statistics and spatial econometric techniques to analyze regional dynamics and convergence for the European regions. The results of the analysis both of GDP per worker [based on a dataset covering 129 regions at NUTS 1 level (nomenclature units of territorial statistics) for 1981 and for 1983 – 92], and of GDP per capita (dataset covering 143 regions for the whole of the 1980 – 92 period) suggested that the continuous convergence observed in GDP per worker is not observed in living standards. Thus, a continuous equalization was detected in the GDP per worker, although the GDP per capita levels showed a certain polarization into two clubs.

Magrini (1999) analyzed the evolution of per capita income disparities for 122 major functional urban regions over the period 1979 – 90. His methodology examines the growth process as a time-homogeneous Markov chain; he discovered a tendency towards divergence, although the rate of divergence is extremely slow. On the other hand, the results of the analysis based on 169 NUTS 2 regions show that the vast majority of regions are converging.

Cuadrado-Roura et al (2001) analyzed convergence in terms of GDP per capita and GDP per employee in the European Union from 1977 to 1998. Their study (using conventional analysis) shows a very scarce convergence in terms of living standard and a slightly more significant convergence in GDP per employee. In addition, they identified winning and losing regions in the European Union using a Markov chain technique. In their analysis, Cuadrado-Roura et al (2001) present as winning regions for the period 1977 – 98, the following Spanish regions: Navarra, Madrid, País Vasco, Rioja, Baleares, and Cataluña. In the cases of Navarra and Madrid, the intensity of the changes is higher; no Spanish regions are losing regions.

Some important remarks need to be made about these results in comparison with ours. López-Bazo et al (1999) and Magrini (1999) have analyzed a short time period, whereas our study contains an analysis of a longer period of three decades. Our methodology let us distinguish between long-term and short-term analysis, but this distinction is not made in prior work. Our approach is based on a study of the intradynamics of a regional system, and considers regions as economic units. Last, it is worthwhile to highlight that though our analyses point to País Vasco as the region with the poorest behavior in the long term (in terms of relative productive capacity), Cuadrado-Roura et al (2001) present País Vasco as a winning region (in terms of GDP per capita).

With respect to the specific literature about the Spanish case, there is currently an abundance of empirical evidence on the economic growth and development of the regions and provinces of Spain (see Cuadrado-Roura et al, 1998; FUNCAS, 2002). Most of the Spanish literature is concentrated on the specification and estimation of 'beta' and 'sigma' convergence regressions for key variables (GDP per inhabitant, labor productivity, capital per worker, etc) with the introduction of additional explanatory variables that pick up factors such as human capital, regional infrastructures, research and development, migratory movements, etc (see Goerlich and Mas, 2001; Tortosa-Ausina et al, 2005). Different authors argue that, in the Spanish regions, convergence processes may well be now becoming exhausted. Thus, Cuadrado-Roura et al (1999) have shown that, in the case of the Spanish regions, from 1950 to the late 1970s, the prevailing process is convergence; whereas, since the 1980s, a lack of convergence is observed.

At a different level of spatial aggregation, evidence of the convergence of the provinces of Spain is offered by Goerlich and Mas (2001), Mas et al (1995), and Tortosa-Ausina et al (2005). Mas et al (1995) indicate that convergence was especially intense until the mid-1970s, slowing down from then onwards. Goerlich and Mas (2001) and Tortosa-Ausina et al (2005) confirm that a slight reduction of inequality among Spanish provinces in per capita income occurred in the last three decades, and detect the existence of two clearly differentiated convergence clubs. Also, these studies show that the convergence process has been especially intense in labor productivity, total productivity of the factors, and intensity of the capital, whereas in production per capita the profile has been less pronounced.

Some significant issues have not been sufficiently considered in the large number of studies that have analyzed this problem. First, the major shortcoming of most of these convergence studies has been that they do not take into account the space in which a region, as an economic unit, is located, and they thereby ignore the interactions between each region and its neighboring regions. Second, the use of per capita income to determine if economic homogeneity is taking place overlooks the fact that this measure of regional development is the product of the production per worker (a measure of productivity level) and the number of employed workers divided by the total production (that is, the gross employment rate). Therefore, biased conclusions could be generated owing to the existence of migration or the effect of an increase of the productivity level over the employment rate. Regional convergence in per capita income could coexist with divergence in the regional income level; that is, migration and/or labor mobility could be the origin of the convergence in per capita income, while regions as economic units are diverging.

As a result, the use of regional shares instead of GVA per capita may produce different results when the evolution of regional growth is analyzed. In fact, almost all the Spanish literature analyses the convergence or divergence of regions in terms of GVA per capita, but only a few papers have paid attention to the fact that, behind an apparent regional convergence, a progressive loss of weight appears in terms of production of the poorest regions—this loss benefiting the most developed ones. Therefore, to analyze the convergence only in per capita terms can offer a biased vision of the economic evolution of regions in Spain. For example, Dolado et al (1994) and Raymond and García (1996) revealed that the convergence observed in terms of GVA per capita can be attributable to the movements of population from the less developed regions to those most developed regions (dominated by movement from the agriculture sector to the industrial or services sectors). In fact, these studies suggest that the stagnation or deceleration of the convergence process in GVA per capita in Spain observed from the 1980s can be attributed in part to the reduction of interregional migration. In contrast, the present paper develops a procedure that detects significant movements in the evolution of the different regions within a regional system, complementing the analysis conducted in the 'per capita literature'.

Our results point to divergence in the regional share (as can be seen from the entropy diversity indices), contrary to the existing evidence in terms of per capita production, which shows that, in general, Spanish regions have converged, more or less markedly, over the period analyzed in this paper (1972–2000). It is precisely this divergence that we try to explain, at least in part, by investigating the geographical dimensions that are causing the observed spatial concentration of production.

Further, the spatial structure assumes a preeminent role, as the analysis considers regions as economic-geographic units. The analysis suggests that, in general, regional imbalances in the Spanish regional system are strongly influenced by the macroeffects that are operating within this system. In general, peripheral regions show negative economy-wide effects, whereas core regions are being affected by positive global effects. This implies that, in terms of the whole Spanish system, peripheral regions are not increasing their relative productive capacities. The interpretation of these results suggests evidence of 'divergence forces' operating in this Spanish regional system. This result challenges the contrary convergence-analysis results.

Our work is significantly differentiated from the previous body of applied spatial econometrics literature. Quah (1996a; 1996b) obtained a rapid overview of the dynamics of the regional distribution of a variable through the application of a density function; hence, it is necessary to study the dynamics of an entire distribution in order to analyze convergence. His results (Quah, 1996a) emphasize the great stability and persistence in the regional income distribution as well as the importance of spatial spillovers in the context of adjacent regions. Magrini (1999), in common with Quah, analyses the intradistributional dynamics and the change in the external shape of the cross-sectional distribution of per capita income. His main contribution is the use of a discrete income space rather than a continuous one, thereby developing a procedure that reduces subjectivity in the choice of the income class size.

López-Bazo et al (1999) consider a parallel analysis both for GDP per capita and for GDP per worker. To explore the existence of convergence clubs, they used the estimation of the density function for the regional distribution of these variables. The contribution to overall inequality of each region (statistically and dynamically) was assessed by means of an expanded rank-size function. The mobility within regional GDP distribution was analyzed by using graphical methods improved by means of a model of explicit distribution dynamics (Quah, 1993; 1996a; 1996b; 1996c). Finally, in order to consider explicitly the space in the regional dynamics and convergence process in the European Union, tests of global spatial dependence and tests of local spatial association are used to look for signals of large territorial integration (positive and significant global spatial correlation) and significant local spatial association (clusters of high or low levels of production, or fast or slow growth).

Consequently, the empirical analysis in our paper contains two new contributions to this area of research. First, as usual in spatial econometrics, we introduce the spatial dimension in the basic model, adding a spatial lag for the dependent variable, but not following the standard practice, we permit the spatial lag parameters to be different for each region. In our application the equality (of parameters) hypothesis was tested and clearly rejected by the data, which thereby reinforced the value of our approach. Second, and most important, the empirical specification that is used to estimate the short-run effects generalizes the standard error-correction formulation used in the time-series econometrics literature, and introduces a new term that we refer to as a spatial error-correction term. This new term needs to be highlighted because it represents in each region the adjusting mechanism which results from the disequilibrium in the neighboring regions, and complements the usual time-series error-correction term that corrects only for the disequilibrium in the region itself.

4 Summary

This paper is a contribution to regional macroeconomic analysis and focuses on the dynamic effects under which the regional economic processes operate by considering them at two spatial scales (neighborhood and economy wide). Through the use of a dynamic space – time formulation, these effects are uncovered. Although both effects are mainly related to long-run dynamic sources of growth, they are also considered in the short run. This perspective argues for competition among regions as a process that consists of two broad components, which are generated by the long-term evolution of neighborhood (in a spatial sense) and national effects.

An important implication of this investigation is the detection of the macroeffects through their incorporation into a definite geographic realization. Any intervention must take into account the location of these macroeffects before a specific policy is promulgated.

However, the empirical model provides a way to take into account spatial and temporal information relative to the evolution of the regional economic shares within a regional economic system. The space – time empirical approach combined a time-dynamic perspective with a scheme of interaction that exploited the role of the geographical location of the regions in the context of cointegration processes. Further, the incorporation in the basic ECM formulation of a new *spatial error-correlation term* could provide new insights in the context of the cointegration.

An application of the empirical model to regional shares within a Spanish regional system facilitated identification of the location and nature of these Spanish effects. These outcomes revealed a 'bird's-eye' view in contrast to the neighborhood effects. In this context the spatial structure assumes a preeminent role, because the analysis considers regions as economic-geographic units. The analysis reveals a distinctive regional imprint, thereby suggesting that, in general, regional imbalances in the Spanish regional system are strongly influenced by the macroeffects that are operating within this system. The interpretation of these results suggests evidence of 'divergence forces' operating in this Spanish regional system: in general, peripheral regions show negative economy-wide effects, whereas core regions are being affected by positive national effects. This implies that, in terms of the whole Spanish system, peripheral regions are not increasing their relative productive capacities.

Although the distinction that has been revealed between economy-wide and neighborhood effects within a regional system represents an important contribution to identifying the structure of the system, the next important task will be the formulation and testing of theoretical explanations that account for this uneven pattern of regional competition. In this sense, information contained in table 1, but for a more extensive time series, would provide a basis to achieve this goal.

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