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European integration, regional structural change and cohesion in Spain

EURECO

The Impact of European Integration and Enlargement on Regional Structural Change and Cohesion

Workpackage No. 2

Regional Structural Change and Cohesion in the EU

European Integration, Regional Structural Change and Cohesion in Spain

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The Impact of European Integration and Enlargement on Regional Structural Change and Cohesion

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Executive Summary

The present country study summarizes stylized facts for Spain about the general topographic, demographic, economic and political conditions as well as about the evolutions of industrial concentration and regional specialization during the last about 20 years. The study summarizes the results of the initial phase of Workpackage 2 within the EURECO project "The impact of European integration and enlargement on regional structural change and cohesion". The main purpose of the EURECO project is to assess the relevance of European integration in general, and the recent eastern enlargement of the EU in particular, derogating the process of economic cohesion among European regions. On the background of new trade theories and theories of new economic geography, the project analyses empirically (i) the impact of European integration on the specialization of regions, and (ii) the impact of regional specialization on regional income, employment and growth. Workpackage 2 within this project, focusing on the incumbent EU Member States, summarizes and analyzes the experiences to be drawn from the European integration process so far, laying particular emphasis onto previous EU enlargements. Subsequent phases of Workpackage 2 will analyze the links between economic integration and regional specialization more rigorously.

The present paper analyses regional specialization and spatial concentration in Spain during the time period 1978 to 1995. The period is sufficiently long for capturing important milestones of the integration of the Spanish economy into the EU: Spain's EU accession in 1986, and the completion of the Single Market in 1992.[1] The analysis distinguishes 18 Spanish NUTS 2 regions and 4 sectors (agriculture, manufacturing, construction, services; value added), respectively 88 industries within the manufacturing sector (employment). Several statistical concentration and specialization measures are employed. The concentration of a sector or industry is measured either relative to land surface (reference: uniform distribution across space; labelled "topographic concentration"), or relative to the uniform distribution (reference: uniform distribution across regions; labelled "absolute concentration"), or relative to the distribution at the EU15 or the country level (reference: aggregate average distribution; labelled "relative concentration"). Similarly, the specialization of a region is measured either relative to a uniform distribution (reference: uniform distribution across sectors or industries within a region; labelled "absolute specialization"), or relative to the specialization pattern at the EU15 or the country level (reference: aggregate average specialization; labelled "relative specialization").

[1] The latest milestones, however, the north enlargement in 1995 and the creation of the European Monetary Union in 1999/2002, are too recent for being covered by the present analysis.

The results can be summarized as follows:

1. *Levels of industrial concentration*: On the backdrop of a generally low degree of topographic concentration of population and economic activity in the EU as a whole, Spain was among the EU countries exhibiting the highest topographic concentration of economic activity in the early 1980s at both the aggregate as well as the sectoral levels. This can be traced to the dominance of the country's outstanding center, Madrid, that covers only one sixtieth of the country's acreage but accounts for one seventh of total output. Within the manufacturing sector, some food processing industries, and resource dependent industries were somewhat more concentrated than manufacturing sector as a whole (relative concentration). The concentration patterns of manufacturing industries with increasing returns to scale (IRS industries) were heterogeneous: Some of the IRS industries were highly concentrated, others were dispersed.

2. *Evolution of industrial concentration*: In the course of the European integration process during the 1980s and early 1990s, the concentration patterns changed very slowly both throughout Europe as a whole, and within Spain. At the EU level, a weak tendency towards topographic deconcentration of economic activity as a whole as well as of sectors prevailed.[2] The sectoral concentration within Spain evolved very similarly to that in other member states; the only notable difference being that an increase of topographic concentration of services, and a decrease of manufacturing in the mid-1980s was not matched by other EU member states. Within the manufacturing sector, relative concentration tended to increase in the highly-concentrated resource intensive industries but to decrease in IRS industries.

3. *Path dependence of industrial concentration*. There is some evidence for Spain that sectors or industries which were highly concentrated in the late 1970s exhibited lower country-wide growth rates in terms of value-added or employment during the 1980s and early 1990s than sectors or industries which were distributed more evenly across space within Spain. At the same time, however, there is no indication of path dependence in the evolution of concentration of sectors or industries: There was no obvious relationship across sectors or industries between the initial degree of concentration of the sector or industry and the subsequent evolution of its concentration.

4. *Level of regional specialization*. In general, Spanish regions did not exhibit particularly strong sectoral or industrial specialization patterns in the early 1980s compared to both average specialization of the EU15 as a whole, and average specialization of the Spanish economy. In the European context, Spain was, in fact, among the countries with the

[2] Nonetheless, the topographic concentration measure assumed a slightly higher value in 1995 than in 1980. The reason was a temporarily increasing concentration in the early 1990s caused by the unification boom in Germany. The unification boom in Germany increased the concentration differences *between* the EU member states but did not affect the regional concentration patterns *within* countries to a notable extent.

lowest degree of specialization. In this respect, it was more similar to rich northern than to poor Mediterranean member states like Greece and Portugal which were much more specialized. Among the Spanish regions, there were a few exceptions of highly specialized regions, however: A few small, peripheral regions like the off-shore regions of the Baleares and Ceuta y Melilla on the one hand, and the iron-and-steel region of Asturias on the other hand. The center region of Madrid, by contrast, differed from other Spanish regions only in its sectoral and industrial mix but not in its degree of specialization.

5. *Evolution of regional specialization*. As to the evolution of specialization patterns over time, a tendency towards decreasing specialization prevailed throughout the 1980s and the first half of the 1990s. This is true for the EU15 as a whole, for Spain as a whole, and most of the Spanish regions. The only exception was the iron-and-steel region of Asturias where decreasing specialization at the aggregate level of sectors coincided with increasing specialization within the manufacturing sector.

6. *Path dependence of regional specialization*. Similar to 3., no evidence was found for a path dependence in the degrees of specialization of Spanish regions: Neither a region's initial degree of specialization in general nor a region's initial specialization in a specific sector or industry group (e.g. high IRS industries) had a significant impact on the region's subsequent evolution of specialization.

7. *Specialization and regional performance*: With respect to the relationship between a region's initial degree of specialization and its subsequent value added or employment growth, the results are mixed: A region with a high initial specialization regarding 17 large sectors that cover the entire regional economy seems to perform particularly well (with respect to overall value added). A region with a high initial specialization within 88 manufacturing industries seems to perform particularly bad (with respect to manufacturing employment). This indicates that not specialization by itself, but rather specific kinds of specialization affect the regional performance. Accordingly, there is some evidence of a region's initial specialization in a specific industry group within the manufacturing sector having affected subsequent employment growth within that region-industry negatively. I.e., the more specialized a region was in a specific manufacturing industry, the worse this region-industry tended to perform subsequently. This trend, which is consistent with the observed tendency towards regional de-specialization (see 5), is found to be significant for almost all industry groups, including IRS industries. The region-industry specific negative effect of initial specialization was, however, limited in sectoral scope. There is no indication of a region's specialization in a single industry group having significantly shaped the region's aggregate manufacturing employment growth.

Map of Spain and its NUTS2 regions (“communidades autónomas”)

Part A. Introduction

In May 2004, the first round of the EU east enlargement was completed. This new integration step is likely to increase trade and factor mobility thereby increasing interregional competition and affecting the interregional division of labor within the enlarged EU. From this, worries arise that cohesion between countries and regions might deteriorate. Against this background the EURECO project "The impact of European integration and enlargement on regional structural change and cohesion" was conceptualized drawing on trade theories, inter alia the new economic geography (NEG). These theories supply us with different predictions of possible effects of integration on the concentration pattern of industries and the specialization patterns of regions, some of them supporting, others contradicting such worries (cf. EURECO paper on Workpackage 1: Bode, Bradley et al. 2003). The EURECO project is assigned to provide empirical answers, particularly regarding (i) the impact of European integration on the specialization of regions, and (ii) the impact of regional specialization on regional income, employment and growth.

Within the EURECO project, Workpackage 2 aims at providing empirical evidence on the experiences of *incumbent EU Member States* with the European integration process, particularly with previous enlargements of the EU. Changes in regional specialization pattern observed during this process may help predict future changes in the regional specialization pattern of new member states. WP 2 will

- *describe* the evolution of regional specialization pattern since the 1970s,
- *analyse* the impact of integration on the degree and nature of regional specialization,
- *analyse* the impact of the degree and nature of regional specialization on regional income, employment and growth.

In pursuing the first of these three steps, a series of country studies is provided of which the present study for Spanish regions is one. Others concern Austrian, British, French, German, Greek, Irish, Italian, and Portuguese regions. All taken together will constitute a basis for comparing various different regional experiences with European integration. The country studies describe the specialization of the respective regions over time, taking into consideration the specific concentration characteristics of each country's sectors and industries. Moreover, to distinguish further, exogenous influences on industrial concentration and regional specialization, distinct from the integration induced economic forces, basic information on the topographic situation, history of settlement, orientation of economic policies of the respective countries and their regions is provided as well.

The present country paper on Spanish regions is organized as follows: Part B gives some general background information on the topographic and economic characteristics of these regions (chapter 1) as well as on the economic policy pursued in the country (chapter 2). Part C represents the central part of the paper. It contains the description of regional specialization pattern and their evolution in Spain since the late 1970s. Part D summarizes and concludes.

Part B. Stylized characteristics of Spain

1. Stylized country characteristics

1.1. Population and space

The country of Spain, situated at the outmost South-West of Europe, covers an area of about 500 thousand square meters and inhibits a population of about 38 million people (table 1). Quite broadly, it can be stated that population density in Spain decreases from the coastal areas to the central highlands and from north to south.

Spain is divided into 18 “communidades autónomas” (regions at NUTS2 level), including the off-shore regions of the Islas Baleares, the Islas Canarias and of Ceuta y Melilla (two small enclaves next to Morocco). Even the 15 continental of these 18 regions vary considerably with respect to size and population density. On the one hand, there are several very large and very sparsely populated regions situated in central Spain like Aragón, Castilla y León, Castilla la Mancha and Extremadura. On the other hand, there are a number of quite small and relatively densely populated regions in northern Spain like Asturias, Cantabria, País Vasco, Rioja and Navarra and the center region, Madrid. Between these extremes, there are the coastal regions of Galicia, Cataluña, Communidad Valenciana, Murcia and Andalucía that are large and densely populated at the same time. Accordingly, these regions do not easily compare to each other.

Also, the regions enjoy different states of autonomy.

Table 1-1: Population and space in Spain

	Acreage	Population 2001	Population change last decade	Population density	Employment potential (pop15-65)	Participation rate (workforce) 2000
	1000 sqkm	Mio.	average annual	persons/sqkm	% of pop	% of potential
Galicia	29.4	2.7	0.0	92.5	68.1	66.8
Asturias	10.6	1.1	0.4	99.6	68.4	61.2
Cantabria	5.3	0.5	0.0	99.9	68.9	62.7
País Vasco	7.3	2.1	0.2	284.7	70.5	68.3
Navarra	10.4	0.5	-0.4	51.7	68.1	70.1
Rioja	5.0	0.3	-0.1	52.9	67.5	68.4
Aragón	47.7	1.2	0.2	24.5	65.7	68.5
Madrid	8.0	5.2	-0.5	649.1	70.0	71.5
Castilla y León	94.2	2.5	0.3	26.2	66.0	64.9
Castilla la Mancha	79.2	1.7	-0.3	21.7	64.8	62.8
Extremadura	41.6	1.1	-0.1	25.9	65.5	65.4
Cataluña	31.9	6.2	-0.2	194.1	68.5	71.7
Co. Valenciana	23.3	4.1	-0.5	174.6	69.1	69.1
Baleares	5.0	0.8	-1.2	159.1	68.7	67.6
Andalucía	87.3	7.3	-0.5	83.3	68.3	63.5
Murcia	11.3	1.1	-0.8	100.1	67.9	65.5
Ceuta y Melilla	0.0	0.1	-1.3	4545.2	66.5	60.2
Canarias	7.2	1.7	-1.4	236.9	71.3	65.1
España	504.8	40.1	-0.3	79.5	68.4	67.4

1.2. Economic geography

Most prominently, the Spanish regions are characterized by their situation with respect to their distance to the coasts. The central highlands of Spain are subject to a relatively hot and dry climate, owe less fertile soils, and their mountainous landscape traditionally resisted the development of transport infrastructure. Accordingly, they remained relatively sparsely populated and less accessible – safe the center region of Madrid. By contrast, the coastal regions traditionally enjoyed a more favorable climate, more fertile soils, and more favorable conditions for the development of transport infrastructure, be it ports or roads along the coasts. Accordingly, they are relatively densely populated (see above) and much better accessible even from abroad.

Also, the economic distance to central Europe plays a major role in shaping the economic landscape of Spain. This influences the regions situated most closely to the border of France: Cataluña at the north east, and Navarra and País Vasco at the north west part of Spain (Aragón, also directly neighboring France, is yet insulated from it by the Pyrenées mountains).

With respect to specific resource facilities, most obvious are the coal deposits to be found in Asturias. As there are also some iron ore deposits close by, in Castilla y León and in Cantabria, the geographic conditions favored the emergence of the Spanish iron-and-steel industry in this area. All other deposits are of minor significance.

1.3. Economic activities in space

The density of economic activities quite closely follows along the lines alleged by the conditions of geography and the spatial distribution of the population.

Table 1-4: Economic activities in space in Spain

	Unemployment rate	GDP	Economic density	Per-capita income	Productivity	Growth rate	Employment change	Sectoral structure GVA 2000		Sectoral structure employment 2000		Export rate	Investment	Foreign direct investment
	2001	2000	2000	2000	2000	last decade	last decade	Agriculture	Services	Agriculture	Services			
	% of workforce	Mio €	€/ sqkm	€/ population	€/ employment	average annual %	average annual %	%	%	%	%	% of GDP	% of GDP	% of GDP
Galicia	14.7	32594	1107	12045	30845			6.3	65.3	6.3	54.3			
Asturias	14.4	13854	1311	13152	37504			2.2	65.2	2.2	60.9			
Cantabria	13.3	7873	1486	14919	39522			4.2	67.8	4.2	61.5			
País Vasco	11.2	38887	5356	18861	44044			1.6	62.8	1.6	60.0			
Navarra	6.1	10507	1008	19607	42834			5.1	57.6	5.1	52.5			
Rioja	7.3	4484	891	17012	39650			9.1	57.1	9.1	49.9			
Aragón	8.4	19068	400	16310	38780			4.9	64.9	4.9	60.5			
Madrid	9.8	105131	13150	20566	45819			0.2	79.1	0.2	75.3			
Castilla y León	12.2	34793	369	14078	37822			7.1	64.1	7.1	59.8			
Castilla la Mancha	12.9	21221	268	12427	34840			11.5	61.9	11.5	55.8			
Estremadura	22.1	10566	254	9860	30187			10.8	69.3	10.8	61.3			
Cataluña	8.8	113942	3568	18556	40997			1.8	65.2	1.8	61.3			
Co. Valenciana	11.4	59395	2549	14819	34893			2.6	68.1	2.6	60.5			
Baleares	6.6	14412	2874	18508	41945			1.5	84.6	1.5	74.8			
Andalucía	22.3	82170	942	11400	34276			6.8	73.5	6.8	66.4			
Murcia	11.4	14343	1267	12846	32671			6.9	68.2	6.9	59.6			
Ceuta y Melilla	21.9	1771	57129	12732	42881			0.2	95.1	0.2	89.3			
Canarias	13.1	24308	3357	14624	36461			2.5	81.7	2.5	73.5			
España	13.1	609319	1207	15335	38319			3.7	69.8	3.7	63.7			

2. Stylized policy characteristics

2.1. General economic policy orientation

The economic structure of any country and the structural change that is taking place within the country are likely to be influenced deeply by the respective economic policy in the country. Hence, when assessing the impact of European integration on regional structural change, it is necessary to allow for the influences of national economic policy.

In Spain, there exists a long and pronounced tradition of state corporatism (see: Balbín, in: Foreman-Peck/ Federico, 1999). This tradition likewise relied on external protection via high customs tariffs, and on internal dirigisme, both aiming at obtaining an autarkic economy. Most particularly, during the Franco régime until the end of the 1950s, the Spanish economy was isolated from external markets and did not take part in the rapid economic growth in other western economies. In the late 1950s, however, Spain gradually opened up to world markets. Still, protectionism and state intervention remained strong throughout the 1960s and 1970s. After General Franco died in 1975, industrial policy was influenced strongly from the fragile social conditions. The challenges of the late 1970s and early 1980s were to convert the country's political system into a democracy, shifting power from the central government to regional authorities, opening up the economy and improving competitiveness of the industry while controlling inflation and unemployment. A cornerstone for Spain's industrial policy during this transition phase was the Moncloa Agreement (Pactos de la Moncloa) agreed on by all political parties, trade unions and employers in 1977, which directed policy measures towards enabling Spain to finally join the European Community.

Spain's entry to the EU in 1986, the agreement on the first phase of monetary union in 1989 and finally the signing of the Maastricht Treaty in 1991 accelerated the changes in the Spanish economy. The taxation and regulation framework was streamlined with those of other EU members and trade barriers and capital controls were removed. Many unprofitable public firms were shut down or privatized. Finally, the commitment to the 'convergence criteria' gave a halt to loose monetary policy, high public deficits and soaring inflation.

2.2. Trade policy

During the late 1950s, Spain made first steps towards trade liberalization and international integration. Spain joined international institutions (1958 World Bank, 1959 IMF and OEEC) and introduced a stabilization plan (Plan Nacional de Estabización Econoómica), which broke with the strict autarchy policy. This plan embraced tight monetary and fiscal policies as well as a devaluation of the peseta and measures to liberalize international trade and investment.

However, it was not until the accession to the European Communities (now the European Union) in 1986 before Spain broke completely with its protectionist tradition. As a member of the EU, Spain commits itself to the full free movement of goods, services, capital, and people with EU member states and much more open trade relationships with non-EU countries (see OECD 2000: Regulatory Reform in Spain). The adjustment process following EU membership made huge trade liberalization efforts necessary. The prevailing Spanish customs tariffs for most products originating from the EU and the European Free Trade Association (EFTA)countries were abolished after a seven-year transition phase, with a 10 year period for some agricultural products. For imports originating from other countries, Spanish duties were reduced to the level of the EU common external duties over a seven year period. The reduction of tariffs was accompanied by the dismantling of most of Spain's over 4500 quantitative import restrictions (QRs), affecting goods from both EU and non-EU countries.

Radical changes were also necessary in the Spanish foreign investment regulatory framework. In 1985, prior to the accession, several restrictions on foreign investment and free capital flows were lifted. However, investment in five special sectors (gambling, radio, television, air transport, and defence-related) remained dependent of prior authorization and the obligation to register through Spanish notaries. Also, various obstacles to the abroad transfer of profits and dividends and the repatriation of capital stayed in place. In 1992, exchange controls were repealed to transpose the EU Directive on the deregulation of capital flows. In April 1999, a new investment regime was approved that transposed various EU provisions relating the application of the Maastricht Treaty. It also eliminated the remaining obstacles for investments of non-EU residents in the special sectors, except in the defence-related sector.

2.3. Regional policy

Policy instruments for regional development in Spain can be divided into two groups: (i) instruments to foster economic development *within* the regions, and (ii) instruments to foster economic convergence *between* the regions by particularly supporting the development of lagging regions. The first instruments lie mainly within the responsibilities of the regional and local authorities and consist of administrative regulations and measures to improve infrastructure. The latter instruments are subject to national responsibility and consist mainly of the Regional Investment Grant.

As a federal state with a high degree of autonomy for the regions, Spain has devolved many responsibilities for regional planning to the local governments. The regional governments are responsible for regional economic and urban development, planning, infrastructure and environmental protection. Since 1992, local planning is the responsibility of the 8077

municipalities. Municipalities with a population greater than 5000 have to produce legally binding general urban plans in which land is divided into three groups (land excluded from development, land available for development and land already developed). The second group is sub-divided into programmed land and non-programmed land, referring to whether land-development strategies exist for the specific types of land in the general plan. The general plan then describes the specific use of each zone, designates transport networks and indicates the location and siting of public buildings, conservation areas and open space (Balchin and Sýkora 1999).

As a country with strong regional disparities, in 1986 Spain introduced the Regional Investment Grant. This state (and, depending on the regions, EU) funded program offers investment subsidies of between 20 and 50% of the net investment sum to eligible projects. Eligibility of projects is restricted to designated areas, which were selected according to European Comission criteria (GDP per capita and unemployment levels) as well as to projects in selected sectors. The areas in which the Grant is available cover as much as 60.7% of the national population (as of 1999). Also, the height of awards given varies between the different areas, with maximum award only given in the most backward municipalities (figure.., will be supplemented). Eligible projects include investments in the manufacturing and extractive sector, as well as selected services, such as tourism, industrial services, and services 'which improve the commercial structure'. The actual height of awards given is calculated according to rules taking into account the following five factors: job creation; use of indigenous raw materials; value added; technological interest; interest of the project for the locality. Out of these five factors, job creation is the single most important, however exact weighting percentages are not made public.

2.4. Industrial and technology policy

Direct public intervention in the economy through state owned enterprises was a common feature of industrial policy in most European countries after the second World War. Spain was no exception to this, however the institutional context of Spain was different. After the victory of General Franco in the civil war, the country was turned into an autocratic dictatorship. The new regime's economic policy aimed at a rapid industrializing of the country under autarchy. Main part of this policy was the creation of the INI, Instituto National de Industria (National Institue of Industry), which was a state owned holding company. Under the umbrella of the INI, many state owned companies were created through acquisition in sectors considered most important for industrial development and self-sufficiency, such as steel, energy, chemicals, and engineering. However, sectoral concentration of public enterprises was lower than in other countries. This direct state participation was accompanied by other interventionist measures on prices, wages, agricultural output and trade restrictions as well as

by attempts of indicative planning through national development plans and public investment grants. Most favored of theses measures were declining sectors or the basic industries, such as chemicals, steel, shipbuilding and transport equipment (Salomon, 1995).

After the death of the dictator, the industrial policy aimed at stabilizing the new democratic system. Therefore, the role of the INI changed towards serving as an “enterprise hospital”, preventing massive lay-offs in unproductive industries. Between 1976 and 1983, INI acquired more than 20 large private firms in trouble. The cost of this social “appeasement policy” were massive losses, huge overcapacity and very low productivity of the public sector. Thus, in the mid-1980s, the government started the restructuring of the public sector via privatizations, closures and mergers of unprofitable public enterprises. Many of the privatized firms were sold to foreign multinationals. The government played an active role in picking suited buyers, hoping this would accelerate the process of technology transfer and allow for the viable operation of the formerly state-owned enterprises. In 1995, the INI was finally dissolved.

The accession to the EU limits the room for an independent national industrial policy. The Maastricht-treaty sets limits to the public budget deficit (and therefore for direct interventions via loss-making public enterprises) and trade restrictions as means of industrial policy lie at the EU commission.

Part C. Descriptive Analysis of Structural Change in Spain

1. Introduction

1.1. Subject and structure of the work

This part describes and analyses the extent and evolution of industrial specialization of Spanish regions, and of the spatial concentration of Spanish industries during the past about two decades. From the perspective of the EURECO project as a whole, the predominantly descriptive analysis will develop stylized facts about the general patterns of structural change during the process of European integration. On the background of theoretical models of trade and economic geography, surveyed in Workpackage 1 (Bode, Bradley et al. 2004), the stylized facts shall help formulate hypotheses about the effects of economic integration on regional specialization and economic growth.

The analysis will focus on the following guiding questions:

- What have been the specific characteristics of the industrial specialization of Spanish regions, and of the spatial concentration of Spanish industries in the late 1970s, before Spain's accession to the EU? Did there exist an explicit core-periphery system?
- How have the specialization and concentration patterns changed during the subsequent process of European integration?
- To what extent can the directions and magnitudes of these changes be attributed to the initial conditions: Did highly concentrated / highly dispersed industries get more concentrated or more dispersed during the observation period? Did highly specialized / highly diversified regions get more specialized or more diversified? Did peripheral regions evolve differently than central regions?
- To what extent can the subsequent development of regional and industrial performance be attributed to the initial conditions: Do concentration or dispersion trends of industries and specialization or diversification trends of regions coincide with growth or decline, with job gains or losses of respective industries and regions? Did peripheral regions perform differently than central regions?
- In particular, to what extent has a specific industry mix of regions, such as a historically high specialization on agriculture or on so-called increasing returns (IRS) industries or on industries with a high dependency on localized resources, affected the subsequent evolution of industrial specialization and economic development in these regions? Did such regions exhibit a characteristic evolution distinct from other regions?

The analysis addresses the specialization of Spanish regions with respect to large economic sectors as well as to detailed manufacturing industries. The time period covered by the

subsequent investigation, 1978 to 1995, is sufficiently long for capturing important milestones of the integration of the Spanish economy into the EU: Spain's EU accession in 1986, and the completion of the Single Market in 1992.[3]

The results indicate that most Spanish regions, with few outliers, exhibit moderate degrees of specialization in the initial year and, on average at least, few change during the observation period. Most Spanish sectors like manufacturing and various services sectors, as well as Spanish industries within manufacturing, appear relatively equally concentrated in the initial year, with the exception of agriculture, of resource dependent industries, of some though not all IRS industries, and of some other, usually small, usually food industries. Sectors and manufacturing industries exhibit, on average, few change during the observation period. Initial specialization and concentration degrees seem to exhibit little influence on the subsequent evolution of regions and industries. More particularly, a high initial specialization on specific sectors or industries, e.g., resource dependent industries or high IRS industries, does not seem to entail a specific impact on the subsequent evolution of specialization. Yet, there are indications that highly specialized regions and highly concentrated industries decline relative to other Spanish regions /industries (i.e., lose shares in total value added or employment). This gives rise to two conclusions: (i) The concentration of industries seems to lose significance for Spain, as concentrated sectors /industries decline relative to others. (ii) A high degree of specialization, particularly on highly concentrated sectors /industries, seems to be to the detriment of regions, as they decline relative to others.

The investigation is divided into five chapters, dealing with methodological and data issues (section1.2.), the spatial concentration of industries (chapter 2), the industrial specialization of regions (chapter 3), and the structural change in more detail (chapter 4). A concluding summary of results is presented in Part D.

Chapters 2 and 3, dealing with the spatial distribution of industries and the industrial specialization of regions, will start from a European perspective by identifying the specific position of Spanish regions in the European division of labour, and comparing the extent and evolution of sectoral specialization of Spanish regions to that of other European regions. In a second step, the two chapters will focus on industries within the Spanish manufacturing sector, exploiting a national data base which allows for a deeper sectoral breakdown. In doing so, the analysis of the spatial distribution of industries in chapter 2 will identify groups of industries of similar (exogenous) characteristics related to trade theories. The purpose of this exercise is to investigate to what extent trade and new economic geography theories may help explain the observed spatial concentration of industries in Spain before it joined the EU,

[3] The latest milestones, however, the north enlargement in 1995 and the creation of the European Monetary Union in 1999/2002, are too recent for being covered by the present analysis.

the changes in concentration over time during the subsequent integration process, and the consequences on the rise or decline of such industries. The characterisation of these industry groups will be used as input to chapter 3. Chapter 3, dealing with industrial specialization of Spanish regions, will identify classes of regions according to their specialization on sectors and on those industry groups with similar characteristics. It will describe the characteristics of the specialization patterns of regions, resp. classes of regions, in the pre-EU era, will investigate the evolution of the specialization patterns during the subsequent integration process, and the consequences on the rise or decline of these region classes.

Chapter 4 will investigate structural change in more detail disentangling the interaction between industrial concentration and regional specialization. It will look for the specialization of specific regions on specific industries (IRS industries, resource dependent industries), and for the consequences it has on the subsequent evolution of these regions, with respect to their further increase or decrease of specialization, as well as to their economic performance relative to other regions. The main goal is to help formulate hypotheses about causal relationships between specialization and regional performance, which are to be tested in subsequent phases of the EURECO project.

1.2. Methodology and database

Methodology

For measuring industrial concentration or regional specialization, a large number of measures has been used in the literature, including the Herfindahl, Theil and Gini indices, the coefficients of variation and of specialization, and the “dartboard” measures (Ellison-Glaeser, Maurel-Sédillot coefficients). Appendix 2 gives a comparative overview. The decision upon which measure is most appropriate for a specific investigation depends to a great deal on the purpose of the investigation with respect to weighting observations of different magnitudes, data availability, and specific properties of the respective measures.

Not withstanding the merits of other indicators, this paper suggests to use Theil indices, recently proposed by Brülhart and Träger (2004). For comparison, the Herfindahl index and the Krugman index will also be presented. Formally, the Brülhart/Träger Theil index in a generalized form can be written as

$$T_{(j)}^{BT} = \sum_{i=1}^{I} \frac{n_i}{N} \frac{a_i(j)}{a_i} \ln\left(\frac{a_i(j)}{a_i}\right)$$

j denotes the unit investigated which, in the present paper, is either a specific region – in the analysis of the industrial specialization of regions – or an industry – in the analysis of the spatial concentration of industries; *I* the number of observations the distribution of which shall be investigated (either industries *i* in region *j*, or regions *i* where industry *j* may be located);

$a_i(j)$ the "local" share of observation i in unit j (in terms of employment or value added); and a_i the corresponding "global" share at a super-regional or super-industrial level which serves as a benchmark for the $a_i(j)$. n_i/N is the weight given to the i-th observation, such that $\Sigma_i n_i/N = 1$; n_i denotes the absolute number of basic units (e.g., workers, EUROs of value added, square kilometres) in observation i, and N the corresponding total number of basic units at the super-regional or super-industrial level. Different benchmarks may be applied: One possible benchmark may be the uniform distribution of industries or regions ($a_i=1/I$) transforming the Brülhart/Träger Theil index into the well-known Theil index:

$$T_{(j)} = \sum_{i=1}^{I} a_i(j) \ln\left(I\, a_i(j)\right)$$

Another possible benchmark may be the topographic distribution yielding the topographic Theil index (as a concentration measure, only).

Depending on their specific properties, different measures may produce different results, and may suit, or not suit for the question to be investigated. A marked parting line runs between so-called absolute and relative measures. Absolute measures are, i.a., Herfindahl index and Theil index, relative measures are, i.a., Krugman index and Brülhart/Träger Theil index. Absolute measures are based on shares which they refer to a zero distribution or a uniform distribution (1/I). In the context of industrial specialization of a region, e.g.,[4] the Herfindahl index, referring to a zero distribution, assigns higher weights to big than to small industries:

$$H_{(j)} = \sum_{i=1}^{I} (a_i(j))^2$$

The Herfindahl index may be useful for comparing regions with respect to their quantitatively most important industries. It is, however, rather insensitive to the issue of arbitrary definition of industries: A broadly defined industry is given a higher weight than a comparable industry which was – for whatever reason – split up into several small sub-industries. Similarly, the Herfindahl index may be useful for analyzing changes in a region's industry structure over time, if changes in big industries are judged more relevant than changes in small industries.

Other absolute measures, like the coefficient of variation, the Gini or Theil index, use the uniform distribution rather than zero as a reference. In a comparison of regional specialization patterns, they tend to deal more symmetrically with big and small industries than the Herfindahl index. Assigning higher weights to both very big and very small industries, they may draw a more balanced picture of specialization. This property does, however, not imply neutrality with respect to arbitrarily defined industries. Though drawing a more balanced picture, they still employ the same kind of – mechanical – weights as the Herfindahl index. An

[4] The following discussion of the merits and drawbacks of different measures will be confined to the specialization issue. The arguments can easily be transposed to the issue of spatial concentration of industries.

industry that happens to be mediocre within a specific region does not affect the measures, irrespective of how big or small it is in other regions. As to the analysis of the evolution of specialization patterns over time, the major merit of absolute measures is that the reference is constant. The measures are able to capture what happens within a region, irrespective of what happens elsewhere. But again, this comes at the cost in the context of interregional comparisons of structural change: A change of given magnitude (say, a gain of 1% of total regional employment) in a big or small industry is given a higher weight than the same change in a mediocre industry. Consequently, the measures may respond differently to quantitatively and qualitatively similar changes.

Relative measures are based on localization coefficients or analogues[5] that refer "local shares" to "global shares" (this is the usual procedure) or to any other reference shares. One example, besides the Brülhart/Träger Theil index, is the Krugman index:

$$SC_{(j)} = \sum_{i=1}^{I} \left| a_i(j) - a_i \right|$$

The relative measures allow for specifying explicitly of what size an industry is expected to be. They thus allow for dealing appropriately with arbitrary statistical definitions by tailoring the benchmark. As a consequence, however, information from the sheer absolute size of industries is lost: Relative measures assign regional deviations from (nationally) small industries essentially the same value than deviations of similar magnitude from big industries. As to the analysis of the evolution of specialization patterns over time, relative measures allow for netting out national trends. This may be helpful if the national trends should be assumed exogenous, or if the focus is on regional evolution within the country. It may be helpful as well when different regions are compared because the same global trend is removed everywhere. But if the focus is on absolute changes, relative measures tend to draw an incomplete picture.[6]

Similar trade-offs are relevant when choosing between different absolute, or relative measures. Some measures, like the coefficient of variation, tend to put more emphasis on big deviations from the reference distribution, while others, like the Theil index, tend to put more emphasis on small deviations. The question of which measure to prefer depends, i.a., on the focus of the analysis, and on the relevance of outliers. As analyzed in detail by Cowell (….), the former are particularly sensitive to variations in the tails, while the latter are less sensitive. In some cases, the choice may be made in favor of measures that are somewhere in-between

[5] I.e., the Krugman index is defined as a difference instead of a quotient.

[6] In the context of measuring the spatial distribution of industries, this potential drawback of relative measures can be avoided by choosing as a reference a distribution that is constant over time, such as total area, or area available for economic use.

as a compromise. One of those measures is the coefficient of specialization, the projection function of which is uniformly linear.

The major advantage of the Brülhart/Träger Theil index, as compared to the other measures, is that it tends to downgrade the influences of outliers and of indivisibilities in firm sizes. Moreover, it is suitable for addressing a wide variety of questions, , may be used for assessing the statistical significance of differences, and can be interpreted in a fairly straightforward manner.[7] It allows for meaningful international, interregional and intertemporal comparisons by its decomposition property: any Theil index can be decomposed into additive components for subgroups of the sample. That is, the overall concentration of a specific industry across European regions can be traced to a component that is due to the concentration across countries and another that is due to the concentration across regions within countries. Also, the overall specialization of a region can be traced to the component that is due to the specialization on industry groups and another that is due to the specialization on industries within these groups. These properties will be used in particular to give an idea of the position of Spanish sectors and industries, as well as of Spanish regions in the overall European division of labor.

Database

For the purpose of the present study, two different databases are exploited:

- annual real value added by 17 sectors 1980 to 1995 from the Eurostat database, revised and amended by Hallet (2000).[8]
- annual employment by 88 manufacturing industries 1978 to 1992 from the enterprise surveys database of the Spanish INE.

For the first database, Hallet (2000) completed the Eurostat dataset, reporting gross value added at current prices in ECU from national sources, to cover 17 sectors for NUTS 2 regions in Belgium, Spain, France, Italy, Netherlands, and Portugal, and for NUTS 1 regions in Germany and the UK. The sectors include agriculture, 10 manufacturing and energy sectors, and 6 service sectors. The dataset allows us to compare the specialization Spanish regions and concentration of Spanish sectors on a European yardstick. The data include, however, data breaks that seem to be due to statistical problems rather then real world evolutions (e.g., a major break for several time series between 1985 and 1986 in the Spanish case). We do not dispose of any information on the background to these breaks. They will, therefore, largely remain uncommented.

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[7] For a more detailed analysis of the advantages of the Theil indices, cf. Appendix 2.

[8] We would like to thank Martin Hallet for the generous provision of his data.

For the second database, the “Instituto Nacional de Estadistica de España (INE)” offers yearly data on regional employment (persons employed) for 88 manufacturing branches, for 18 “comunidades autónomas”, and for the period 1978 to 1992 from the “Encuesta Industrial (EIG)”. These data include several missing values due to confidentiality restriction, but as there are several data available on totals, sub totals and cross totals, these missing values can be estimated by an iterative interpolation procedure. More recent data are not available, since the mode and classification system of the INE’s yearly enterprise surveys changed considerably after 1992. In particular, the industrial disaggregation for regional data was reduced to cover only 15 manufacturing branches.

2. Concentration of industries

The purpose of this chapter is to set out the major characteristics of large Spanish sectors, as well as of Spanish manufacturing industries, with respect to their concentration pattern and their economic performance, in order to enter the results into the analysis of Spanish regions. Given the distortions of the various concentration measures stemming from the arbitrariness of any chosen benchmark, the analysis starts from a European perspective at the Spanish economy, and proceeds stepwise to more detail.

The analysis will rely mainly on simple Theil indices (as an absolute concentration measure), on weighted Theil indices referring to economic concentration (as a relative concentration measure), and on weighted Theil indices referring to topographic concentration. Correlation analyses will demonstrate the conformity of these measures with other, absolute and relative concentration measures.

2.1. Position of the Spanish economy in the European division of labor

Spatial concentration in the early 1980s

To get an idea of the spatial concentration of economic activity in Europe in the run-up of Spain's accession to the EU, two weighted Brülhart/Träger Theil indices are calculated: The first one employs area as a reference, the second aggregate economic activity. The two indices characterize spatial concentration of specific sectors from different angles: The first index is used to measure *topographic concentration* of both aggregate and sector-specific economic activities. The measure allows for assessing which sectors are more and which are less concentrated in space than economic activity as a whole. The second index measures *economic* concentration. It measures directly the deviation of the location pattern of a specific sector from that of aggregate economic activity but is not informative as to the direction of the deviation. The two Theil indices are decomposed by countries to distinguish between-country to within-country concentration patterns.[9]

The values obtained for the *topographic concentration* measure in 1980 are summarized in the upper panels of Table 2.1-1. The Theil value for topographic concentration of economic activity as a whole across the 118 EU15 regions is 0.69 which is at the lower end of the range of the index: If all economic activity would have been concentrated on a single square kilometre, the value had been 14.93 ("upper bound" in Table 2.1-1); if all economic activity would have been distributed uniformly across space, the value had been 0. Among the four sectors, manufacturing (0.74) and services (0.76) exhibited a slightly higher topographic concentration, while agriculture (0.27) was distributed more evenly across space. The

[9] The analysis is based on data on valued added by four sectors (agriculture, manufacturing, construction and services) in 118 regions from 15 EU countries (Hallet dataset). The data base covers the period 1980–1995. The spatial distribution of industries within the manufacturing and the service sectors will be analyzed in more detail in the subsequent scetions.

comparatively low extent of topographic concentration of economic activity indicates that the spatial division of labor within Europe was not too distinct in the early 1980.[10]

Table 2.1-1 — Topographic concentration of four sectors across 118 regions in EU15 countries 1980: Total, between and within components of Brülhart/Träger Theil indices, reference: area

Index-component/ Country-specific within	All sectors	Agriculture	Manufac-turing	Construc-tion	Services	upper bound
Total	0.69	0.27	0.74	0.59	0.76	14.9
Between	0.36	0.19	0.41	0.35	0.37	14.9
Within	0.33	0.08	0.33	0.24	0.37	—
Austria	—	—	—	—	—	—
Belgium	0.59	0.16	0.43	0.40	0.73	10.3
West-Germany	0.20	0.03	0.18	0.15	0.24	12.4
Denmark	—	—	—	—	—	—
Spain	**0.56**	**0.12**	**0.68**	**0.48**	**0.63**	**13.1**
Finland	—	—	—	—	—	—
France	0.55	0.06	0.52	0.42	0.67	13.2
Greece	—	—	—	—	—	—
Ireland	—	—	—	—	—	—
Italy	0.19	0.12	0.36	0.09	0.18	12.6
Luxembourg	—	—	—	—	—	—
The Netherlands	0.24	0.09	0.20	0.18	0.33	10.4
Portugal	0.45	0.13	0.48	0.34	0.58	11.4
Sweden	—	—	—	—	—	—
United Kingdom	0.47	0.16	0.41	0.40	0.54	12.4

About one half of the observed total topographic concentration of economic activity can be attributed to concentration at the country level: The ‘between’ component of the Theil index is 0.36, which is 53% of the total value. That is, given the regional grid used in the present investigation, only half of the observed topographic concentration of activities within Europe was due to the co-existence of city- and peripheral regions within the countries. The other half was due to differences in country-average densities of economic activity.[11] The differences between sectors in the between and within-country concentrations are notable: The landscape of agricultural production was dominated by differences in the concentration patterns between countries, indicating that in agricultural production the international division of labor was more significant than the interregional one: No less than three fourth of the total concentration (0.19/0.27) observed in agricultural production were due to differences between

[10] This general conclusion does not change fundamentally if the manufacturing sector is split up into 10 and the service sector into 5 industries. The Theil value does not exceed 1.2 in any of these manufacturing or service industries.

[11] The contribution Luxembourg to the between-country concentration measure in the geographic distribution is negligible. Note that the contributions of countries to the Theil measure are weighted by their relative size.

countries.[12] For the other sectors, the shares of the between components in total observed concentration were lower, ranging between 49% and 59%.[13]

The extent of the within-country concentration of economic activity differed by the factor of three between the countries. Belgium (0.59) exhibited the highest and Italy (0.19) the lowest spatial concentration (Table 2.1-1, lower panel). With a within value of 0.56, Spain was among the countries exhibiting the highest intra-national topographic concentration. The manufacturing and construction sectors were even higher concentrated than in any of the other countries under consideration. The high spatial concentration within Spain can be shown to be due to three regions:[14] Madrid, Cataluña (Barcelona), and Pais Vasco. Madrid in particular shaped significantly the economic landscape within Spain in all sectors except agriculture, while Cataluña and Pais Vasco featured a significant concentration of manufacturing industries.

Economic concentration in 1980 was generally much lower than topographic concentration in the three non-agricultural sectors (Table 2.1-2). None of these sectors deviated markedly from the distribution of overall economic activity. Only for agriculture the results suggest a somewhat higher "concentration" which, however, just reflects the fact that agricultural production usually takes place outside the economic centers.

Again, the total Theil values can be decomposed into within and between components to observe that economic concentration is a cross-regional rather than a cross-national phenomenon. In the manufacturing sector, e.g., differences between countries accounted for only about 19% of the total concentration measure (e.g., 0.006/0.031). Recall from Table 2.1-1 that the respective area-relative between components accounted for 49-59%. This difference suggests that there was no marked specialization of specific countries in any of the sectors. The sectoral shares by country corresponded very closely to the shares of overall economic activity.

There were, however, some differences between the distributions of sector-specific and total activities within countries, as indicated by the country-specific within components of the Theil index. As in topographic concentration, Spain was among the EU15 countries exhibiting the highest economic concentration in all four sectors (Table 2.1-2): Only in Belgium and France the distribution of sector-specific activities deviated stronger from that of total activity than in

[12] Again, this conclusion is subject to the definition of regions. A different result would probably obtain from a finer spatial grid that allows to observe the heterogeneity between cities and peripheral regions in more detail. Notetheless, recall from Appendix ?? that the weighted measure used in the present investigation is the best measure available, i.e., the measure that minimizes the bias resulting from incomplete information on intraregional heterogeneity.

[13] Figures of similar magnitude, which are not reported here, are obtained for all of the 10 manufacturing and 5 service industries distinguished in the underlying Hallett data set.

[14] Details are available from the authors upon request.

Spain. A closer inspection of the Spanish data indicates that manufacturing industries were over-represented in Pais Vasco and Cataluña but not in Madrid.

Table 2.1-2 — Economic concentration of four sectors across 118 regions in EU15 countries 1980: Total, between and within components of Brülhart/Träger Theil indices, reference: total value added

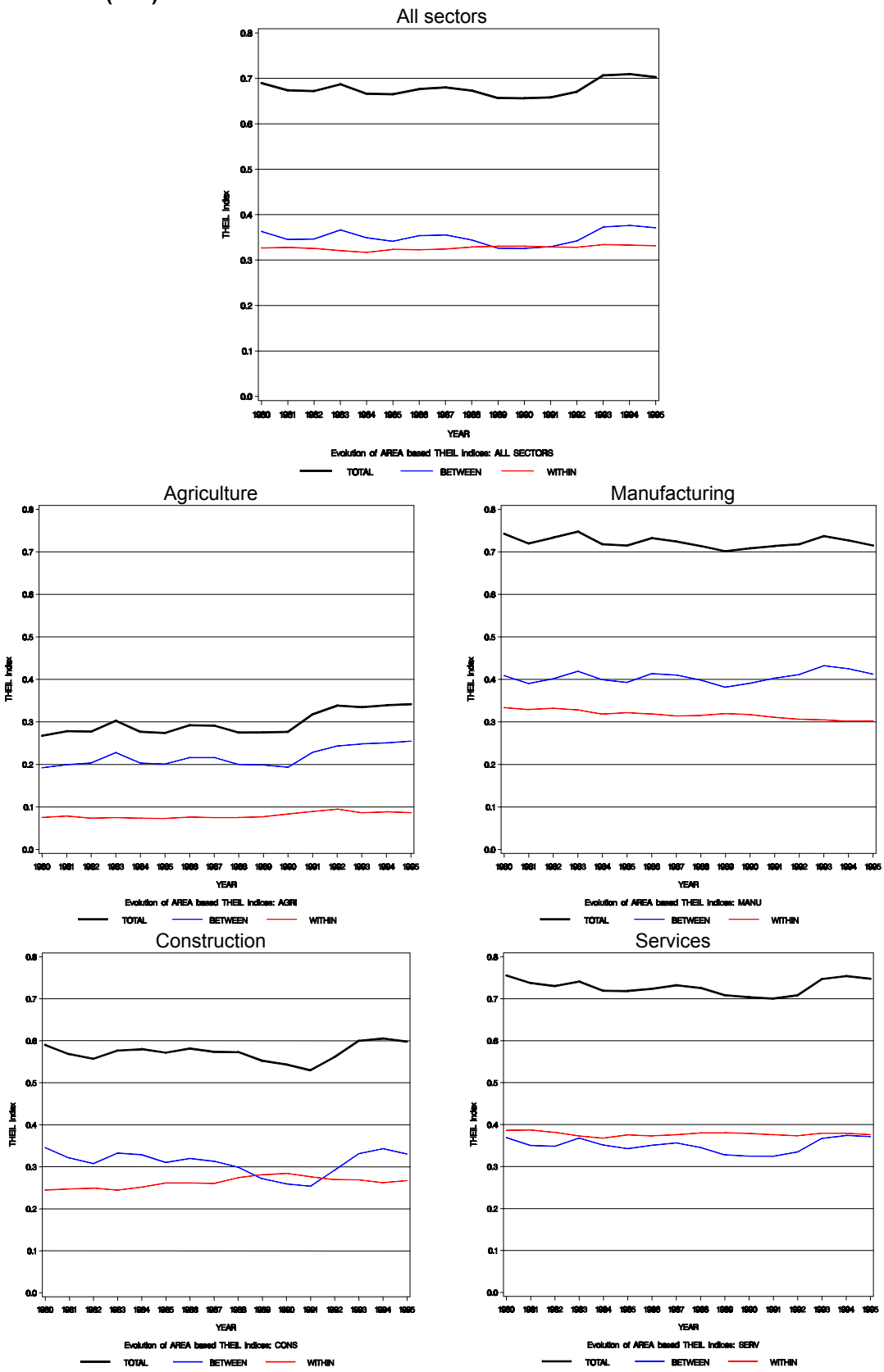
Index-component/ Country-specific within	All sectors	Agriculture	Manufac-turing	Construc-tion	Services	upper bound
Total	—	0.32	0.03	0.02	0.01	14.6
Between	—	0.15	0.01	0.00	0.00	14.6
Within	—	0.17	0.03	0.01	0.01	14.6
Austria	—	—	—	—	—	—
Belgium	—	0.30	0.02	0.02	0.01	11.3
West-Germany	—	0.17	0.01	0.00	0.00	13.2
Denmark	—	—	—	—	—	—
Spain	**—**	**0.26**	**0.05**	**0.02**	**0.01**	**12.0**
Finland	—	—	—	—	—	—
France	—	0.31	0.02	0.02	0.01	13.0
Greece	—	—	—	—	—	—
Ireland	—	—	—	—	—	—
Italy	—	0.14	0.06	0.04	0.01	12.7
Luxembourg	—	—	—	—	—	—
The Netherlands	—	0.10	0.07	0.03	0.02	11.6
Portugal	—	0.14	0.03	0.04	0.01	9.8
Sweden	—	—	—	—	—	—
United Kingdom	—	0.20	0.03	0.01	0.01	12.7

Evolution of spatial concentration 1980 – 1995

The evolution over time of the spatial concentration pattern of economic activity as a whole, and of the four sectors can be analysed by exploring the time series of the Theil indices measuring geographic and economic concentration. In the present investigation the focus is on changes in the topographic concentration because the reference (area) is constant over time. The evolutions of the Theil measures for topographic concentration are depicted in Figure 2.1-1. The first, upper graph shows the evolution of topographic concentration of economic activity as a whole as well as the respective within and between components. It indicates that economic activity in the EU as a whole tended to deconcentrate throughout the 1980s but to re-concentrate again in the early 1990s (see also Hallet 2002; Brülhart and Träger 2002).[15] The topographic concentration ended up at about the same level in the mid-1990s than it has had in the early 1980s. Both the decreasing topographic concentration during the 1980s and the increasing concentration in the early 1990s were driven by differences between countries, as the between-component of the index indicates. The level of concentration within countries did not change to a notable extent during the whole period under investigation, by contrast.

[15] Based on the Cambridge Econometrics data set, Brülhart and Träger (2002) report a similar evolution of the topographic concentration of total employment. The changes are, however, not statistically significant, as indicated by bootstrap tests.

Figure 2.1-1: Evolution of topographic concentration across 118 regions in EU15 countries by four sectors 1980–1995: Total, between and within components of Brülhart/Träger Theil indices 1980-1995, reference: area (km²)



The deconcentration in the 1980s was mirrored by all sectors except agriculture. The services and construction sectors, in particular, were distributed more evenly across space in the late 1980s than they had been in the early 1980s.[16] In both sectors, the driving forces were decreasing inequalities between countries: The country-average densities tended to become more similar over time (see also Brülhart and Träger 2002). The manufacturing sector showed a somewhat different evolution in two respects: First, its geographic deconcentration occurred at a slower pace. And second, the deconcentration of manufacturing was driven mainly by deconcentration within countries rather than between countries.[17] The country-specific within Theil values, which are not reported here in detail, indicate that manufacturing industries deconcentrated in most of the countries under consideration, except France and The Netherlands where there was some concentration going on in the early 1980s.

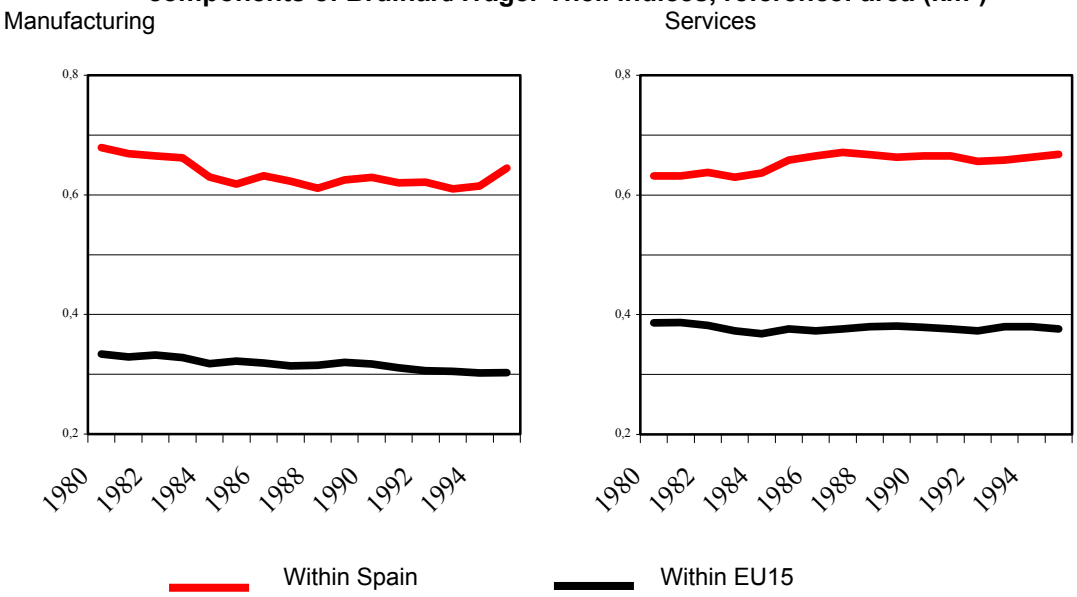
The re-concentration in the early 1990s was also mirrored by all sectors, including agriculture, and it was also driven by an increasing concentration at the country level in the first line. The process can be attributed to the German re-unification to a good deal. Experiencing a re-unification boom in the early 1990s, the (West-) German economy disconnected temporarily from the international business cycle which shows up as a rising concentration at the national level, as measured by the index.

The evolution of the topographic concentration of economic activity within Spain showed only minor differences to the respective evolutions within other countries. Figure 2.1-2 exemplifies the similarities for the two biggest sectors, manufacturing and services. The only notable difference is an increase in the topographic concentration of the Spanish service sector in the mid-1990 which was not matched by the service sectors in other countries.

[16] These results are broadly in line with those reported by Brülhart and Träger (2002) for sector-specific employment. The tendencies towards increasing topographic concentration of agriculture, and towards decreasing topographic concentration of manufacturing were even stronger in terms of employment than in terms of vale added. Both were found to be statistically significant by Brülhart and Träger (2002).

[17] In terms of exports, Brülhart (2001) reported no significant changes in the concentration patterns of industries at the national levels. In terms of employment, however, Brülhart and Torstensson (1998) and Brülhart (2001) reported evidence of an increasing concentration of manufacturing industries at the country level.

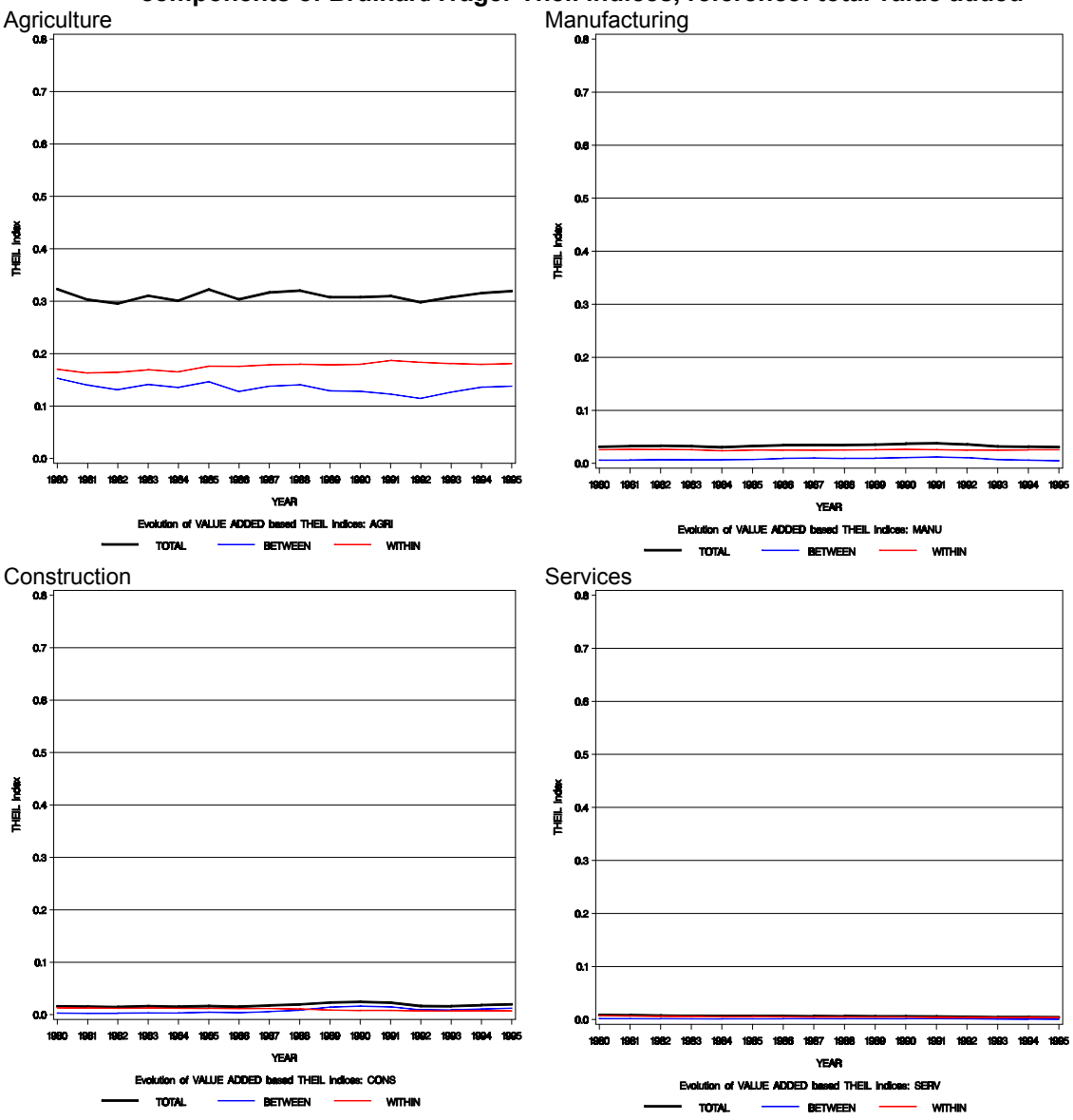
Figure 2.1-2: Evolution of topographic concentration of manufacturing and service sectors within Spain and within EU15 countries 1980–1995: within components of Brülhart/Träger Theil indices, reference: area (km²)



Turning to the evolution of economic concentration in Europe, as evidenced by value added-relative Theil indices (Figure 2.1-3), no significant changes could be observed. The only sector which, according to this measure, exhibits some economic concentration, is agriculture because agricultural production is concentrated outside the economic centers. The remaining sectors are distributed very much in line with economic activity as a whole. Consequently, both the levels and the changes in the respective economic concentration measures are negligible.

Summing up, Spain is found to be among the EU countries exhibiting the highest concentration of sectors, in terms of topographic concentration as well as in terms of economic concentration. In particular, the agricultural and the manufacturing sector are more concentrated than in most other EU countries. Still, the concentration was low regarding the range of values of the indices. Over time, concentration change of Spanish sectors occurred by and large in line with the overall European trends, with agriculture getting more concentrated, and with manufacturing getting less concentrated (the latter referring to area only). The Spanish services sector, different from the European trend, exhibited some increase of concentration (yet again, referring to area only).

Figure 2.1-3: Evolution of economic concentration across 118 regions in EU15 countries by four sectors 1980–1995: Total, between and within components of Brülhart/Träger Theil indices, reference: total value added



2.2. Concentration characteristics of sectors and industry groups in Spain

Trade theories and new economic geography hold that different types of sectors/ manufacturing industries shape regions in different ways. Most remarkably, the existence of increasing returns to scale (IRS) for specific industries, and the dependency of specific industries on the availability of specific highly localized resources are likely to affect the spatial allocation. Hence, in order to assess the impact of integration on regions that are differently equipped with sectors /industries at a given starting point, some preparative work on groups of sectors /industries with similar characteristics related to trade theory is required. Preferably, this identification of characteristic industry groups should be accomplished for all industries of the Spanish economy. Due to insufficiently disaggregated data for all other sectors, the classification is restricted here to the (88) industries of the manufacturing sector,

yet some broad concentration characteristics for the other sectors within Spain are offered before.

The concentration pattern differ remarkably between *sectors*. On the one hand, the agricultural sector proves to be highly concentrated in terms of relative concentration, i.e., compared to the distribution of overall employment, yet little concentrated in terms of absolute and topographic concentration (table 2.2-1). By contrast, credit and insurance services, other market services and manufacturing (as a whole) reveal to be concentrated in terms of absolute and topographic concentration, not in terms of relative concentration. The other services sectors and the building and construction sector are to be found somewhere between these extremes, yet more resembling the credit and insurance sector than the agricultural sector. The different messages between these indicators reflect the fact that manufacturing and services are where the people are (in urban areas with higher population densities), whereas agriculture is where the land is. Referring to the employment of people (i.e., to the relative concentration measures), the results show Spain to be an industrialized country with a broad dispersion of manufacturing, and also of sectors complementary to manufacturing or necessary for supplying basic needs like construction and most services sectors.

Table 2.2-1: Concentration of Spanish sectors in 1980

Economic sectors	Theil index	Weighted Theil index	Topographic Theil index
Agricultural, forestry and fishery products	0.4164	0.2810	0.1167
Manufacturing	0.4717	0.0301	0.6785
Building and construction	0.3921	0.0261	0.4766
Recovery, trade, lodging and catering services	0.3618	0.0419	0.5890
Transport and communication services	0.3879	0.0279	0.6407
Services of credit and insurance institutions	0.5020	0.0354	0.7807
Other market services	0.4710	0.0206	0.7300
Non-market services	0.4079	0.0578	0.5598

Source: Hallet (2000).

These messages from the chosen three concentration measures are confirmed when comparing them to other absolute and relative measures. Table 2.2-2 depicts the correlations between the various measures for the case of Spanish sectors – it reveals the high correlation between the absolute Theil and Herfindahl measures, on the one hand, and between the relative, weighted Theil and specialization measures, on the other hand. Moreover, it indicates a relatively high correlation between topographic and absolute measures.

The classification of groups of *Spanish industries* is conducted for the year 1978, the initial year of the database. It is based on three characteristics: (i) the dependency on *highly localized resource deposits* (drawing on an OECD, 1987, classification of resource intensive industries, yet applying it only to those industries where resources are localized and not

ubiquous; cf. Table A3-5 in Appendix 3), (ii) the existence of *internal IRS* (drawing on Pratten, 1988, who identified industries with different levels of technical IRS; cf. Table A3-4 in Appendix 3), (iii) the *observed concentration* in the initial year 1978, measured by a weighted Theil index – for comparison, the simple Theil and the topographic Theil index are also presented.[18]

Table 2.2-2: Correlation matrix for concentration measures of Spanish sectors in 1980 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.62789 (0.0070)	**0.97450 (<.0001)**	0.74226 (0.0006)	0.82911 (<.0001)
Weighted Theil index		1.00000	0.56715 (0.0176)	**0.94497 (<.0001)**	0.57880 (0.0149)
Herfindahl index			1.00000	0.69056 (0.0021)	0.76461 (0.0004)
Krugman index				1.00000	0.58725 (0.0132)
Topographic Theil index					1.00000

The classification proceeds in three steps yielding four groups of Spanish manufacturing industries (table 2.2-3):

- *Resource intensive industries*: includes all industries depending on highly localized resources, i.e., coal mining and coke ovens, iron and steel works, mining, production and transformation of non-ferrous metals and non-metal minerals, petroleum refining. These industries are usually characterized by high internal IRS. The observed concentration of these industries is usually quite high, which fits both traditional trade theory (more particularly, a Ricardo setting) and NEG.
- *High IRS industries*: includes the remaining industries as far as they reveal high internal IRS according to Pratten, i.e., aircraft industry, some branches of the chemical and machinery industries, automobile industry, office and computing machinery and electronic material industries, optical and professional instruments industries, some food industries. According to NEG, it is the existence of such internal IRS that also generates external IRS and acts towards a concentration of the respective industries. Different to such expectations, however, the observed concentration varies considerably from high to extremely low, and this is true for whatever measure is drawn upon.

[18] The reasons for deciding to use these indices to measure industrial concentration are laid down in section C.1.2.

Table 2.2-3: Groups of Spanish industries – Results of classification

Ind. Class	Manufacturing industries	Re-source depend.	Inter-nal IRS	Weight Theil index 1978	Theil index 1978	Topo-gr. Theil index 1978
	Resource intensive industries					
1140	COQUERIAS(1140)	1	high	1.997	1.998	2.974
1110-1130	COMBUSTIBLES SOLIDOS(1110-1130)	1	high	1.876	1.709	1.905
1220,1400	HIDROCARBUROS Y MINERALES RADIOACTIVOS	1	high	1.113	1.450	0.690
1300	REFINO DE PETROLEO	1	medium	1.092	0.932	1.023
21	MINERALES METALICOS(2110,2120)	1	high	1.024	0.928	0.785
2210-2230	SIDERURGIA Y PRIMERA TRANSFORMACION DEL HIERRO Y DEL ACERO(2210-2230)	1	high	0.893	1.119	2.059
2241-2249	PRODUCCION Y PRIMERA TRANSFORMACION DE METALES NO FERREOS(2241-2249)	1	high	0.242	0.554	0.696
	High IRS industries					
3820	AERONAVES(3820)	0	high	1.594	2.199	2.331
3300	MAQUINAS DE OFICINA	0	high	0.814	2.134	2.134
3511-3552	MATERIAL ELECTRONICO(3511-3552)	0	high	0.714	1.467	2.087
2513	QUIMICA INORGANICA(2513)	0	high	0.707	0.934	1.051
2516	FIBRAS ARTIFICIALES Y SINTETICAS(2516)	0	high	0.541	1.368	1.396
3910-3990	INSTRUMENTOS DE PRECISION, OPTICA Y SIMILARES(3910-3990)	0	high	0.428	1.279	1.945
2511,2512	PETROQUIMICA Y QUIMICA ORGANICA(2511,2512)	0	high	0.342	0.848	0.693
2410	MATERIALES DE CONSTRUCCION EN TIERRA COCIDA(2410)	0	high	0.272	0.466	0.233
3410-3460	MAQUINARIA Y MATERIAL ELECTRICO(3410-3460)	0	high	0.247	0.902	1.433
3610-3630	AUTOMOVILES, PIEZAS Y ACCESORIOS(3610-3630)	0	high	0.186	0.823	0.923
4211,4212	CACAO, CHOCOLATE Y PRODUCTOS DE CONFITERIA(4211,4212)	0	high	0.142	0.525	0.661
2421-2423	CEMENTOS, CALES Y YESOS(2421-2423)	0	high	0.126	0.491	0.456
	Footloose industries					
4260	SIDRERIA(4260)	0	low	2.579	2.373	3.343
4150	CONSERVAS VEGETALES(4150)	0	low	1.484	1.034	1.281
4200	AZUCAR(4200)	0	low	1.468	1.643	0.683
4160	CONSERVAS DE PESCADO(4160)	0	low	1.344	1.088	1.521
4241,4242	ALCOHOLES(4241,4242)	0	low	1.330	1.036	0.383
4290	TABACO(4290)	0	low	1.280	0.829	1.471
4510,452	CALZADO(4510,4520)	0	low	1.250	1.347	1.657
4660	INDUSTRIA DEL CORCHO(4660)	0	low	1.091	1.702	1.395
4110-4124	ACEITES Y GRASAS(4110-4124)	0	low	0.975	1.213	0.572
3710,372	CONSTRUCCION NAVAL(3710,3720)	0	medium	0.933	1.056	1.198
2536	ACEITES ESENCIALES Y AROMAS(2536)	0	low	0.892	1.403	1.377
4360	ACABADOS TEXTILES(4360)	0	low	0.858	2.149	2.058
4920	INSTRUMENTOS DE MUSICA(4920)	0	low	0.839	1.610	1.974
4243	LICORES(4243)	0	low	0.719	1.001	0.644
2541,2542	PRODUCTOS FARMACEUTICOS(2541,2542)	0	medium	0.653	1.630	2.113
4251-4259	VINO(4251-4259)	0	low	0.646	0.730	0.423
4941,4942	JUEGOS Y JUGUETES(4941,4942)	0	low	0.638	1.407	1.585
4311-4340	PREPARACION, HILADO Y TEJIDO(4311-4340)	0	low	0.607	1.699	1.559
4610	ASERRADO DE MADERA(4610)	0	low	0.601	0.643	0.566
2554	MATERIAL FOTOGRAFICO SENSIBLE(2554)	0	low	0.574	1.287	1.513
2514,2515	MATERIAS PLASTICAS Y CAUCHO	0	medium	0.531	1.293	1.330
4911,4912	JOYERIA Y BISUTERIA(4911,4912)	0	low	0.508	0.926	1.339
4371-4399	ALFOMBRAS Y OTROS(4371-4399)	0	low	0.492	1.406	1.466
4351-4354	GENEROS DE PUNTO(4351-4354)	0	low	0.481	1.410	1.382
4170	MOLINERIA(4170)	0	medium	0.470	0.415	0.043
3830,389	MATERIAL DE TRANSPORTE DIVERSO(3830,3890)	0	medium	0.463	1.288	1.840
1520	GAS(1520)	0	medium	0.462	1.472	1.717
4670	JUNCO, CA¥A, CESTERIA, BROCHAS Y CEPILLOS(4670)	0	low	0.458	1.068	1.110
4811-4819	TRANSFORMACION DEL CAUCHO(4811-4819)	0	low	0.448	0.819	1.345
3111,3112	FUNDICIONES METALICAS(3111,3112)	0	medium	0.445	0.948	1.592
4560	PELETERIA(4560)	0	low	0.442	1.111	1.516
2471-2479	PRODUCTOS CERAMICOS(2471-2479)	0	medium	0.422	0.956	1.113
4951,4959	MANUFACTURAS DIVERSAS(4951,4959)	0	low	0.337	1.146	1.443
4270	CERVEZA(4270)	0	low	0.330	0.782	0.931
2553-2559	OTROS PRODUCTOS QUIMICOS DE CONSUMO(2553-2559)	0	medium	0.319	1.198	1.564
2521,2522	ABONOS Y PLAGUICIDAS(2521,2522)	0	low	0.318	0.417	0.591
4410	CURTIDOS(4410)	0	low	0.313	1.086	1.281
4421-4429	CUERO(4421-4429)	0	low	0.306	0.759	0.834
2551,2552	JABONES, DETERGENTES Y PERFUMERIA(2551,2552)	0	medium	0.297	1.205	1.455
23	MINERALES NO METALICOS Y CANTERAS(2311-2399)	0	low	0.284	0.418	0.375
4930	LABORATORIOS FOTOGRAFICOS(4930)	0	low	0.273	0.863	1.329
3120,313	FORJA Y OTROS TRATAMIENTOS DE METALES(3120,3130)	0	medium	0.272	1.001	1.564

to be continued

Table 2.2-3 continued

Ind. Class	Manufacturing industries	Re-source depend.	Inter-nal IRS	Weight Theil index 1978	Theil index 1978	Topo-gr. Theil index 1978
3211,3212	MAQUINARIA AGRICOLA(3211,3212)	0	medium	0.260	0.459	0.369
4220	PRODUCTOS DE ALIMENTACION ANIMAL(4220)	0	low	0.240	0.478	0.264
16	AGUA(1600)	0	medium	0.230	0.311	0.370
2533,2534	PINTURAS, BARNICES Y TINTAS(2533,2534)	0	medium	0.229	1.103	1.447
3810	MATERIAL FERROVIARIO(3810)	0	medium	0.226	0.798	1.178
4710,472	PASTA PAPELERA, PAPEL Y CARTON(4710,4720)	0	low	0.225	0.983	1.152
4731-4739	TRANSFORMACION DE PAPEL Y CARTON(4731-4739)	0	low	0.211	0.801	1.147
3221-3299	MAQUINARIA INDUSTRIAL(3221-3299)	0	medium	0.192	0.866	1.325
4181-4239	PRODUCTOS ALIMENTICIOS DIVERSOS(4181-4239)	0	low	0.190	0.647	0.832
4741-4759	ARTES GRAFICAS Y EDICION(4741-4759)	0	low	0.181	0.825	1.293
4540	CONFECCION A MEDIDA(4540)	0	low	0.168	0.285	0.482
2531-2539	OTROS PRODUCTOS QUIMICOS INDUSTRIALES(2531-2539)	0	low	0.163	0.965	1.164
4131-4133	MATADEROS E INDUSTRIAS CARNICAS(4131-4133)	0	low	0.152	0.514	0.392
4821,4822	TRANSFORMACION DE MATERIAS PLASTICAS(4821,4822)	0	low	0.137	0.929	1.195
4531-4559	CONFECCION EN SERIE(4531-4559)	0	low	0.123	0.658	0.684
4191,4192	PAN, BOLLERIA, PASTELERIA Y GALLETAS(4191,4192)	0	low	0.121	0.357	0.349
3161-3169	ARTICULOS METALICOS(3161-3169)	0	low	0.118	0.687	1.131
3191,3199	TALLERES MECANICOS(3191,3199)	0	low	0.117	0.612	0.787
4620-4650	INDUSTRIA DE LA MADERA(4620-4650)	0	low	0.117	0.430	0.553
2431-2434	HORMIGON Y DERIVADOS DEL CEMENTO(2431-2434)	0	low	0.113	0.356	0.385
4681-4685	MUEBLES DE MADERA(4681-4685)	0	low	0.104	0.497	0.741
1510	ENERGIA ELECTRICA(1510)	0	medium	0.103	0.404	0.487
4141-4144	INDUSTRIAS LACTEAS(4141-4144)	0	low	0.099	0.395	0.592
4281,4282	BEBIDAS ANALCOHOLICAS(4281,4282)	0	low	0.093	0.472	0.716
2461-2465	VIDRIO Y SUS MANUFACTURAS(2461-2465)	0	medium	0.089	0.661	0.838
2440-2490	PIEDRA NATURAL, ABRASIVOS Y OTROS PRODUCTOS MINERALES NO METALICOS(2440-2490)	0	low	0.043	0.524	0.677
3141-3150	CARPINTERIA METALICA, ESTRUCTURAS Y CALDERERIA(3141-3150)	0	low	0.043	0.409	0.685

Source: INE, Encuesta Industrial (EIG).

- *Footloose industries*: includes all remaining industries, and assumes them to be footloose, as they owe none of the properties linking them to specific locations. Accordingly, their pattern of concentration should fit into a Heckscher-Ohlin setting. This large group is structured according to the observed degree of concentration:
    - Some industries are *concentrated*, i.e, several food industries, footwear industry, shipbuilding, the pharmaceutical industry.
    - Other industries are fairly *dispersed*, like several branches of the textiles industry, branches of the automotive and the chemical industry, gas supplies, foundries and metal finishing, rubber and plastic materials industries, ceramic, construction material and glass industries, water and electricity supplies, paper industries, branches of the machinery industry, clothing, wood and other consumption goods industries.

The two alternative concentration measures also presented in table 2.2-3 reveal a high overall similarity to the weighted Theil index, although differing considerably in specific cases. In fact, they exhibit high correlations with the weighted Theil index (table 2.2-2). Also, once more, the high correlation between different absolute measures (i.e, Theil and Herfindahl index), on the one hand, and different relative measures (i.e., weighted Theil index and Krugman index), on

the other hand, is confirmed. The results from other concentration measures thus largely support the impression drawn on the basis of the weighted Theil index.

Table 2.2-2: Correlation matrix for concentration measures of Spanish manufacturing industries in 1978 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.71234 (<.0001)	**0.96076 (<.0001)**	0.78459 (<.0001)	0.83660 (<.0001)
Weighted Theil index		1.00000	0.67245 (<.0001)	**0.94497 (<.0001)**	0.56280 (<.0001)
Herfindahl index			1.00000	0.72706 (<.0001)	0.79146 (<.0001)
Krugman index				1.00000	0.58030 (<.0001)
Topographic Theil index					1.00000

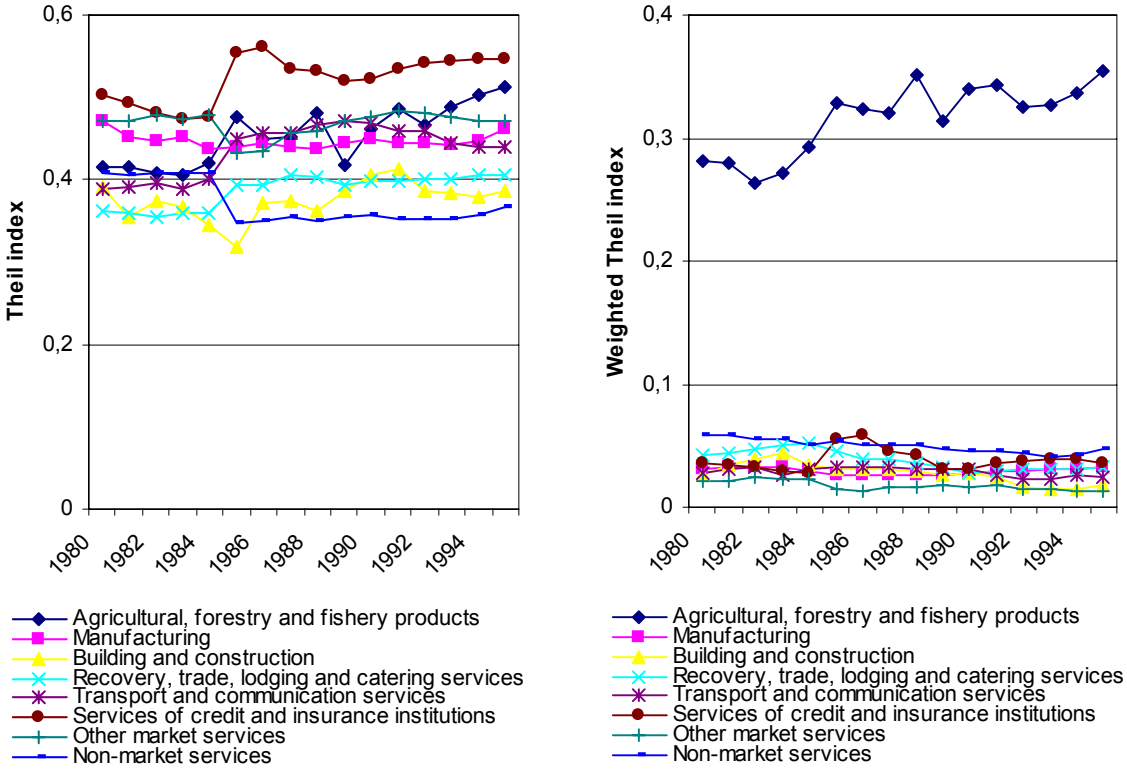
And this impression yields that the concentration of industries is not in all cases as one might expect it to be, given the characterization of these industries on the basis of indicators related to trade theory. On the one hand, drawing on NEG, one might expect all high IRS industries to be highly concentrated in the country's centers, yet in Spain several of these industries are not, like branches of the chemical, machinery industries, optical and professional instruments industry, automobile and electro-technical industry. On the other hand, drawing on Heckscher-Ohlin theory, one might expect such footloose industries as the food industries, ceramic and glass industries, paper, leather and wood industries to be fairly dispersed, yet again, in Spain, this is not always the case. Some of these are even quite highly concentrated like breweries, canned food, sugar, alcohol and tobacco industries, footwear industry and textile finishing – and this concentration is even more pronounced if referring to topographic areas instead of employed workers. Part of an explanation is that even in a deep sectoral breakdown like in the Spanish case of 88 manufacturing industries, these industries in some cases are not very homogenously defined. Take, for instance, the automobile industry: It does not only include the large automobile assembling plants concentrated at few locations, but also various component suppliers where plants are quite often small and dispersed. Another part of an explanation is that some industries are extremely narrow defined and are thus highly concentrated simply due to indivisibilities. Examples are in particular some food industries like breweries (Spanish: sidreria) that represent 727 persons employed, or less then 0.03 percent of Spanish manufacturing employment (in 1978) and is present in only 4 out of 18 Spanish regions.

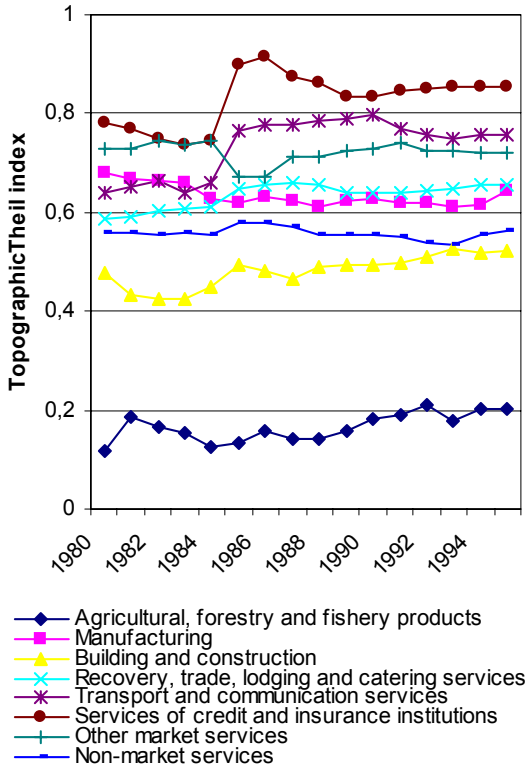
2.3. Evolution of concentration over time by sectors /industry types

Given these *groups of industries* with similar characteristics related to trade theory, the next questions concern their concentration behavior over time that may in turn shape the evolution of regions specialized on these group of industries: how do the identified resource intensive industries and the industries with high internal IRS develop? Do highly concentrated / highly dispersed industries get more concentrated or more dispersed during the observation period?

Before turning to analyze these question for the manufacturing industries, an overall assessment concerns the general concentration trends of *sectors*. Again, Theil indices weighted Theil indices, and topographic Theil indices are provided demonstrating the divergent messages from these concentration measures (figure 2.3-1): the high absolute and topographic concentration of some services and manufacturing, and the high relative concentration of the agricultural sector.

Figure 2.3-1: Evolution of concentration by economic sectors, value added





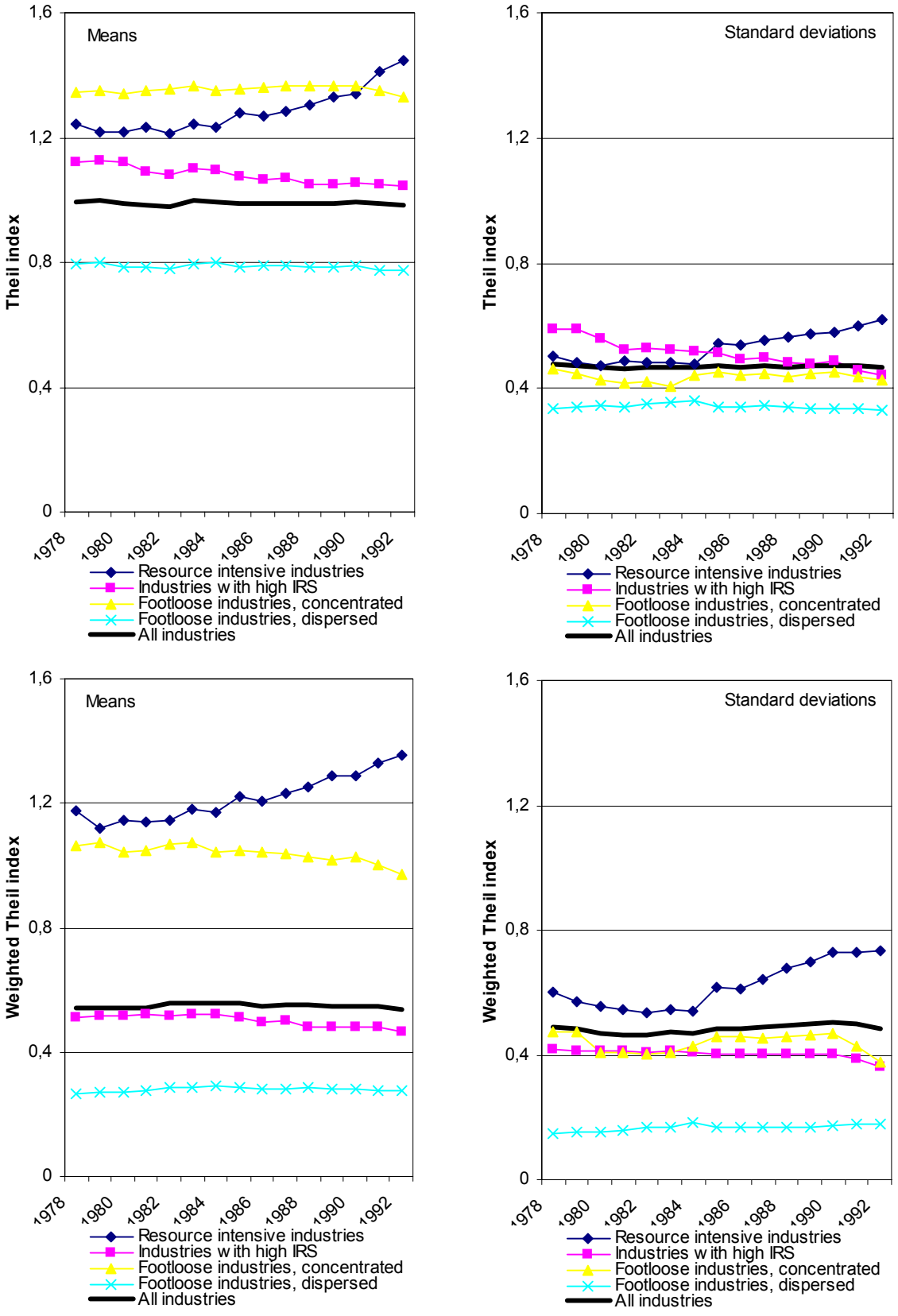
Source: Hallet (2000).

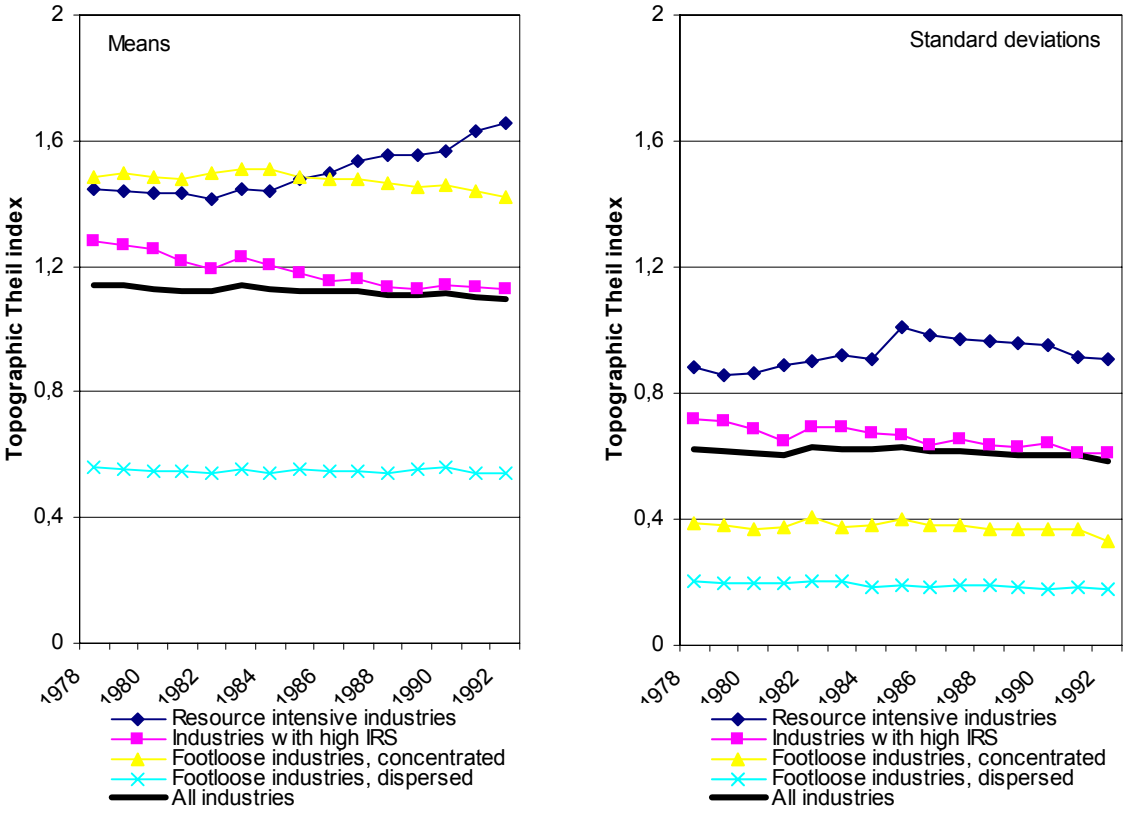
Over time, however, the messages of the three indicators are more coherent: If abstaining from the break in the data between 1985 and 1986,[19] there seems to be small change of the concentration of sectors, except for the agricultural sector whose concentration seems to have increased remarkably. Some services sectors (recovery, trade, catering and lodging, transport and communication services, other market services) and the building and construction sector exhibit concentration tendencies in terms of absolute and topographic concentration, but not in terms of relative concentration, indicating a concentration process in lockstep with a concentration of employed population.

The concentration behavior of *manufacturing industries* is also analyzed on the basis of weighted Theil indices in comparison to Theil indices and topographic Theil indices. To offer a comprehensive view on the evolution of all 88 industries without getting lost in details, means and standard deviations are calculated across industries for each industry group (figure 2.3-2). As discussed in the previous section, the figures demonstrate the high average concentration of resource intensive industries, the low average concentration of industries with internal IRS, the concentration degrees of concentrated and dispersed footloose industries in accordance to their definition, and the respective within-group variations of the industry groups.

[19] Cf. the comment in section C.1.2.

Figure 2.3-2: Evolution of industrial concentration by industry groups, employment





Source:INE, Encuesta Industrial (EIG).

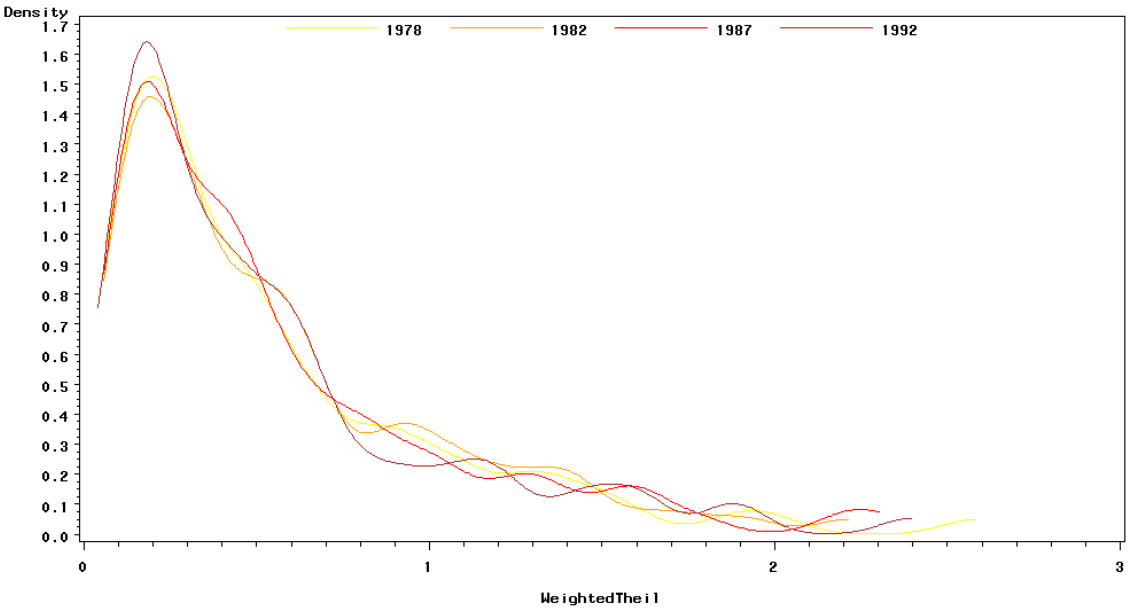
Over time, the average change across all industries is small, whereas the average change in most industry groups seems a bit more pronounced, and this holds true whatever indicator is applied.[20] Resource intensive industries reveal the clearest direction of change, their high concentration seems to increase further. The other industry groups seem to exhibit some convergence towards a similar concentration, as the concentration of highly concentrated groups decreases and that of lowly concentrated industry groups increases. Most pronounced, the concentration decrease of high IRS industries is expressed by the topographic measure indicating that this group not only tends to spread across the persons employed, but also across space. Also, slightly decreasing standard deviations for the group of high IRS industries and for the group of concentrated footloose industries indicate some tendency for within-group convergence.

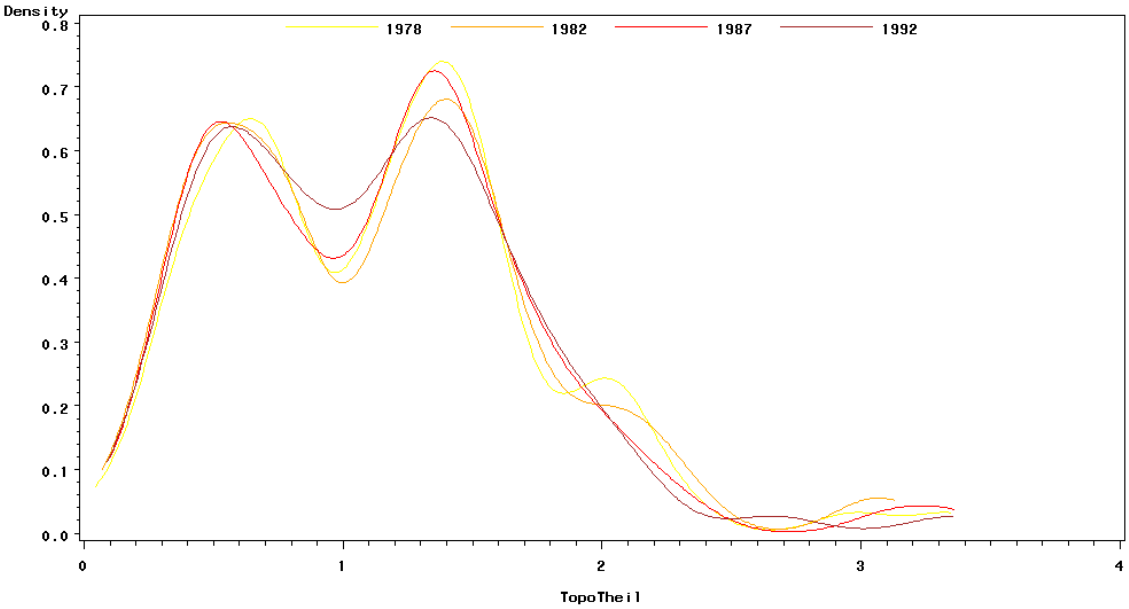
This impression of slow change of industrial concentration, as well as of some convergence of concentration degrees between industries is confirmed by kernel density functions of industrial concentration for several years (figure 2.3-3). According to such functions based on the weighted Theil index, the distribution of industrial concentration reveals a remarkable peak at a value of about 0.2 points. The distribution is skewed as there seem to be more

[20] To give an impression of magnitudes: A change of the weighted Theil concentration degree of 0.01 points is produced by a removal of about 1 percent of all persons employed in an industry from one region to another. The relationship is not linear and depends also on the absolute number of persons removed (cf. table A3-3in Appendix 3).

industries with higher than with lower concentration compared to the peak. However, based on the topographic Theil index, we get another impression: the distribution is two-peaked, one peak at a value of about 0.55 points, the other at a value of about 1.35 points. One explanation could be that, as in the case of sectors, there are industries more related to people and others more related to land. All of these may look similarly dispersed when referring to the employment weight, but fall apart when referring to topographic space: Some of them are concentrated in urban areas, e.g., IRS industries and several of the footloose industries. Others are localized in rural areas, which implies by itself a reduced topographic concentration, e.g., several footloose industries. *Over time*, there is not much change as to the positions of the peaks. Only in the case of the weighted Theil index, the peak gets lower from 1978 to 1982, and higher thereafter, and in the case of the topographic Theil index, the valley between the two peaks gets steeper from 1978 to 1982, and flatter thereafter. This indicates: no substantial change of the average concentration degrees of industries but perhaps a slight convergence of industries towards these average concentration degrees, at least since the 1980s.

Figure 2.3-3: Kernel density estimates of industrial concentration for various years





Source: INE, Encuesta Industrial (EIG).

2.4. Sectoral /industrial concentration and the performance of sectors /industries

At the end of this chapter, we turn to the question in how far the evolution of sectoral and industrial concentration is to the detriment or advantage of the Spanish economy – and may accordingly be also to the detriment or advantage of Spanish regions hosting these sectors /industries. Do concentration or dispersion trends coincide with growth or decline, with job gains or losses of respective sectors and industries?

Again, the first view is on sectors in Spain and their overall performance (table 2.4-1). During the observation period, other market services, non-market services, and recovery, trade and lodging services seem to grow the most quickly in terms of value added. By contrast, agriculture, and, to a lesser degree, manufacturing seem to drag behind. This is broadly in line with the well-known international trends of structural change from agriculture via manufacturing towards the services sector. Relating this information to the above notations on the concentration of sectors, it appears that concentration coincides with slow growth, and dispersion with quick growth, rather then the other way round. The impression is confirmed by correlation coefficients calculated across all sectors of the database (table 2.4-1): The correlation between initial concentration degree and subsequent performance is highly negative and significant when applying relative concentration measures (weighted Theil index or Krugman index), though insignificant when applying the topographic measure. Accordingly, sectors common to, and dispersed across, densely populated areas grow faster then sectors common to sparsely populated areas (e.g., in particular agriculture).

Table 2.4-1: Concentration and average annual growth rates of sectoral value added

Economic sectors	Relative concen-tration in 1980	Shares in 1980	1980-1985	1985-1990	1990-1995	1980-1995
Agricultural, forestry and fishery products	0.281	6.94	3.72	6.80	-6.95	1.01
Manufacturing	0.030	29.70	7.70	8.43	1.06	5.68
Building and construction	0.026	8.30	2.65	19.23	-0.09	6.93
Recovery, trade, lodging and catering services	0.042	17.93	9.63	12.84	2.23	8.14
Transport and communication services	0.028	5.67	6.82	10.61	6.13	7.84
Services of credit and insurance institutions	0.035	5.81	8.65	15.54	-1.10	7.48
Other market services	0.021	14.77	9.19	10.65	6.99	8.93
Non-market services	0.058	10.89	9.84	13.07	3.17	8.61
Total economy	.	100.00	7.89	11.51	2.29	7.16
Correlation between initial concentration (1980) and subsequent value added growth (1980-1995)						
Concentration measures	Pearson correlation coefficients			Error probabilities		
Theil index	-0.43339			0.0822		
Weighted Theil index	**-0.74147**			**0.0007**		
Herfindahl index	-0.43904			0.0779		
Krugman index	**-0.76303**			**0.0004**		
Topographic Theil index	-0.18336			0.4812		

Source: Hallet, revised and amended Eurostat figures.

Turning to employment figures for manufacturing industries (table 2.4-2), manufacturing as a whole obviously loses employment throughout the observation period. Yet this downward trend seems to be more moderate since the period of Spain's EU entry. Dispersed footloose industries and industries with high internal IRS experience the weakest job losses – even some job gains in the late 1980s. In analogy to the case of sectors, it seems thus that high concentration coincides with comparatively strong job losses (=relative decline of industries) and dispersion with weak job losses (=relative growth of industries). Calculations of correlation coefficients, however, show this trend to be weak and not significant (table 2.4-2).

Table 2.4-2: Concentration and average annual rates of change of industrial employment

Groups of industries	Relative concen-tration in 1978	Shares in 1978	1978-1982	1982-1987	1987-1992	1978-1992
Resource intensive industries	1.18	6.69	-1.74	-4.55	-5.42	-4.07
Industries with high IRS	0.51	15.25	-3.48	-2.39	-0.12	-1.90
Footloose industries, concentrated	1.06	15.24	-4.60	-3.89	-2.45	-3.58
Footloose industries, dispersed	0.27	62.83	-4.27	-1.73	0.76	-1.59
Total manufacturing	.	100.00	-4.03	-2.34	-0.16	-2.06
Correlation between initial concentration (1978) and subsequent employment change (1978-1992)						
Concentration measures	Pearson correlation coefficients			Error probabilities		
Theil index	-0.07430			0.4915		
Weighted Theil index	-0.16379			0.1273		
Herfindahl index	-0.10149			0.3468		
Krugman index	-0.20319			0.0576		
Topographic Theil index	-0.05344			0.6210		

Source: INE, Encuesta Industrial (EIG).

The general conclusion on industrial concentration is thus: With few exemptions, the Spanish sectors and industries appear *relatively equally concentrated* even in the initial year, and this pattern did not change much over 15 years. On the direction of the very slight change we may state, if anything: highly concentrated sectors and industries seem to get smaller relative to other sectors. Or, to put it more plainly, highly concentrated sectors and industries seem to retreat in some niches whereas the already quite dispersed sectors and industries increasingly dominate the scenery. *Increasing dispersion* tends to be a weak overall trend of the Spanish economy, particularly so in the later part of the observation period which happens to be the period shortly before and after Spain's EU entry.

3. Specialization of regions

3.1.1. Position of the Spanish economy in the European division of labor

To put the specialization patterns of Spanish regions into a broader, European perspective, this section will briefly describe the position of Spain as a whole, and of the Spanish regions within the EU-wide division of labor.

Investigating the national specialization patterns within the EU15 by means of the four sectors by an Brülhart-Träger Theil index (reference: value added at EU15 level) we find generally low levels of sectoral specialization throughout the EU (Figure 3.1-1). Even the highest Theil value of about 0.15, obtained for Greece in 1980, is very low, compared to the theoretical upper bound of the measure (about 15). The differences in the extent of specialization between the countries are mostly due to the specialization of Greece (GR), Ireland (IE) and Portugal (PT) in agriculture. In contrast to the other southern European countries with comparatively low per-capita income levels, the Theil value for Spain does not differ from the values for the highly developed northern European countries to a notable extent.

During the 1980s and early 1990s, the sectoral specialization of most European countries converged towards the EU average.[21] The only notable exception is Luxembourg (LU) which witnessed significant losses in manufacturing industries. The structural convergence towards the EU average seems to have been a general tendency in the 1½ decades under consideration.[22] The results do not unambiguously point to specific reasons: Neither was the convergence generally stronger for newcomers than for incumbent member states, nor was it generally stronger for poor than for rich countries.

The Spanish economy participated in the process of structural convergence within the EU, albeit less than proportionally. As Figure 3.1-2 shows, the comparison of just two points in time, 1980 and 1995, is somewhat misleading for Spain because a notable decrease in specialization in the early 1980. During most of the 1980s and the early 1990s, specialization of the Spanish economy evolved very similarly to that of richer incumbent member states like Germany, France, and the Netherlands (see Table A.?-1 in Appendix A? for more details): An increasing specialization during the 1980 was followed by a decrease in the early 1990s. This is – in addition to the generally lower degree of specialization – what distinguished Spain from other southern European countries, which experienced a continuous decrease in specialization during the entire period.

[21] Similar results are reported in Hallet (1999) for the same data set, employing a GDP-weighted average of regional specialization measures.

[22] There is, however, some empirical evidence suggesting that specialization of EU member states onto industries within the manufacturing sector increased during the 1980s (Amiti 1999).

Figure 3.1-1 Specialization of EU15 countries 1980 and 1995 – value added in 4 sectors relative to EU15

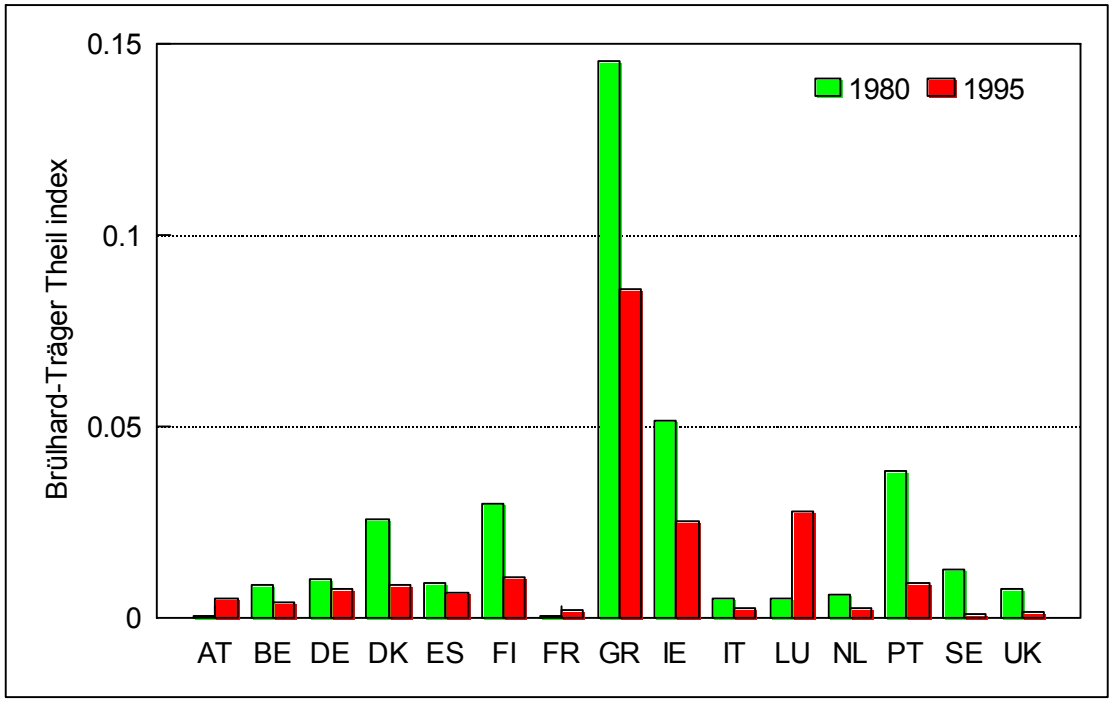
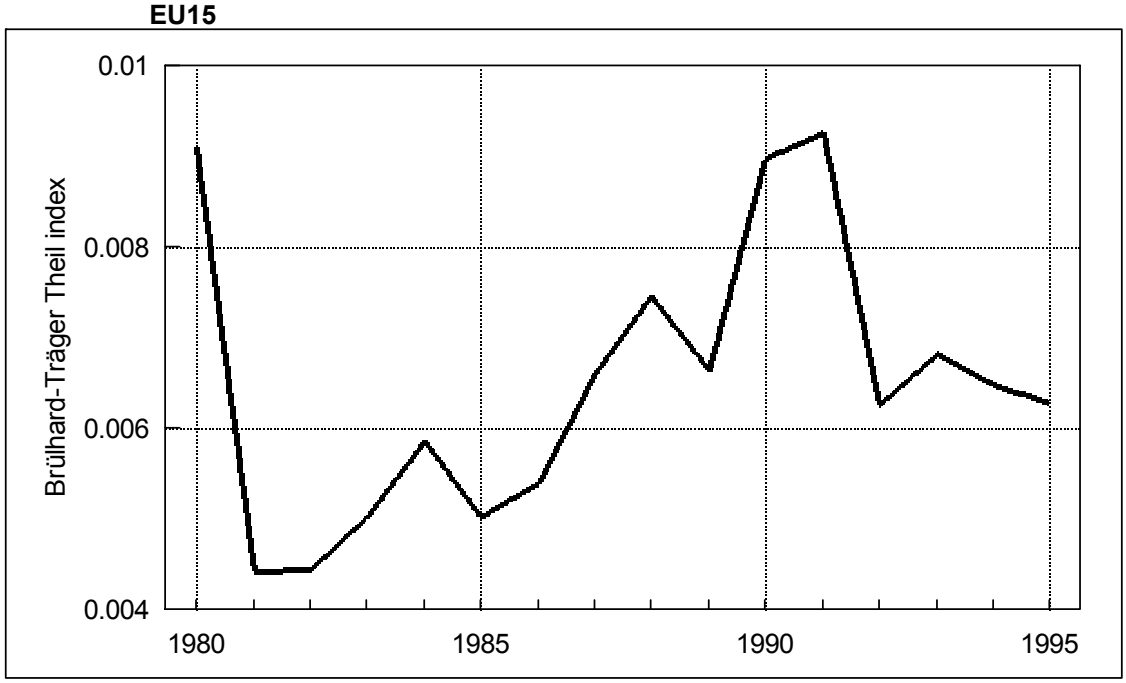


Figure 3.1-2 Specialization of Spain 1980–1995 – value added in 4 sectors relative to EU15



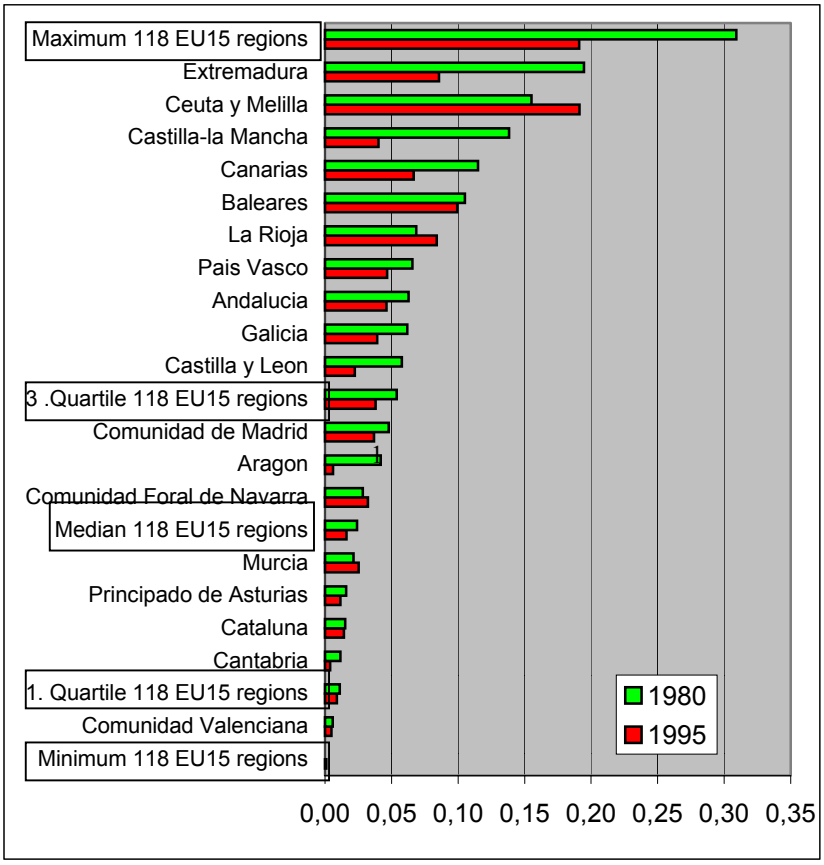
Specialization of Spanish regions

To assess the degree of specialization of the 18 NUTS 2 regions in comparison to all 118 EU 15 regions, the EU-relative weighted Theil index was calculated for each region. Figure 3.1-3 gives the values of the Theil index in 1980 and 1995 for each of the 18 Spanish regions. For comparison, Figure 3.1-3 also reports the quartiles of the distribution of the Theil indices across all 118 EU15 regions. The Figure shows that in 1980 13 of the 18 Spanish regions

exhibited a degree of specialization above the EU15 median. 10 of them fell into the highest quartile, i.e. were among the 25% regions with the highest degree of specialization. This comparatively strong specialization seems to contrast with the low specialization level of Spain as a whole within Europe. However, most of the highly specialized regions are fairly small. Consequently, their influence onto the national specialization pattern is low.

As to the evolution over time, most Spanish regions experienced decreasing specialization during the period under investigation (1980–1995),[23] as did Spain and the EU15 as a whole.[24] The only notable exception is Ceuta y Melilla, two small enclaves at the African coast.

Figure 3.1.1-3 Specialization of Spanish regions 1980 and 1995 – value added in 4 sectors relative to EU15



As to the evolution over time, most Spanish regions experienced decreasing specialization during the period under investigation (1980–1995), as did Spain and the EU15 as a whole.[25] The only notable exception is Ceuta y Melilla, two small enclaves at the African coast.

[23] For similar results, see Paluzie et al. (2001).

[24] See Figure A?-2 in the Appendix for more detailed plots of the evolutions of specialization by Spanish regions over time.

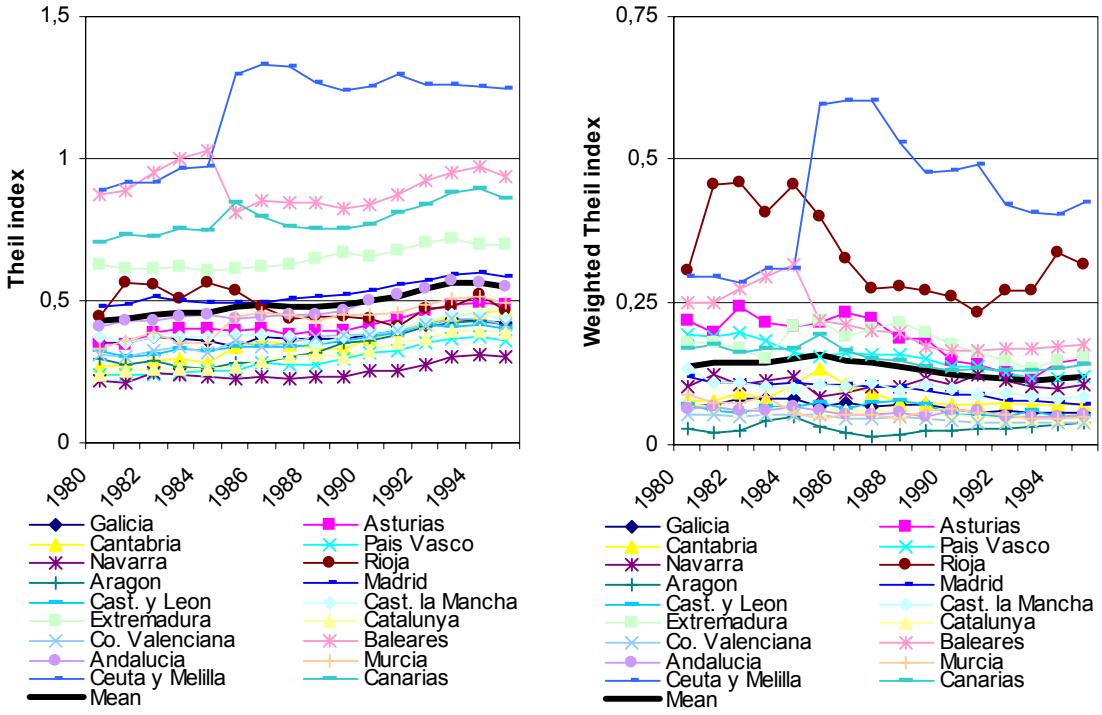
[25] See Figure A3-2 in the Appendix 3 for more detailed plots of the evolutions of specialization by Spanish regions over time.

3.1.2. Overview on the specialization of Spanish regions

As an introduction to the specialization part of the paper, an overview on the specialization pattern of *all* 18 Spanish regions is provided, whereas in the following parts the focus will be on *classes of regions* with typical attributes in order to get more insights into the forces driving specialization.

Figure 3.1.2-1 presents the absolute and relative specialization of Spanish regions referring to the 17 *sectors* of the Hallet data set, as measured by Theil indices and weighted Theil indices. The figure indicates most Spanish regions to be similarly specialized. A higher degree of specialization is to be observed in particular for Ceuta y Melilla, the small enclaves on the African continent made up of two small towns. Also, the Baleares and the Canarias are shown to be more specialized than the other regions in terms of absolute specialization, whereas Rioja is shown to be more specialized in terms of relative concentration. That is to say, the Baleares and Canarias are shaped by a predominance of some sectors (e.g., recovery, trade, catering and lodging services) and an almost complete lack of others (e.g., metal producing, transport equipment producing), whereas Rioja is shaped by a high localization of some industry (food producing) in this very region.

Figure 3.1.2-1: Specialization of Spanish regions, sectors 1980-1995



Source: Hallet, revised and amended Eurostat figures.

Over time, absolute specialization seems to increase in most regions while relative concentration seems to remain constant or even to decrease.[26] Thus, there is an overall Spanish trend towards an increase of specialization, due to the (absolute and topographic) concentration of services (cf. section C.2.2).

These results for the Theil and weighted Theil indices are confirmed by similar results for respective other absolute and relative specialization measures. Table 3.1.2-1 depicts the high and significant correlation between absolute Theil and Herfindahl indices and relative weighted Theil and Krugman indices.

Table 3.1.2-1: Correlation matrix for measures of sectoral specialization of Spanish regions in 1980 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	0.64881 (0.0036)	**0.96268** **(<.0001)**	0.7004 (0.0012)
Weighted Theil index		1.00000	0.62372 (0.0057)	**0.95495** **(<.0001)**
Herfindahl index			1.00000	0.67979 (0.0019)
Krugman index				1.00000

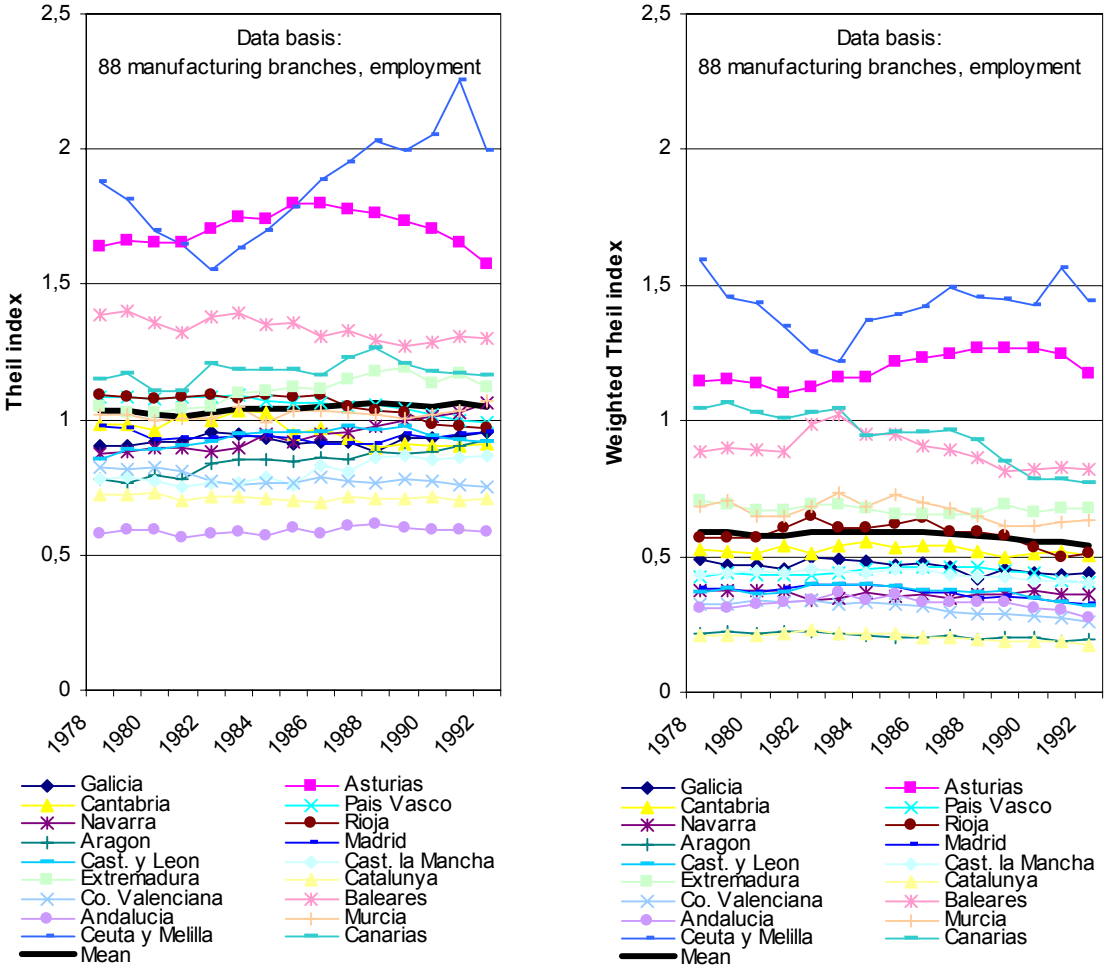
Source: Hallet, revised and amended Eurostat figures.

The general assessment of the specialization of all Spanish regions on large sectors is now supplemented by a glance on their specialization regarding *manufacturing industries*. For comparison, Theil indices and weighted Theil indices are provided and visualized in figure 3.1.2-2.

The graphs show a bulk of Spanish regions to exhibit resembling degrees of specialization around 0.95 points for the Theil index, and around 0.4 points for the weighted Theil index. Both indicators also find some outliers with considerably larger specialization degrees, e.g., Ceuta y Melilla and Asturias. By and large, both indicators come up with similar rankings of regions according to their specialization. Only some regions (like the populous regions Madrid and Cataluña, and the less populous Aragón) appear a bit less specialized as compared to the bulk of regions when applying the weighted Theil index, and some regions (like the small regions Ceuta y Melilla, Baleares, Canarias and Murcia, and the large region Andalucía) appear a bit more specialized. The similarity of results is confirmed by high correlations between all specialization measures, but most particularly between the two absolute measures (Theil and Herfindahl index) and the two relative measures (weighted Theil index and Krugman index; table 3.1.2-2).

[26] Again, the break in the data between 1985 and 1986 is abstained from.

Figure 3.1.2-2: Specialization of Spanish regions, manufacturing industries 1978-1999



Source: INE, Encuesta Industrial (EIG).

Over time, the major impression is that overall changes are small (c.f. in particular the evolution of the mean of all regions).[27] In terms of all indicators, regional specialization, on average, almost does not change at all. Only some regions, like Ceuta y Melilla and the Baleares, exhibit pronounced movement over time. For these small regions even slight changes within one industry yield large reactions on the side of the specialization index. Also, the standard deviation across all regions does not change much. As to the direction of this almost imperceptible change, however, there is a difference between unweighted Theil / Herfindahl index, on the one hand, and weighted Theil index / Krugman index, on the other: Whereas the former exhibit a very slight tendency towards an increase of specialization, the latter exhibit an a bit more explicit tendency towards a decrease of specialization. This could be interpreted – if the effects were not this small – to indicate an increase of specialization of the average Spanish region as to the EU and the rest of the world, yet a decrease of specialization, i.e., an increase of coherence, among Spanish regions.

[27] To give an impression of magnitudes: A change in the Theil concentration degree of 0.01 points is produced by a removal of about 1 percent of all persons employed in a region from one industry to another. The relationship is not linear and depends also on the absolute number of persons removed (cf. table A3-3 in Appendix3).

Table 3.1.2-2: Correlation matrix for measures of industrial specialization of Spanish regions in 1978 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	0.93046 (<.0001)	**0.95735 (<.0001)**	0.91517 (<.0001)
Weighted Theil index		1.00000	0.87587 (<.0001)	**0.97819 (<.0001)**
Herfindahl index			1.00000	0.84039 (<.0001)
Krugman index				1.00000

Source: INE, Encuesta Industrial (EIG).

To sum up, a cautious conclusion is that specialization of Spanish regions seems to be moderate and that there seems to be no clear tendency for it to increase or decrease during the observation period of growing EU integration. Moreover, for neither indicator, a pushing influence of major integration steps on specialization (e.g., Spain's EU entry in 1986) becomes obvious. Yet, this overall conclusion overrides considerable variation between the regions, which gives rise to expectations on perhaps more conclusive results for specific groups of regions.

3.2. Classes of regions and their characteristics

In order to analyse the specialization pattern of Spanish regions according to their specific sectoral characteristics, *types of regions* with similar structural composition are identified by means of a cluster analysis drawing from the above classification of industries. For the years 1978 and 1980, respectively, the initial years of the data bases, eleven discriminating variables are applied: (i) seven variables characterizing each region's structural composition with respect to economic sectors (i.e., each region's value added shares of the agricultural, the construction, and five services sectors), and (ii) four variables characterizing each region's structural composition within the manufacturing sector with respect to industry groups (i.e., each region's employment shares of resource intensive, high IRS, concentrated footloose, and dispersed footloose industries).

Applying a Ward's minimum cluster analysis (based on standardized values for each variable, six types of Spanish regions can be distinguished. Although classified solely according to their structural composition, several of them exhibit further common characteristics, e.g., with respect to their geographic situation and their level of economic development. This observation by itself indicates the spatial reference of a region's industrial mix, and allows labeling these type classes with some associative names (cf. table 3.2-1, figure 3.2-1) :

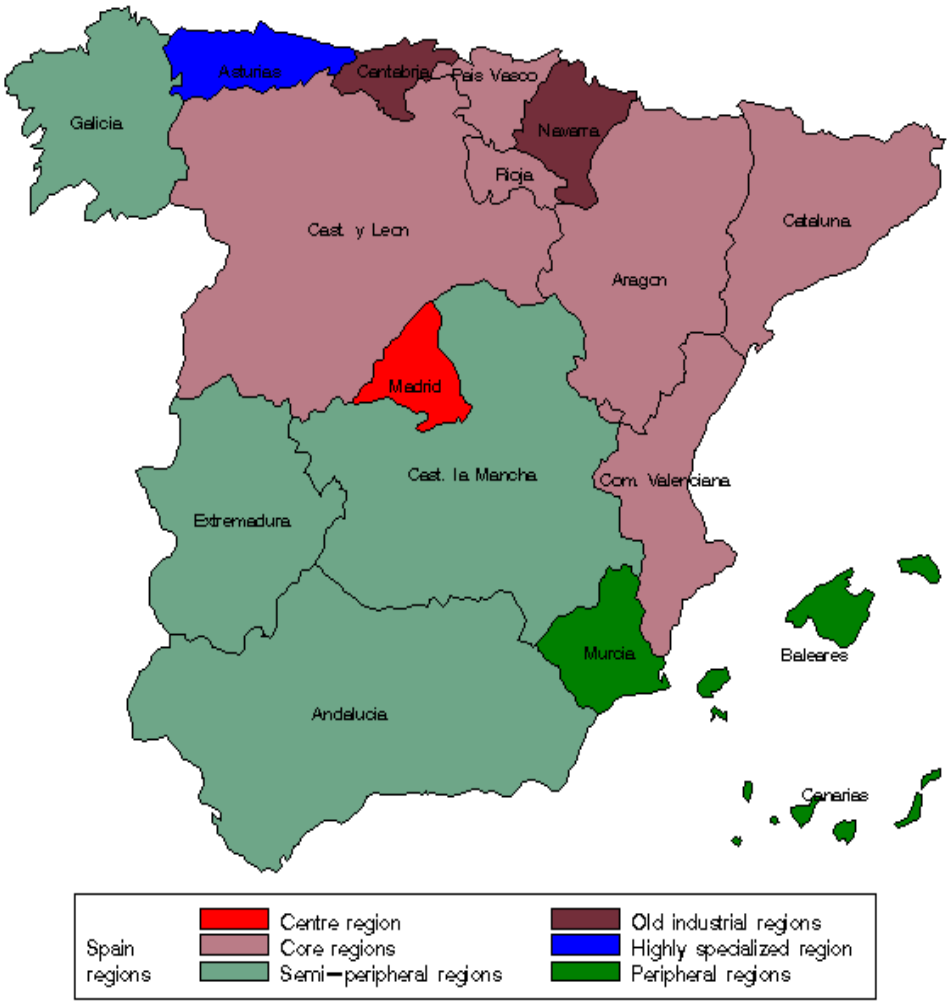
- *Highly specialized region*: is characterized by the extreme specialization on very few industrial branches, includes the coal and iron-and-steel region Asturias.

Table 3.2-1: Classification of Spanish regions

Regions	Agriculture	Building and construc-tion	Recovery, trade, lodging and catering	Transport and communi-cation	Credit and insurance	Other market services	Non-market services	Manufac-turing	Resource intensive industries	Industries with high IRS	Concen-trated footloose industries	Dispersed footloose industries
	Shares in percent of total economy (value added)								Shares in percent of total manufacturing (employment)			
						Highly specialized regions						
Asturias	5.06	8.32	16.59	4.85	4.75	11.67	10.75	**43.07**	**54.03**	3.10	6.45	36.42
						Old industrialized regions						
Cantabria	6.80	6.16	16.88	**6.75**	5.13	13.30	10.63	**41.15**	**16.38**	**18.14**	11.96	53.52
Navarra	7.70	7.03	13.50	**8.28**	4.18	12.23	9.12	**45.67**	**6.84**	**18.79**	13.92	60.45
						Centre region						
Madrid	0.55	7.72	17.71	7.45	**9.12**	**20.02**	**14.56**	23.42	1.04	**29.67**	6.02	63.26
						Core regions						
PaisVasco	2.81	4.98	13.11	4.36	5.05	13.59	7.64	51.28	13.98	14.53	5.74	65.76
Rioja	9.51	6.86	12.10	4.10	5.75	10.67	8.66	51.86	0.38	7.08	33.05	59.49
Aragon	11.00	7.69	16.56	4.86	5.77	13.41	10.80	40.91	6.43	15.29	8.40	69.88
Castilla yLeón	12.39	8.09	16.24	5.28	5.38	12.93	11.70	40.38	9.64	18.55	9.45	62.36
Cataluña	3.32	7.67	16.11	4.90	6.36	15.90	6.77	42.29	1.56	17.68	17.22	63.53
Co. Valenciana	6.10	8.72	19.44	5.22	5.24	15.96	9.55	35.86	2.64	7.54	20.74	69.08
						Semi-peripheral regions						
Galicia	**11.97**	**10.29**	18.40	5.27	5.44	11.74	**11.64**	37.23	4.18	12.02	**23.90**	59.90
Castilla la Mancha	**17.51**	**9.89**	14.57	5.11	4.41	10.45	**10.57**	45.00	3.03	14.67	**17.30**	65.01
Extremadura	**17.48**	**10.33**	20.03	4.86	5.79	12.80	**16.13**	30.05	1.93	3.43	**19.82**	74.82
Andalucía	**11.51**	**10.02**	18.90	5.71	4.37	12.81	**14.67**	33.52	5.06	12.25	**23.05**	59.63
						Peripheral regions						
Baleares	3.79	7.76	**42.48**	5.52	5.17	16.34	6.88	15.84	0.36	2.51	**28.58**	68.56
Murcia	8.43	8.65	**15.93**	7.38	4.01	13.50	10.44	40.09	4.89	5.13	**29.95**	60.03
Canarias	8.25	9.89	**29.22**	8.02	4.56	15.70	12.86	19.74	4.96	6.33	**24.18**	64.53
Ceuta y Melilla	1.17	10.16	**31.92**	7.83	5.46	11.05	22.56	11.02	0.00	5.66	**25.82**	68.52
						Total						
Spain	6.94	8.30	17.93	5.67	5.81	14.77	10.89	29.70	6.69	15.25	15.24	62.83

Source: Hallet. – INE, Encuesta Industrial (EIG).

Figure 3.2-1: Spanish region classes



- *Old industrialized regions*: characterized by relatively high shares of manufacturing, with a focus on resource dependent and on high IRS industries; contains Cantabria and Navarra. These regions are situated at the north of Spain, close to the border of France, and they are thus the most central Spanish regions viewed from a European perspective.
- *Center region*: characterized by relatively high shares of credit and insurance and other market and non-market services, of intermediate and high IRS industries; contains the country's capital region Madrid.
- *Core regions*: characterized by shares close to average for all sectors and branches, could almost be taken as median regions; contains País Vasco, Rioja, Castilla y León, Communidad Valenciana, Aragón and Cataluña. These regions are situated in a belt stretching from north west to east Spain between the old industrialized regions and the center region.

- *Semi-peripheral regions*: characterized by relatively high shares of agriculture, and relatively high shares of concentrated footloose industries; contains Galicia, Extremadura, Castilla la Mancha, and Andalucía. These regions are situated in the south and the utmost west of the country.
- *Peripheral regions*: characterized by relatively high share of recovery, trade and lodging services, and a high share of concentrated footloose industries; contains the Baleares, Murcia, Ceuta y Melilla and the Canarias. These are regions that are small, very distant from the center and particularly well-known as holiday regions.

All in all, this specialization pattern of Spanish seems to imply the spatial structure of Spain still being significantly shaped from the industrialization process that spread from central Europe across the Spanish border and proceeded stepwise further southwestwards (cf. Rosés 2003).

3.3. Evolution of specialization over time by region classes

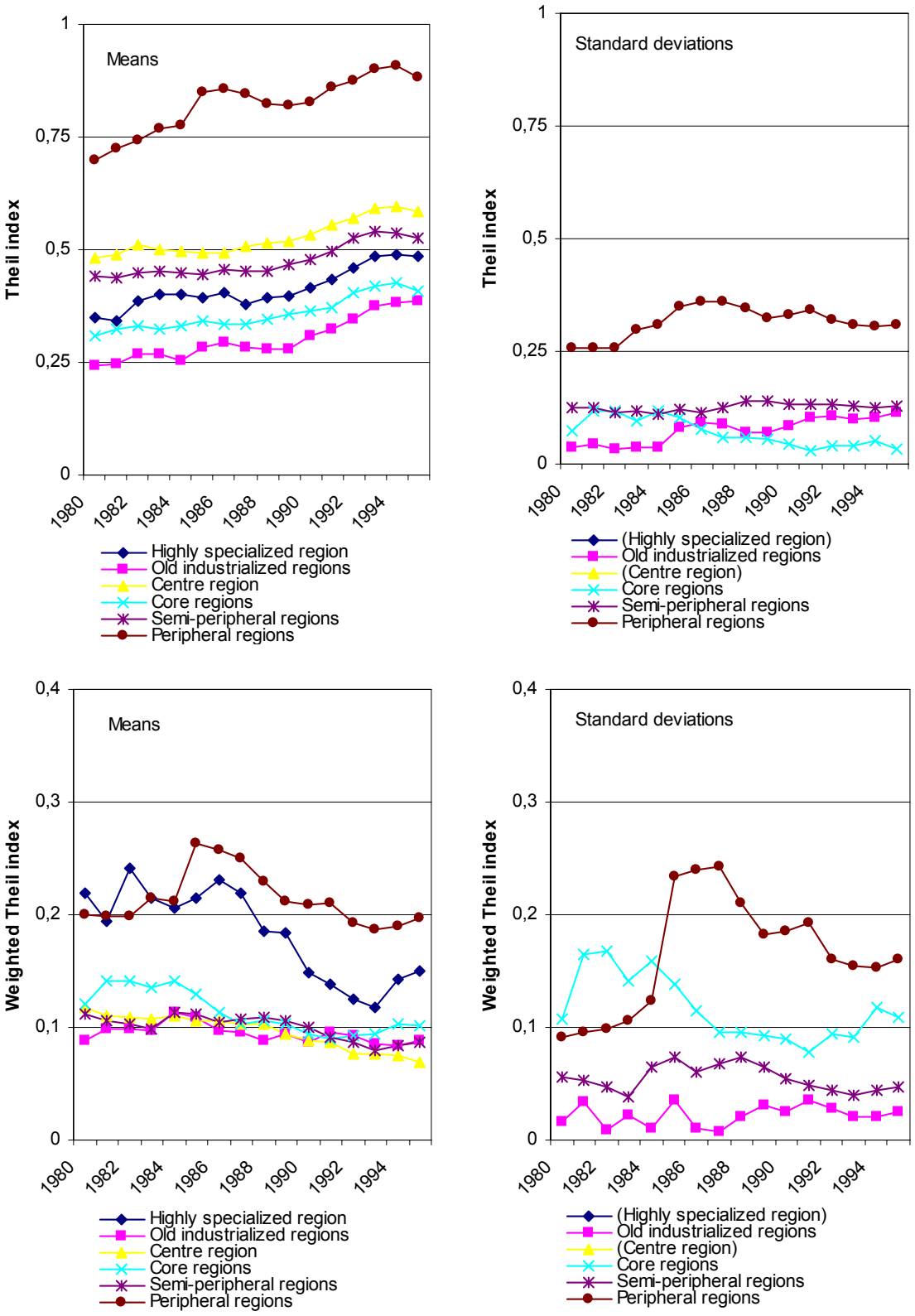
As trade theories hold that the initial structural mix of a region matters for its further economic development, the evolution of regional specialization within these classes of regions should reveal similar characteristics. Questions are, what region classes get more specialized, what more diversified, over the observation period of 15 years? Do regions of a region class exhibit a characteristic evolution distinct from other region classes? What interaction is there in space between different region classes with respect to specialization?

Regional specialization is once again analyzed by means of the Theil and weighted Theil index. On the basis of these indicators, means and standard deviations for region classes are calculated over time.

Figure 3.3-1 presents these class means and standard deviations referring to *sectors*. Accordingly:

- the peripheral regions (including the off-shore regions of Spain plus Murcia) and the highly specialized region (Asturias) exhibit the highest specialization degrees – though the latter only in terms of relative specialization, owing to the localization of the manufacturing sector in this region;
- all regions seem to envisage an increase of absolute specialization during the observation period, yet a decrease of relative specialization, indicating an increase of specialization for Spain as a whole, whereas the specialization pattern of the region classes seem to converge to similar specialization degrees.

Figure 3.3-1: Evolution of regional specialization by classes of Spanish regions, sectors

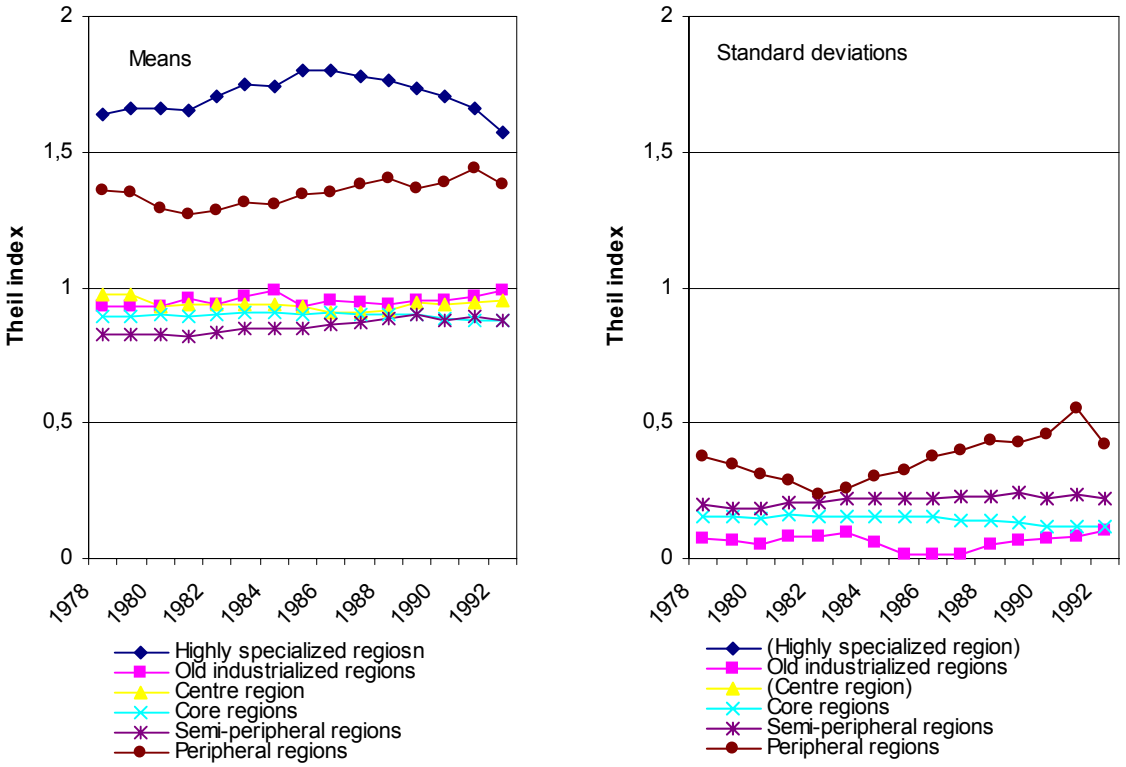


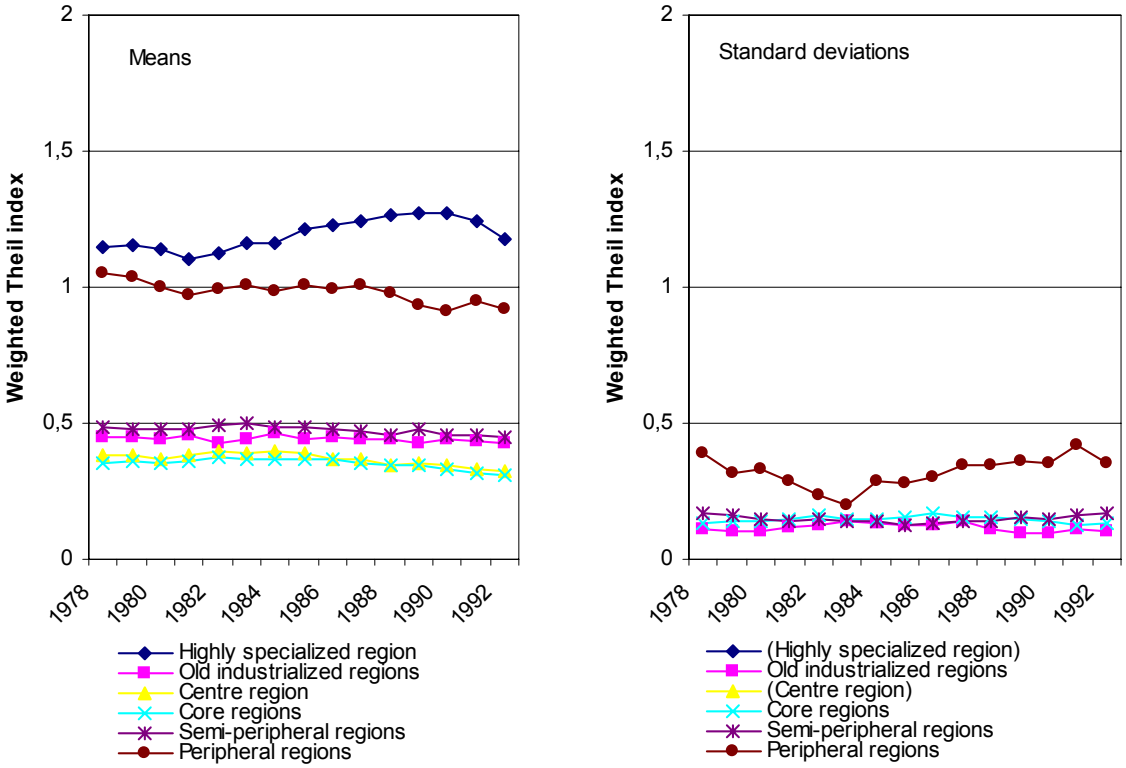
Source: Hallet, revised and amended Eurostat figures.

To complete the pattern of specialization for region classes, figure 3.3-2 presents means and standard deviations of specialization measures referring to *manufacturing industries*. Quite broadly, the results are here:

- Apart from the highly specialized region, only one region class exhibits remarkably high average specialization, namely the peripheral regions. All other region classes exhibit very similar and significantly lower average specialization. The ranking of these other region classes differs between absolute or relative specialization measures: the former puts the centre region in first place, semi-peripheral regions in the last, the latter does it the other way round. The standard deviations of these region classes are low, indicating the homogeneity of the classes.
- The specialization of most region classes changes little over time, yet some movement is to be observed for highly specialized and peripheral regions. As to the direction, the results differ between the absolute and relative indicators. The absolute indicators seem to show inverted-U-type / U-type evolutions of highly specialized / peripheral regions, and a slight *increase* of specialization for all other region classes. By contrast, the relative indicators seem to show a slight specialization decrease for peripheral regions, no clear direction for the highly specialized region, and a slight *decrease* of specialization for all other region classes. For all indicators, the standard deviations of the region classes reveal some movement but no marked direction of change.

Figure 3.3-2: Evolution of regional specialization by classes of Spanish regions, manufacturing industries





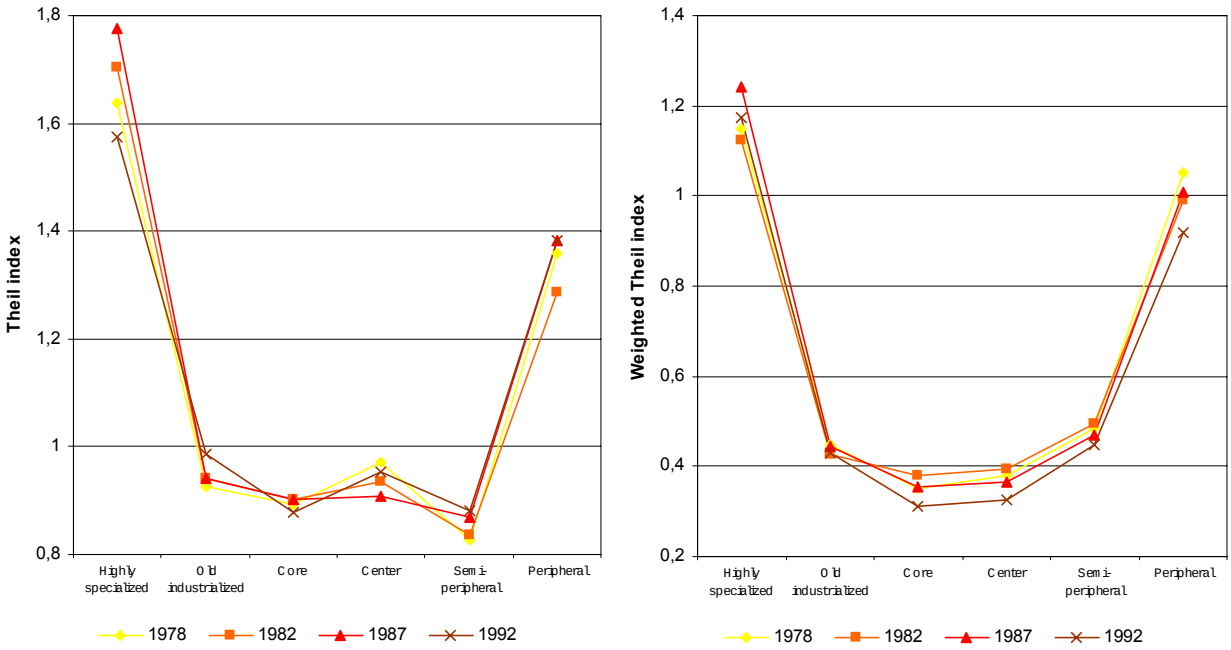
Source: INE, Encuesta Industrial (EIG).

The same issue is addressed from a different angle in figure 3.3-3 that visualizes the specialization and diversification relations in space. Again, average specialization measures for region classes are displayed. The region classes are, however, arranged according to their approximate topographic situation from north east to south west of Spain. If only focusing on the absolute measures, the Theil index, this figure seems to tell an appealing story: Regional specialization is high at the periphery of the country, and it is elevated at the center, whereas it is relatively low for regions between center and periphery. [28] Over time, specialization of the center decreases until the mid 1980s and increases again after Spain's EU entry, whereas almost the opposite evolution is to be observed for the neighboring regions. This story would comply to some NEG models suggesting a high specialization of the center (on IRS industries), a high specialization of the periphery (on non-IRS industries), and no particular specialization for areas in-between due to the competition from the neighboring region. Yet however appealing the story, differences between center region and neighboring regions are small and most certainly not significant, as is the movement over time. What is worse, when considering the relative measures the argument is more or less converted, with respect to specialization relative to other regions as well as with respect to evolution over time.

[28] Similar pattern can also be detected for French and German regions.

In order to understand the messages from absolute and relative specialization measures recall their foundation in shares of industries and in localization coefficients, respectively. The lower ranking of the center region on the basis of the relative measure than on the basis of the absolute measure may be traced to two different explanations with two different conclusions:

Figure 3.3-3: Spatial relations of specialization/diversification of Spanish regions



Source:INE, Encuesta Industrial (EIG).

- The center region is somewhat, though not extraordinarily, specialized on industries far from equal share (with very large or very small shares), they enter with large weight into the absolute measure. However, since the respective localization coefficients are not remarkably high, these industries enter the relative measures only with low weight (e.g., confection and automobile industry), which yields a more appropriate impression of the center region's specialization.
- The center region to some degree shapes the national benchmark of the relative measure itself, as it is a comparably large region. The absolute measure adopting a neutral benchmark thus yields a more appropriate impression of the center region's specialization.

The higher ranking of the semi-peripheral regions also may be traced to two different explanations with two different conclusions:

- The semi-peripheral regions exhibit small shares yet high localization coefficients for some small industries (e.g., petroleum refineries, rubber production), and the higher

weight attributed to them by the relative measure yields a more appropriate impression of the regions' specialization.

- The semi-peripheral regions are much smaller regions than the center region and do not shape the national benchmark as much as the center region does, accordingly they are compared to a center-region-biased benchmark. The absolute measure adopting a neutral benchmark thus yields a more appropriate impression of these region's specialization.

Each of the respective two explanations has its own virtue. Yet, they must also be qualified: On the one hand, the uniform-share benchmark of the absolute measure, in the case of a disaggregation by 88 industries, is not as farfetched a benchmark as it might perhaps be for a less detailed disaggregation level; on average, most industries reveal shares not very far from uniform shares. On the other hand, no region, not even the center region, is large enough to determine the national benchmark of the relative measure in a very decisive way. Accordingly, the best conclusion to be drawn from the diverging results is that the differences between center regions, core regions and semi-peripheral regions are small and not significant.

With respect to the change over time, one may argue that the absolute measure gives a more appropriate impression, because its benchmark is time-independent. Relative measures of specialization are, by contrast, subject to changes in the specialization of Spain as a whole. Accordingly, the results presented seem to indicate some increase of the specialization of center regions, core regions and semi-peripheral regions, while Spain as a whole seems to get even more specialized.

3.4. Regional specialization and performance of regions

At the end of the chapter, we turn to the question in how far the specialization of Spanish regions and its evolution over time is to the detriment or advantage of these regions. Do specialization or diversification trends coincide with growth or decline, with job gains or losses of the respective regions?

The first view is on *sectoral* specialization of Spanish regions and their subsequent performance (table 3.4-1). During the observation period, the peripheral regions and the center region seem to grow the most quickly in terms of value added. By contrast, the highly specialized region and the old industrialized regions seem to drag behind. Relating this information to the above notations on the concentration of sectors, it appears that specialization coincides with quick growth, and diversification with slow growth. The impression is confirmed by correlation coefficients calculated across all regions of the database (table 3.4-1): The correlation between initial concentration degree and subsequent performance is highly positive and significant when applying absolute concentration measures

(Theil or Herfindahl index), though insignificant when applying relative measures (weighted Theil index or Krugman index).

Table 3.4-1: Specialization and average annual growth rates of regional value added

Region types	Absolute specialization in 1980	Shares in 1980	1980-1985	1985-1990	1990-1995	1980-1995
Highly specialized region	0.35	3.02	8.63	12.57	2.94	7.97
Old industrialized regions	0.24	3.14	7.02	10.96	1.99	6.59
Centre region	0.48	14.28	6.84	8.64	1.52	5.62
Core regions	0.31	46.52	7.68	11.14	2.42	7.02
Semi-peripheral regions	0.44	25.25	7.44	11.70	1.66	6.86
Peripheral regions	0.70	7.78	9.93	12.18	2.51	8.13
Spain	.	100.00	7.89	11.51	2.29	7.16
Correlation between initial specialization (1980) and subsequent value added growth (1980-1995)						
Specialization measures	Pearson correlation coefficients			Error probabilities		
Theil index	**0.73898**			**0.0005**		
Weighted Theil index	0.32692			0.1854		
Herfindahl index	**0.67876**			**0.0020**		
Krugman index	0.43471			0.0714		

Source: Hallet, revised and amended Eurostat figures.

Turning to *manufacturing employment*, we find this sector to register overall job losses in Spain throughout the observation period. The highest job losses occur to the highly specialized region and to the center region (table 3.4-2). Also, the peripheral regions exhibit relatively high job losses. These three region classes, however, are those with the highest specialization. By contrast, the less specialized region classes, old industrialized, core and semi-peripheral regions, register much fewer job losses. In line with these considerations, correlations between specialization and performance appear highly negative and significant, particularly when drawing on absolute specialization measures.

To sum up, the region classes, identified by cluster analysis, reveal differences with respect to their specialization, though, apart from the highly specialized region and the peripheral region, these differences are small and their direction is ambiguous. The specialization does not change much during the observation period, yet, the most specialized regions lose the most jobs in the manufacturing sector. In analogy to our observations on industrial specialization we find thus specialized regions losing significance for manufacturing while the specialization degree does not change. *Increasing diversification* seems to be a weak overall trend of Spanish regions, particularly so in the later part of the observation period which happens to be the one shortly before and after Spain's EU entry.

Table 3.4-2: Specialization and average annual rates of regional employment change in manufacturing

Type classes of industries	Absolute specialization in 1978	Shares in 1978	1978-1982	1982-1987	1987-1992	1978-1992
Highly specialized region	1.64	4.00	-5.52	-2.71	-0.04	-2.58
Old industrialized regions	0.93	3.95	-2.49	-2.38	0.05	-1.55
Centre region	0.97	11.69	-2.83	-3.50	-2.52	-2.96
Core regions	0.89	57.69	-4.48	-2.26	-0.26	-2.19
Semi-peripheral regions	0.83	18.10	-2.45	-2.24	0.23	-1.42
Peripheral regions	1.36	4.57	-3.45	-1.84	0.74	-1.39
Spain	.	100.00	-4.03	-2.34	-0.16	-2.06
Correlation between initial specialization (1978) and subsequent employment change (1978-1992)						
Specialization measures	Pearson correlation coefficients			Error probabilities		
Theil index	**-0.68859**			**0.0016**		
Weighted Theil index	**-0.57001**			**0.0135**		
Herfindahl index	**-0.69208**			**0.0015**		
Krugman index	**-0.58547**			**0.0107**		

Source: INE, Encuesta Industrial (EIG).

4. Structural change in interaction of sectors /industries and regions

This final chapter investigates structural change in more detail disentangling the interaction between industrial concentration and regional specialization. To do this, it looks for the specialization of specific regions on specific sectors and industries (agriculture, manufacturing, services, IRS industries, resource dependent industries), and for the consequences this has on the subsequent evolution of these regions, with respect to their further increase or decrease of specialization, as well as to their economic performance relative to other regions. Questions concerned are: Do, e.g., IRS industries (or agriculture, services, resource intensive, footloose industries, respectively) concentrate further in regions in which they are already highly located, and thus increase the specialization of these regions? What implications has a high localization of such industries on the performance of the regions concerned?

In order to answer these questions, correlations are presented for large sectors and for manufacturing industries, respectively: Localization coefficients for sectors and industry groups in the initial year are correlated to (i) the change over time of the various specialization measures in each respective region, (ii) the performance of the respective sector /industry group in the respective region; (iii) the overall performance of the respective region. Such correlations are provided across all regions and, as far as possible, also for region classes in which the respective sector /industry group has been found to be particularly localized.

Regarding manufacturing industries, Table 4-2 shows the correlations of localization coefficients for industry groups (identified by the classification procedure of section C.2.2) and the subsequent evolution of specialization and of performance. It appears that there is no correlation between localization on any specific industry group and the subsequent change of specialization in the region concerned, as almost all correlation coefficients are highly insignificant. Significant correlations can be detected to the performance of the respective sector in each respective region, and they are all negative. That is to say, the more a specific industry group is already localized in a specific region, the more it tends to register job losses in the very region. This is even true for industries with high IRS, contradicting familiar NEG perceptions that such industries would get increasingly localized. However, this backlash trend is most pronounced for resource intensive industries (and least pronounced for dispersed footloose industries). And this backlash trend does not determine the overall employment development of this very region, as is indicated by the insignificant correlations in the last column of table 4-2.

Table 4-2: Impact of highly localized industry groups on the respective regions – Pearson correlation coefficients (error probabilities in parentheses)

Localization coefficients	Correlation to change of regional specialization				Correlation to regional employment change	
	Theil index	Weighted Theil index	Herfindahl index	Krugman index	of resp. ind. group	of all manufact. industries
Resource intensive industries						
Highly specialized region[a]	-	-	-	-	-	-
Old industrialized regions[a]	-	-	-	-	-	-
All regions	-0.22633 (0.3665)	0.38313 (0.1166)	-0.08088 (0.7497)	0.09055 (0.7209)	**-0.97074 (<.0001)**	-0.21402 (0.3938)
Industries with high IRS						
Center region[a]	-	-	-	-	-	-
Old industrialized regions[a]	-	-	-	-	-	-
All regions	0.16603 (0.5103)	0.25189 (0.3133)	0.43574 (0.0707)	-0.41333 (0.0882)	**-0.48451 (0.0416)**	0.10332 (0.6833)
Concentrated footloose industries						
Semi-peripheral regions	-0.79657 (0.2034)	-0.78018 (0.2198)	**-0.98738 (0.0126)**	-0.70183 (0.2982)	-0.55569 (0.4443)	0.42227 (0.5777)
Peripheral regions	-0.29500 (0.7050)	0.96611 (0.0339)	-0.10977 (0.8902)	-0.20922 (0.7908)	0.39551 (0.0619)	-0.00033 (0.9997)
All regions	-0.09318 (0.7131)	**-0.44010 (0.0676)**	-0.31763 (0.1990)	0.05683 (0.8228)	**-0.69975 (0.0012)**	0.16179 (0.5213)
Dispersed footloose industries						
All regions	0.29562 (0.2337)	-0.33635 (0.1723)	0.07438 (0.7693)	0.16925 (0.5020)	-0.23993 (0.3376)	0.06064 (0.8111)

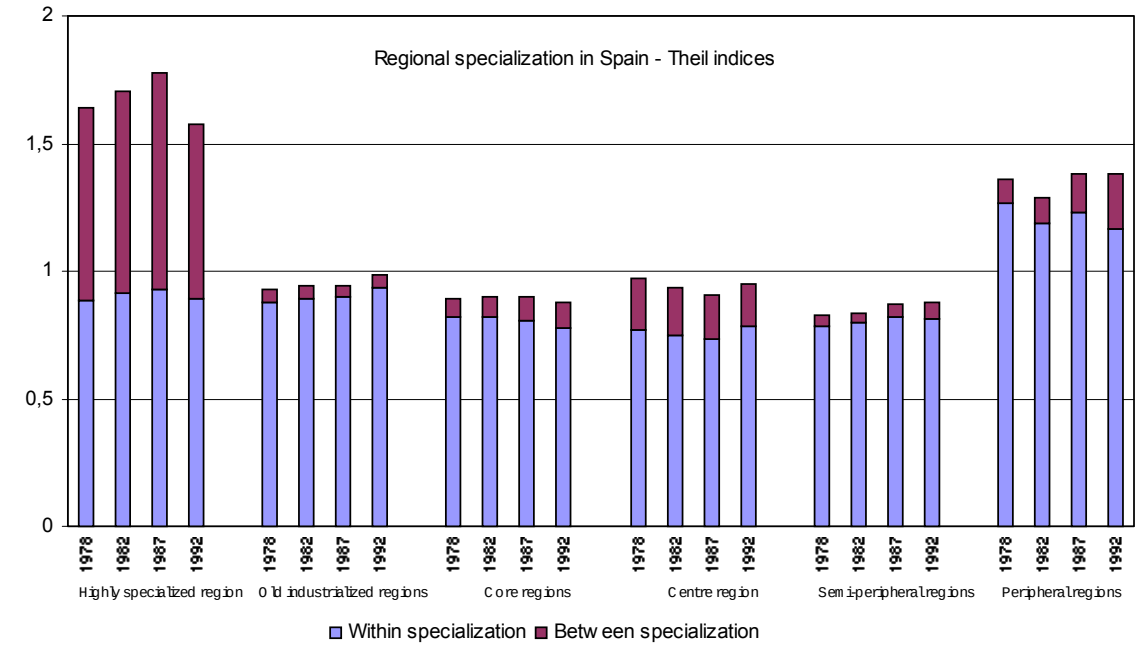
[a] Too few regions in region class to calculate correlations.

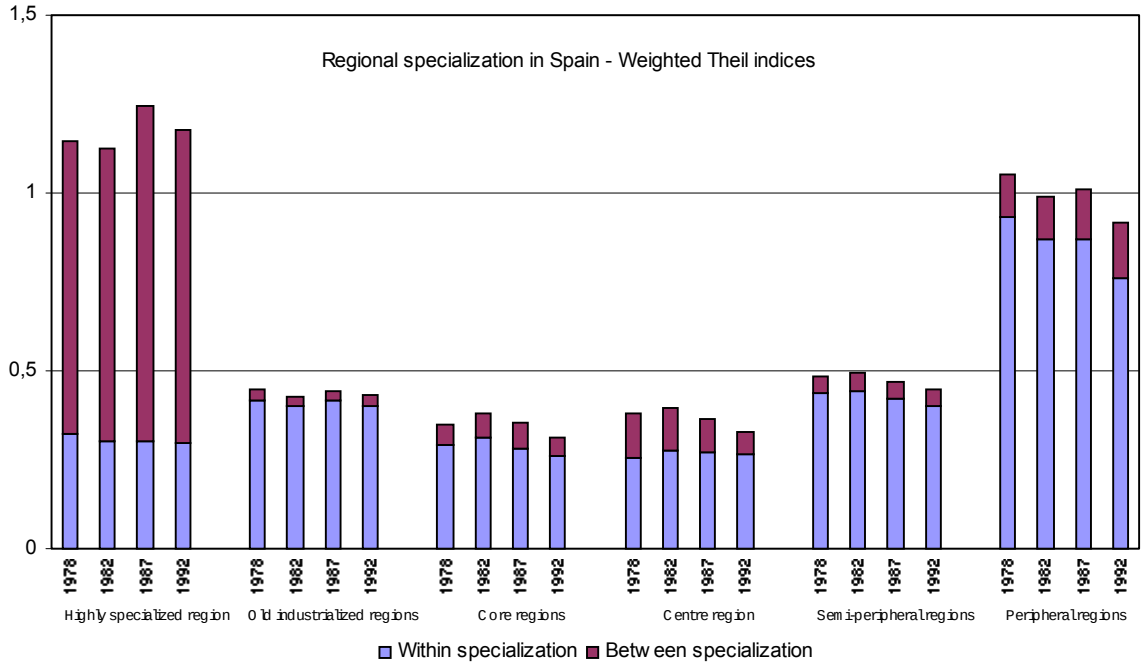
Source: INE, Encuesta Industrial (EIG).

Finally, in order to detect whether the specialization of the Spanish regions is driven at all by the groups of industries with similar trade related characteristics or rather by the specialization on industries within these groups, the decomposition property of the Theil index is once again exploited (figure 4-1): The total regional specialization is decomposed in a component describing the specialization degree on the four groups of industries (between index), and a component describing the specialization degree within these type classes of industries (within index). The results for the different region classes is surprisingly clear: almost all variation of total specialization stems from specialization within the industry types; specialization with respect to the four industry types offers not much explanation for total specialization – with the exception of the highly specialized region (and this result holds whether applying the absolute or the relative measure). Moreover, in the case of the center region and the peripheral regions, the contribution of between specialization is a bit higher than in the case of the remaining three region classes. This leaves some though small space for the presumption

that industrial characteristics derived from trade theories shape the subsequent evolution of regions.

Figure 4. -1: Decomposition of regional specialization – Influence from specialization within and between industry types





Source: INE, Encuesta Industrial (EIG).

Part D. Conclusion: Results for the Spanish case

Picking up the questions from the introduction, we may summarize, drawing from our findings for Spanish industries and regions:

- Spain is found to be among the EU countries exhibiting the highest concentration of sectors, in terms of concentration across space as well as in terms of concentration across people. In particular, the agricultural sector is more concentrated than in most other EU countries. Also, resource dependent industries and some though not all IRS industries, and some, usually small, usually food industries are highly concentrated. Still, the concentration is low regarding the range of values of the indices, and most Spanish sectors like various services sectors and various industries within manufacturing appear relatively equally concentrated in the initial year. Accordingly, most Spanish regions are quite equally specialized, with the exception of very peripheral regions (like the off-shore regions of Spain) and the iron-and-steel region Asturias. The centre region Madrid stands out from other regions not by its degree of specialization yet by its particular industry mix.
- Integration, which can be said to be continuously growing during the observation period, changes concentration and specialization only very slowly even over a period of 15 to 20 years. Some concentration change of Spanish sectors occurs by and large in line with the overall European trends, with agriculture getting more concentrated, and with manufacturing getting less concentrated (across space). The services sector exhibits some increase of concentration across space, along with similar trends of the employment population. The average concentration degree of manufacturing industries does not change substantially, but there seems to be a slight convergence of industries towards the average concentration degree, at least since the 1980s. With respect to specialization of regions, it is difficult to identify any clear direction of change. In absolute terms, specialization of regions, particularly with respect to sectors, seems to increase, yet in relative terms, i.e., compared to the overall Spanish evolution, it seems to remain constant or decrease. This may indicate a weak convergence of regional specialization, in that all regions converge to a medium specialization degree. The major integration step of the observation period, Spain's EU entry, according to some indications, seems to exert some influence on the variables, according to others not. At any rate, all these trends are faint.
- Initial specialization and concentration degrees seem to exert little influence on the subsequent evolution of specialization and concentration of regions and industries. Also, there is no clear distinction of trends for peripheral versus central regions.
- Initial concentration and specialization degrees, however, seem to influence the performance of industries and regions. The more concentrated an industry and the more specialized (within manufacturing) a region is the more they seem to decline in terms of value added shares and in terms of employment.

- A high initial specialization on specific sectors or industries, e.g., on high IRS industries, usually does not seem to entail a specific impact on the subsequent evolution of specialization of the respective region. Yet, the more localized a manufacturing industry is in a region the higher seems to be the job losses in that very regional industry. This trend is particularly relevant and highly significant for resource intensive industries, and in this case, there seems to be an influence on the overall performance of the respective region.

The overall impression one gets from Spanish economic and industrial structures and from structural change in the regions is of quite equal concentration and specialization throughout the country and of slow movement towards dispersion and diversification.

Appendices

Appendix 1: Data

The “EU Statistical Office (Eurostat)” offers the electronic statistical compendium “NewCronos” including the REGIO dataset with data on European regions at various NUTS levels. For NUTS 2 level regions, REGIO is designed to offer yearly data on regional employment (persons employed) since the 1960s with a sectoral breakdown of 17 economic activities, including agriculture, 10 manufacturing and 6 services industries. The actual coverage, however, varies considerably between countries with respect to both periodicity and sectoral disaggregation.

We would like to thank Martin Hallet for the generous provision of an additional data base. For the period 1980-1995, Hallet (2000) completed the Eurostat dataset on gross value added from national sources to cover 17 sectors for NUTS 2 regions in Belgium, Spain, France, Italy, Netherlands, and Portugal, and for NUTS 1 regions in Germany and the UK. The sectors are agriculture, construction, 9 manufacturing and energy industries, and 6 services industries.

The “Instituto Nacional de Estadistica de España (INE)” offers annual data on regional employment (persons employed) by 73 manufacturing industries and 18 “comunidades autònomas”, which cover the period 1978–1992 (“Encuesta Industrial”; EIG). Missing values due to confidentiality restriction were estimated by an iterative interpolation procedure, using available information on totals, sub totals and cross totals.

In 1993, the “EIG” was replaced by the “Encuesta Industrial des empresas” (EIE). Distinguishing only 15 manufacturing industries, the EIE classification is not comparable to that of its predecessor, the EIG. To our knowledge, no data comparable to the EIG is available for non-manufacturing industries.

Appendix 2: **Measures of concentration and specialization**

This appendix discusses the merits and drawbacks of several statistical measures on the background of the aim of the present investigation. In principle there is a large number of indices available for measuring the spatial concentration of industries, or the industrial specialization of regions. To limit the complexity of the exercise, we will focus on measures that have been used most frequently in the related literature, and that may be used for measuring both concentration of industries and specialization of regions.[29] The measures are summarized in Table A2–1. Most of them are functions of the deviations of a specific, or local, distribution to a reference, or global, distribution. The indices differ in three respects: the characteristics of the projection functions which determine the weighting scheme for observations depending on their deviations from an expected value, the restrictions upon – or the flexibility of – the choice of the reference distribution, and data requirements. Since the differences may affect the empirical results to a great deal, the choice of an appropriate index depends upon the purpose of the specific investigation at hand, and upon available data.

These aims of the present investigation, as outlined in chapter C.1, give rise to seven general requirements for the measure to be employed:

(i) The measure should be suitable for measuring both the spatial concentration of industries and the industrial specialization of regions. Being two sides of the same medal they are highly interdependent: Given a (IxR) matrix of annual (employment or value added) data by industry – indexed by i (i = 1, …, I) – and region – indexed by r (r = 1, …, R) – spatial concentration of industries addresses the distribution within rows while industrial specialization of regions addresses the distribution within columns. Drawing a comprehensive picture of the general patterns of structural change within a country should not be complicated by inconsistencies of results originating from differing properties of the measures employed.

(ii) The measure should be suitable for measuring both the extent of concentration and specialization at a given point in time, and evolution of concentration and specialization patterns over time. It should allow to determine the effects of initial conditions onto subsequent evolutions.

(iii) The measure should be suitable for an international comparison of the national patterns and evolutions of concentration and specialization. It should allow for assessing the characteristic differences between incumbent and accession countries in the run-up to

[29] In particular, the measures of spatial concentration of industries based on continuous firm-level data proposed recently by Duranton and Overman (2002) and Marcon and Puech (2003a; 2003b) will not be discussed. From a theoretical point of view such measures share several advantages vis-à-vis measures for aggregate regional data. The main advantage is that they are not subject to the "modifiable area unit problem" (MAUP), i.e., are biased by an arbitrary choice of a regional grid. The measures require, however, detailed data on the location of firms which are not available in the present context.

the latter's accession, and the specific pressures on structural adjustment due to EU accession. Above all, this requires the measure to be independent of the levels of territorial and industrial aggregation which differ markedly between the countries under investigation.

(iv) The measure should use all available statistical information relevant for the purpose of the investigation.

(v) The measure should control for exogenous characteristics of industries and regions as far as possible. One of these characteristics is plant size. The concentration and specialization patterns may, e.g., be affected to a significant extent by the industries' average, or minimal optimal plant size. This is particularly true for small industries where big plants prevail.

The measure should allow for a rigorous, reliable testing of the statistical significance of changes in index values over time, and of differences between regions and industries.

In addition to these requirements, the values of the measure should be straightforward to interpret with respect to the economic question at hand.

The general requirements can be translated into the following basic properties of the statistical measure:

(a) *Scale invariance and population principle*: The general requirements (i) through (iv) are related to the two of the four general principles of inequality measures discussed in the income distribution literature:[30] scale invariance, i.e., independence of the size of the cake, and population invariance, i.e., independence of the number of cake receivers.

In the present investigation, the two principles require the measure to refer to basic units of analysis that are independent of the sizes of countries, regions and industries.[31] These properties were clearly violated if regions and industries would be chosen as basic units, or treated as if they were individuals. The regional and industrial aggregates in the underlying data sets are defined arbitrarily in terms of the questions of interest in the present paper, and differ markedly in size.[32] As a consequence, the measure would be biased. The bias would be

[30] See, e.g., Cowell (1995: 56 ff.). The remaining two principles are the principle of transfers which is not addressed here, and decomposability which will be addressed below.

[31] For a measure of industrial specialization a region, scale invariance addresses the size of the region while the population principle addresses the number of industries. For a measure of spatial concentration of regions, it is the other way around. For the regional level, this kind of aggregation bias, labeled "modifiable area unit problem" (MAUP), has been discussed extensively in the literature (see, e.g., Arbia 1989; Brülhart and Träger 2004).

[32] In general, the choice of the basic units depends on the purpose of the investigation: In an analysis of specific policies adopted by regional governments, e.g., a measure referring to regions as basic units would not be biased because regions would be the level where the policies of interest are decided upon. Since the respective policies affect all parts of the region to the same extent, any intraregional heterogeneity in the variable of interest would introduce a bias.

particularly high in the levels: Comparing concentration patterns across regions and countries, or comparing specialization patterns across industries and countries would be unreliable. In first differences over time, time-independent biases would net out. Nonetheless, time-dependent biases induced, e.g., by migration, would still derogate reliability of the inferences in an unpredictable way.[33] An alternative is to use an individual worker, a unit of area or a unit of value added as a basic unit. These basic units are, in principle, consistent with scale and population invariance.

In the present investigation, even these basic units do not allow for achieving full scale and population invariance because information on the heterogeneity among the basic units within the statistical aggregates is not available. But the bias can be minimized by preferring a *weighted measure* (Brülhart and Träger 2004), i.e., a measure that controls for differences in the frequencies of (unobserved) basic units within the observed units by assigning higher weights to bigger observed units. Note that any of the measures surveyed in Table A2–1 applies a specific, well-defined weighting scheme, at least implicitly. The question of whether to use a measure labeled “unweighted” or one labeled “weighted” is essentially a question of deciding upon the appropriate weighting scheme.

Of the measures in Table A2–1, all but the Herfindahl index are, in general, suitable for minimizing the biases from scale and population invariance.[34] All of them can be defined in terms of individual workers, units of area or of value added as basic units by introducing respective weighting schemes. The Herfindahl index is suitable only if it is standardized by the population size.

(b) *Decomposability*: Comparing measures across related units of analysis (regions, industries or countries) in a consistent way requires accounting for the links between the measures for the related units. This requirement is met by measures that are decomposable, i.e. measures that can be expressed as (weighted) averages or sums of groups within the population covered by the measure. All entropy measures share this property (Cowell 1995), including the Herfindahl and Theil indices, the coefficients of variation and of specialization, and the Finger-Kreinin index. The Gini index is decomposable only if the regions or industries do not overlap with respect to the characteristic analyzed. In the context of the present investigation this condition certainly will not be met.

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[33] Several authors focusing on changes in the measures have preferred unweighted measures, arguing that the problem of scale invariance is irrelevant. The lack of information on the magnitude of a bias is, however, not sufficient for ignoring it, if alternative measures are available that minimize the bias.

[34] There is, however, some uncertainty as to the suitability of the two dartboard measures (Ellison-Glaeser, Maurel-Sédillot), with has not been checked in detail because they are not applicable anyway in the present investigation (see below).

(c) *Reference (benchmark) distribution*: The index should allow for some flexibility as to the choice of the reference, or benchmark, distribution in order to be able to tailor the measure to the specific question at hand. This issue is particular relevant for (i), requiring the measure to suit for concentration as well as specialization issues. Moreover, there may be scope for using different benchmark distributions at the same time even within the two groups. It may, e.g., be informative to compare the spatial distribution of an industry to both the distribution of area and that of total economic activity. In fact, the choice of an appropriate reference distribution is among the most important issues in investigations as the present one because it frequently dominates the outcome. A careless choice of an inappropriate reference may easily produce inconsistent results and/or inappropriate inferences. Note that any of the measures surveyed in Table A2–1 refers to a specific, well-defined benchmark distribution – at least implicitly. The question of whether to use a measure labeled “absolute” or one labeled “relative” is essentially a question of deciding upon the appropriate reference distribution.

Of the measures in Table A2–1, all except the Herfindahl index allow for a fairly flexible choice of a reference distribution. Possible reference distributions include the uniform distribution as well as distributions based on aggregate employment, value added or area. The Herfindahl index uses zero as a reference which is pretty awkward in the presence of significant differences in the sizes of regions and industries. By mixing up the size of an industry or region, as indicated by the reference (or expected) distribution just discussed, and the deviation of the specific observation from the reference distribution, the Herfindahl index assigns a far higher value to a given deviation in an industry or region just because that industry or region happened to have be defined as big in the underlying data set.

(d) *Projection function*: Another aspect that may affect the results severely is the internal weighting scheme, i.e., the projection function transforming the observed value of an observation into a value of in terms of the index. Some measures, like the Theil index, use theoretically well-founded projection functions satisfying specific axioms, while others, like the Gini index, employ persuasive ad-hoc criteria. The major problem with the projection function is that the relative weights are debatable. The weighting scheme is necessarily a matter of individual preferences. Although measures employing theoretically well-founded projection functions may be preferred in general because of their theoretical background, the interpretation of their values may be more demanding because the underlying axioms may form an obstacle for tailoring the lower and upper bounds. The ad-hoc measures, by contrast, are usually tailored to appealing bounds (e.g. between 0 and 1) but are silent when it comes to justifying theoretically why one distribution *should* be assigned a lower or a higher index value than another, and why the value *should* be that much lower or higher.

Requirement (v), demanding to deal appropriately with exogenous influences like an industry's minimal optimal firm size, and to limit the influence of outliers, may be addressed by the choice of the weighting scheme. In general, this requirement suggests preferring one of the dartboard measures, i.e. the Ellison-Glaeser or Maurel-Sédillot index, which control explicitly with the firm-size distribution. Dartboard measures can, however, not be employed in the present investigation because statistical information on the firm-size distributions are not available. As some sort of a second-best solution, this issue can nonetheless be dealt with by preferring a measure that tends to downgrade extreme observations. Biases from indivisibilities at the firm level can be expected to be particularly relevant, and manifest themselves in small industries or regions in the first line. A few observations will assume high deviations from their expected values.[35] Similarly, outliers are characterized by high deviations from their expected values.

Of the measures surveyed in Table A2–1, only the Theil index involves some downgrading of extreme observations. Being based on information-theoretic considerations, it explicitly evaluates the information content of an observation – in an information-theoretic context, or the probability of its occurrence – in a probability-theoretic context. Somewhat exaggerating the issue, the Theil index can be perceived of as evaluating the probability of, say, a big plant being located in a small region, and reducing the impact to this observation onto the index value if the occurrence is held to be rather obscure. More specifically, the weight assigned to a specific observation in the Theil index depends on the information content of the occurrence of this observation: The information content of a strong deviation from the expected value, i.e., the respective value of the reference distribution, is held more obscure than that of a weak or moderate deviation. Consequently, the weights given to the observations increase less than linearly with increasing deviation from their expectation.

For illustration, recall from Table A2–1 that the contribution of a specific observation to the Theil index,

$$\frac{a_i(j)}{a(j)} \ln\left(\frac{a_i(j)}{a(j)}\right),$$

consists of a linear and a logarithmic term.[36] The linear term does essentially the same as the respective terms of most other measures: it assigns a weight to observation *i* that is increasing linearly in the deviation of the relative frequency of observation *i*, $a_i(j)$, from the

[35] For an investigation of the spatial distribution of an industry, e.g., the indivisibility problem can be expected to be more relevant for industries that are small at the national level. If such an industry consists of only, say, two big firms located in two regions, the shares of the industry within the two regions, $a_i(j)$ in Table A???, would be significantly higher than the expected value, a_i, which is the industry's share at the national level. Consequently, the observed values for these two regions would be very high. The observed values for all other regions would be zero.

[36] In an evaluation of the spatial concentration of an industry *j* across regions, $a_i(j)$ may represent the industry's share in region *i*'s employment; $a(j)$ may represent the industry's share in national employment.

corresponding expected, or reference frequency *a*(*j*). Whether this comparison is done by subtraction or division is secondary. The second term is unique, however. The logarithm tends to downgrade more extreme deviations relative to moderate deviations.

It is this second term that makes the Theil index more suitable for coping with indivisibilities in firm sizes and outliers than the other measures listed in Table A2–1.[37] Take, for example, the coefficient of variation: By squaring all observations, the coefficient of variation magnifies the influence of extreme observations onto the index value. Only the sum of all squared deviations is downgraded by the root to make them comparable in size to the mean. Or take the Herfindahl index, which is an extreme case of a measure magnifying outliers – at least among the measures listed in Table A2–1.

Statistical testing: Statistical tests assessing the significance of the differences between two values of a measure for different points in time or different sets of observation in the cross-section dimension have usually employed bootstrap techniques (see, e.g., Cowell 1995; Brülhart and Träger 2004).

The issue of straightforward interpretation of the index values has been addressed briefly in the context of the weighting scheme (point (d) above). While most of the ad hoc measures like the Gini index do have appealing lower and upper bounds, the lower bound of the Herfindahl index ($1/N \leq \mathbf{H} \leq 1$), and the upper bounds of the Theil index ($0 \leq \mathbf{T} \leq \ln N$) and the coefficient of variation ($0 \leq \mathbf{CV} \leq (N\text{-}1)^{½}$) depend on the number of observations (regions, industries) under consideration. The bounds of the Balassa-Aquino index and the dartboard measures are even infinite. To get an idea of the relative distance of the observed value of the measure and the lower or upper bound, the measure may be standardized to the interval (0, 1) by dividing the observed index value by its respective upper bound:

$$T_{(j)}^{BT} = \frac{1}{\ln N} \sum_{i=1}^{I} \frac{n_i}{N} \frac{a_i(j)}{a(j)} \ln\left(\frac{a_i(j)}{a(j)}\right).$$

This percentage measure may be used for comparisons over time, but it may give some indication of differences in the cross-section dimension as well. In should be noted, however, that this is not a rigorous procedure proposed in the literature but rather a kind of back-of-the-envelop calculation which should be made used of very carefully.

[37] These is, notwithstanding, a large number of measures that is, in general, able to do a similar job. Among these measures are the members of the generalized entropy family of measures for which the sensitivity parameter α is somewhere between –1 and +1 (see, e.g., Cowell 1995). The Theil index is the member of this family for which $\alpha = 1$.

Summing up, among the measures reviewed for the purpose of the present investigation (see Table A2–1) the weighted Theil index, proposed by Brülhart and Träger (2004) and defined as

$$T_{(j)}^{BT} = \sum_{i=1}^{I} \frac{n_i}{N} \frac{a_i(j)}{a(j)} \ln\left(\frac{a_i(j)}{a(j)}\right),$$

appears to be the most suitable measure. Minimizing the biases resulting from scale dependence by using individual workers, units of area or of value added as references, it allows for international, interregional and intertemporal comparisons of index values. Being fairly flexible with respect to the choice of a reference distribution, it can be used for answering different kinds of questions. And having the property of downgrading extreme observations, it is more suitable than other measures to cope with outliers and indivisibilities in firm sizes. Moreover, its values can be interpreted in a fairly straightforward manner although the upper bound decreases with sample size. And finally, test statistics assessing the statistical significance may be obtained by bootstrapping.

Table A2–1 — Measures of regional specialization and/or industrial concentration

	Coefficient of specialization	Finger-Kreinin index	Coefficient of conformity	Balassa-Aquino index	Gini coefficient	(weighted) Theil index	(weighted) Coefficient of variation
Formally[a]	$\sum_{i=1}^{I}\lvert a_i(j)-a_i\rvert$	$\sum_{i=1}^{I}\min\left(a_i(j),a_i\right)$	$\frac{\sum_{i=1}^{I}\left(a_i(j)a_i\right)}{\sqrt{\sum_{i=1}^{I}a_i(j)\sum_{i=1}^{I}a(j)}}$	$\sqrt{\sum_{i=1}^{I}a_i\left(\frac{a_i(j)}{a_i}-1\right)^2}$	$1-\sum_{k(i)=1}^{I}a_{k(i)}\left(a_{k(i)}(j)+2\sum_{m}^{k-1}a_{k-1(i)}(j)\right)$	$\sum_{i=1}^{I}\frac{n_i}{N}\frac{a_i(j)}{a_i}\ln\left(\frac{a_i(j)}{a_i}\right)$	$\frac{1}{a(j)}\sqrt{\sum_{i=1}^{I}\frac{n_i}{N}\left(a_i(j)-a(j)\right)^2}$
Bounds:							
identical distr.	0	1	1	0	0	0	0
complete spec/conc.	2	0	0	∞	1	ln*N*	$(N-1)^{1/2}$
scale invariant	no	no	no	no	no	yes	yes
reference distributions	several	several	several	several	several	several	several
decomposable	yes	yes	yes	yes	restricted	yes	yes

[a] *j*: unit under investigation (region in the analysis of the industrial specialization of regions; industry in the analysis of the spatial concentration of industries; *I*: number of observed units in the distribution for the *j* (industries *i* in region *j*, or regions *i* where industry *j* may be located); $a_i(j)$: "local" share of observation *i* in unit *j*; a_i: corresponding share in the reference distribution, expected value for $a_i(j)$; $a(j)$: (weighted) average of the $a_i(j)$ across all *i*; n_i: number of basic units (workers, units of value added, km²) in observed unit *i*; *N*: ($=\Sigma_i n_i$) total number of basic units; k(*i*): *k*-th rank assigned to observed unit *i* when observations ranked by location coefficients in increasing order; *H*: Herfindahl index of firm-size structure.

to be continued

Table A2–1 continued

	Herfindahl index	Ellison-Glaeser index[c]	Maurel-Sédillot index[c]
Formally[a]	$\sum_{i=1}^{I}(a_i(j))^2$	$\frac{\sum_{i=1}^{I}(a_i(j)-a_i)^2}{\left(1-\sum_{i=1}^{I}a_i^2\right)}-H \over 1-H$	$\frac{\sum_{i=1}^{I}(a_i(j))^2-\sum_{i=1}^{I}a_i^2}{\left(1-\sum_{i=1}^{I}a_i^2\right)}-H \over 1-H$
Bounds:			
identical distr.	N^{-1}	0	0
complete spec.	1	∞	∞
scale invariant	no	no	no
reference distributions	0 only	several	several
decomposable	yes	no	no

Appendix 3: Additional figures and tables

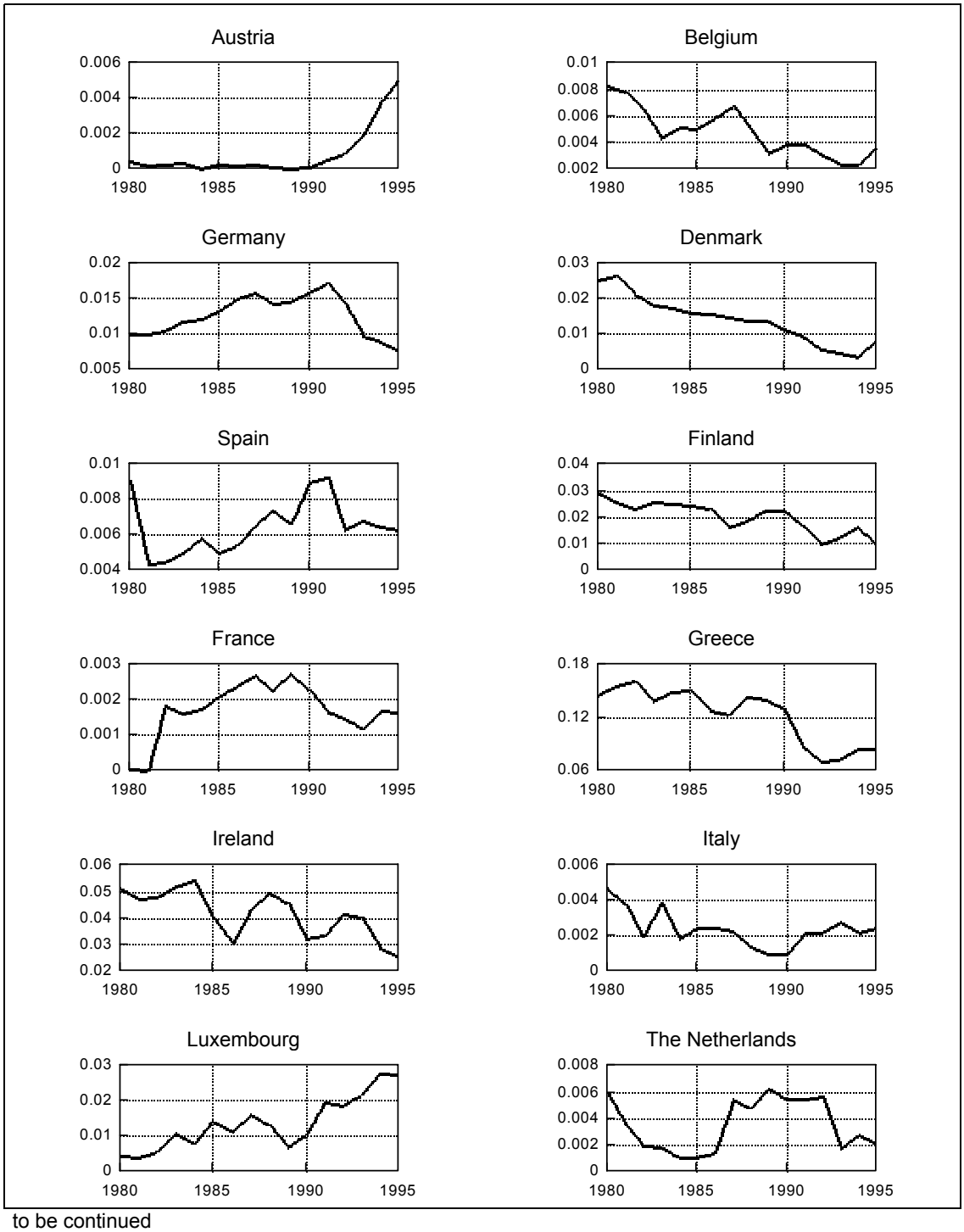
Table A3–1 — Geographic concentration of four sectors across 118 regions in EU15 countries: Absolute changes in total, between and within components of Brülhart/Träger Theil indices 1980-1995, reference: total area

Index-component/ Country-specific within	All sectors	Agriculture	Manufacturing	Construction	Services
Total	+0.013	+0.075	–0.027	+0.008	–0.007
Between	+0.008	+0.063	+0.003	–0.015	+0.002
Within	+0.005	+0.012	–0.030	+0.023	–0.009
Austria	—	—	—	—	—
Belgium	–0.051	–0.014	+0.008	–0.034	–0.109
West-Germany	–0.025	+0.031	–0.031	–0.025	–0.042
Denmark	—	—	—	—	—
Spain	+0.054	+0.088	–0.034	+0.045	+0.036
Finland	—	—	—	—	—
France	+0.074	+0.016	+0.038	+0.082	+0.036
Greece	—	—	—	—	—
Ireland	—	—	—	—	—
Italy	–0,000	–0.034	–0.038	+0.048	–0.001
Luxembourg	—	—	—	—	—
The Netherlands	–0.006	+0.063	–0.056	+0.017	–0.030
Portugal	–0.021	–0.033	–0.067	+0.074	–0.074
Sweden	—	—	—	—	—
United Kingdom	–0.009	–0.021	–0.072	–0.001	–0.010

Table A3–2 — Economic concentration of four sectors across 118 regions in EU15 countries: Absolute changes in total, between and within components of Brülhart/Träger Theil indices 1980-1995, reference: total value added

Index-component/ Country-specific within	All sectors	Agriculture	Manufac-turing	Construction	Services
Total	—	–0.004	–0.000	+0.004	–0.005
Between	—	–0.015	–0.001	+0.010	–0.002
Within	—	+0.011	+0.001	–0.006	–0.003
Austria	—	—	—	—	—
Belgium	—	–0.040	+0.028	+0.002	–0.000
West-Germany	—	–0.009	–0.000	+0.001	–0.001
Denmark	—	—	—	—	—
Spain	—	+0.084	–0.001	–0.004	–0.005
Finland	—	–0.000	–0.000	–0.000	–0.000
France	—	+0.056	+0.006	–0.009	–0.004
Greece	—	—	—	—	—
Ireland	—	—	—	—	—
Italy	—	–0.029	–0.012	–0.021	–0.005
Luxembourg	—	—	—	—	—
The Netherlands	—	–0.016	–0.025	–0.015	–0.011
Portugal	—	+0.042	+0.023	–0.026	–0.002
Sweden	—	—	—	—	—
United Kingdom	—	+0.010	+0.008	–0.002	–0.002

Figure A3-1 Specialization of EU15 countries 1980–1995 – Brülhart/Träger Theil indices for value added in 4 sectors relative to EU15



to be continued

Figure A3-1 continued

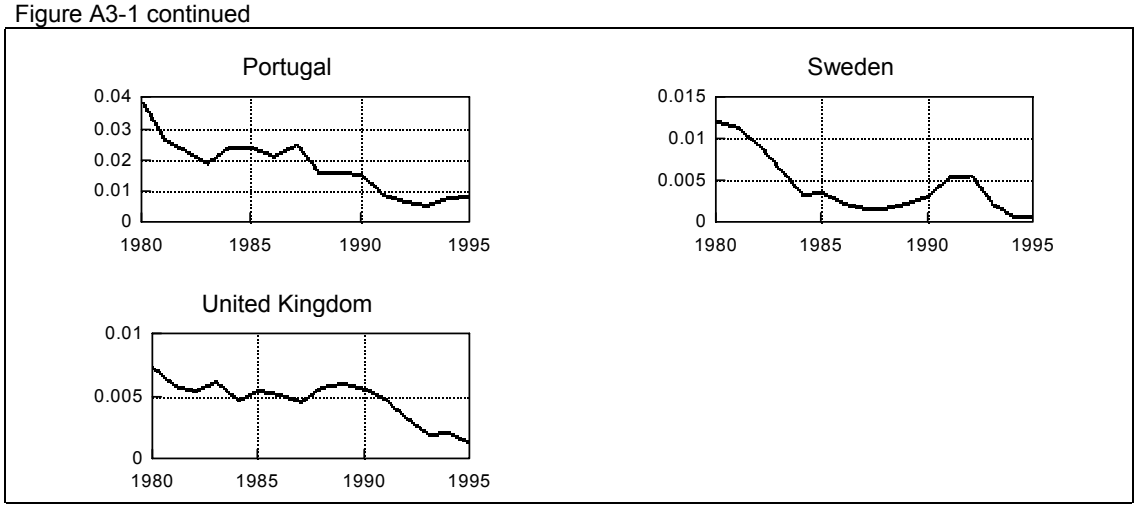
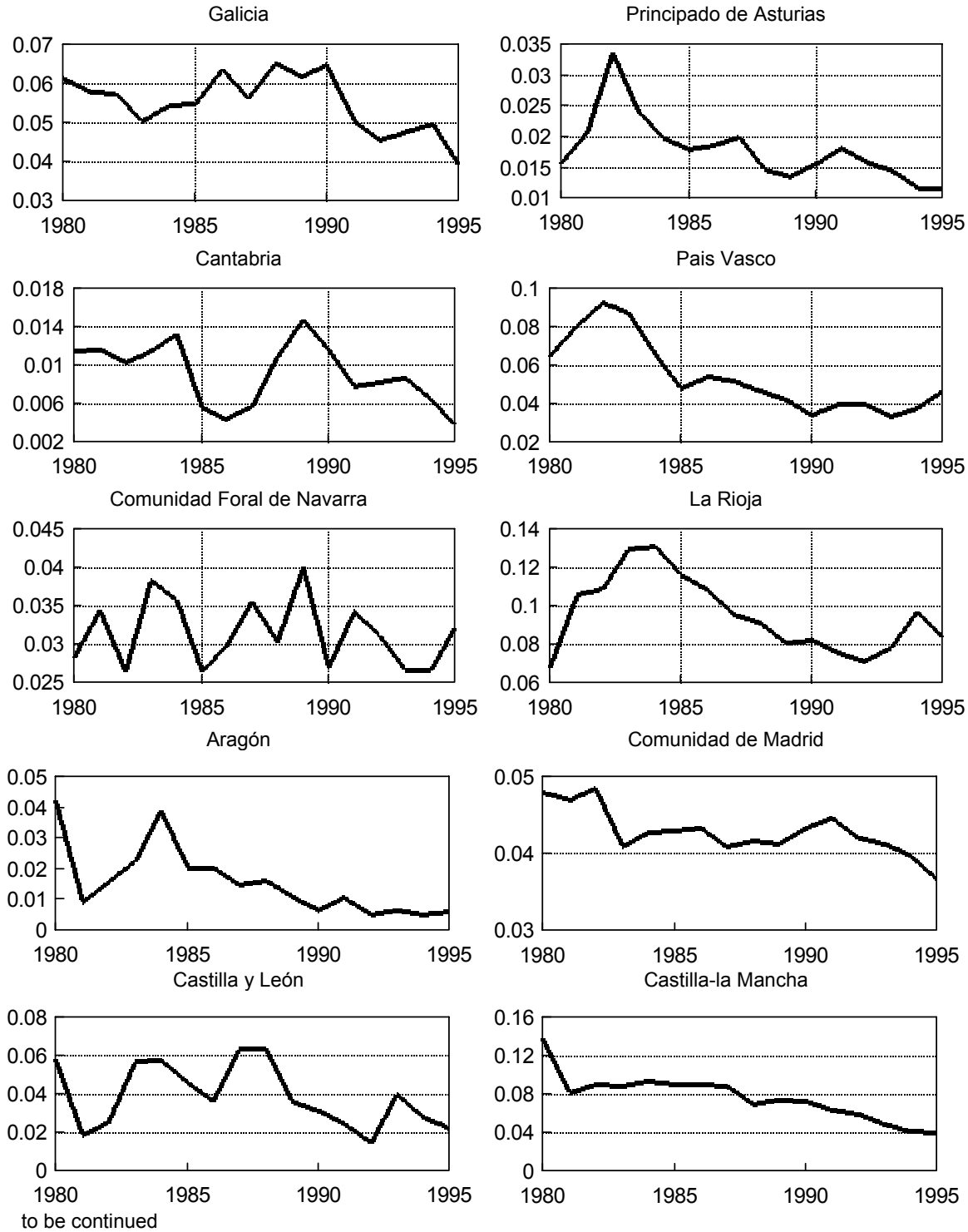


Figure A3-2 Specialization of Spanish regions 1980–1995 – Brülhart/Träger Theil indices for value added in 4 sectors relative to EU15



to be continued

Figure A.3-2 continued

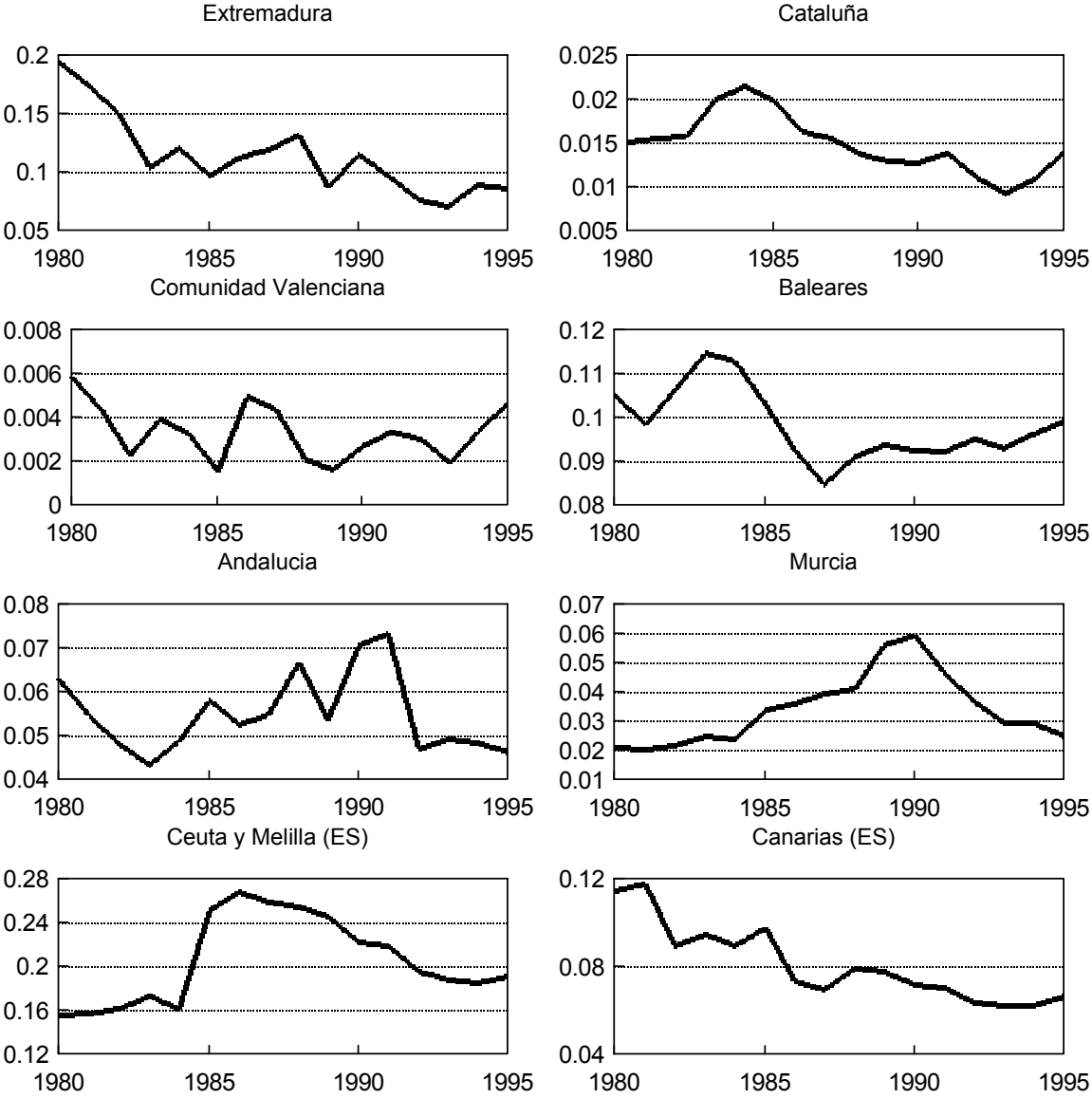


Table A3–3 — Sensitivity of results to a variation in the measure employed: Annual employment changes between industries/regions (absolute differences divided by 2) 1978–1979

Regions	Employment change across industries 1978-1979		Theil index		Weighted Theil index		Herfindahl index		Specialization coefficient	
	persons	percent	1978	1979	1978	1979	1978	1979	1978	1979
Galicia	2716	1.88	0.91	0.91	0.49	0.47	0.0426	0.0427	0.72	0.71
Asturias	1755	1.56	1.64	1.66	1.15	1.15	0.1364	0.1393	1.10	1.11
Cantabria	842	1.73	0.98	0.98	0.53	0.52	0.0471	0.0470	0.77	0.76
Pais Vasco	6642	2.17	1.08	1.08	0.42	0.44	0.0564	0.0567	0.78	0.80
Navarra	1689	2.70	0.88	0.88	0.37	0.38	0.0378	0.0384	0.61	0.63
Rioja	498	1.70	1.09	1.08	0.57	0.57	0.0483	0.0479	0.78	0.79
Aragon	2853	2.73	0.78	0.77	0.22	0.22	0.0356	0.0345	0.48	0.49
Madrid	5531	1.68	0.97	0.97	0.38	0.38	0.0462	0.0462	0.66	0.66
Cast. y Leon	3958	2.38	0.86	0.89	0.36	0.38	0.0438	0.0462	0.67	0.69
Cast. la Mancha	1986	2.15	0.78	0.79	0.43	0.44	0.0353	0.0357	0.74	0.73
Extremadura	1105	4.02	1.05	1.03	0.71	0.69	0.0452	0.0442	0.94	0.93
Catalunya	12418	1.82	0.73	0.72	0.21	0.21	0.0357	0.0352	0.47	0.47
Co. Valenciana	7133	2.14	0.83	0.82	0.33	0.33	0.0407	0.0400	0.59	0.59
Baleares	694	2.23	1.39	1.40	0.89	0.90	0.0918	0.0924	0.99	0.99
Andalucia	3766	1.54	0.58	0.59	0.31	0.31	0.0272	0.0277	0.61	0.61
Murcia	2198	3.53	1.02	1.02	0.68	0.71	0.0584	0.0555	0.80	0.82
Ceuta y Melilla	108	5.69	1.88	1.81	1.59	1.46	0.1379	0.1334	1.36	1.33
Canarias	936	2.80	1.15	1.17	1.04	1.07	0.0520	0.0537	1.04	1.06
Espana	34938	1.24								

Industries	Employment change across regions 1978-1979		Theil index		Weighted Theil index		Herfindahl index		Specialization coefficient	
	persons	percent	1978	1979	1978	1979	1978	1979	1978	1979
1110-1130	828	1.56	1.71	1.69	1.88	1.86	0.4163	0.4122	1.57	1.56
1140	211	7.37	2.00	1.93	2.00	1.88	0.5045	0.4586	1.51	1.50
1220,1400	110	23.66	1.45	1.40	1.11	0.90	0.3038	0.2611	1.17	1.02
1300	379	4.28	0.93	0.92	1.09	1.01	0.1537	0.1505	1.14	1.07
1510	917	1.57	0.40	0.40	0.10	0.09	0.1079	0.1081	0.35	0.33
1520	18	0.47	1.47	1.47	0.46	0.46	0.3706	0.3687	0.88	0.88
16	191	0.68	0.31	0.31	0.23	0.23	0.0920	0.0917	0.56	0.55
21	156	1.51	0.93	0.93	1.02	1.02	0.1823	0.1823	1.17	1.17
2210-2230	846	0.89	1.12	1.11	0.89	0.89	0.2489	0.2456	1.17	1.16
2241-2249	457	2.57	0.55	0.55	0.24	0.27	0.1098	0.1093	0.56	0.58
23	327	1.09	0.42	0.42	0.28	0.28	0.1048	0.1048	0.63	0.62
2410	346	1.20	0.47	0.46	0.27	0.28	0.1087	0.1078	0.61	0.62
2421-2423	125	0.93	0.49	0.50	0.13	0.13	0.1172	0.1188	0.36	0.35
2431-2434	1426	2.56	0.36	0.36	0.11	0.12	0.0958	0.0960	0.37	0.39
2440-2490	489	2.12	0.52	0.52	0.04	0.05	0.1211	0.1194	0.23	0.25
2461-2465	741	2.55	0.66	0.68	0.09	0.10	0.1471	0.1527	0.30	0.33
2471-2479	417	1.06	0.96	0.96	0.42	0.43	0.2463	0.2482	0.78	0.78
2511,2512	179	4.17	0.85	0.92	0.34	0.37	0.1900	0.2099	0.68	0.71
2513	137	1.35	0.93	0.91	0.71	0.68	0.1701	0.1685	0.80	0.79
2514,2515	341	5.06	1.29	1.30	0.53	0.53	0.3171	0.3065	0.89	0.92
2516	238	2.45	1.37	1.36	0.54	0.57	0.3300	0.3177	0.88	0.88
2521,2522	209	1.67	0.42	0.42	0.32	0.32	0.1003	0.1000	0.60	0.59
2533,2534	181	1.84	1.10	1.12	0.23	0.24	0.2476	0.2579	0.56	0.57
2536	28	2.50	1.40	1.40	0.89	0.90	0.2424	0.2393	1.01	1.01
2531-2539	343	1.87	0.96	0.95	0.16	0.16	0.2228	0.2204	0.50	0.49
2541,2542	187	0.56	1.63	1.64	0.65	0.66	0.3825	0.3844	1.02	1.03
2551,2552	282	1.51	1.21	1.22	0.30	0.31	0.2932	0.2936	0.70	0.71
2554	61	3.88	1.29	1.32	0.57	0.57	0.2263	0.2390	0.86	0.87
2553-2559	99	1.66	1.20	1.23	0.32	0.34	0.2738	0.2812	0.68	0.71
3111,3112	458	1.47	0.95	0.98	0.45	0.48	0.2209	0.2277	0.76	0.78
3120,3130	611	2.08	1.00	1.01	0.27	0.29	0.2201	0.2237	0.57	0.59
3141-3150	1032	1.25	0.41	0.40	0.04	0.04	0.1021	0.1012	0.26	0.26
3161-3169	2051	1.57	0.69	0.71	0.12	0.13	0.1600	0.1658	0.35	0.38
3191,3199	687	1.95	0.61	0.60	0.12	0.12	0.1464	0.1445	0.40	0.41
3211,3212	598	3.10	0.46	0.51	0.26	0.25	0.1031	0.1100	0.56	0.53
3221-3299	2503	1.94	0.87	0.87	0.19	0.20	0.1879	0.1888	0.53	0.54

to be continued

Table A3–3 continued

Industries	Employment change across regions 1978-1979		Theil index		Weighted Theil index		Herfindahl index		Specialization coefficient	
	persons	percent	1978	1979	1978	1979	1978	1979	1978	1979
3300	248	6.73	2.13	2.14	0.81	0.84	0.6609	0.6391	1.13	1.09
3410-3460	3939	3.44	0.90	0.92	0.25	0.24	0.1928	0.1998	0.61	0.61
3511-3552	1143	1.94	1.47	1.46	0.71	0.72	0.3650	0.3654	0.89	0.90
3610-3630	4024	2.60	0.82	0.84	0.19	0.22	0.1675	0.1673	0.50	0.52
3710,3720	1338	2.67	1.06	1.07	0.93	0.93	0.2052	0.2061	1.14	1.16
3810	363	2.88	0.80	0.83	0.23	0.25	0.1535	0.1596	0.58	0.60
3820	35	0.55	2.20	2.20	1.59	1.59	0.5018	0.5012	1.59	1.59
3830,3890	226	2.67	1.29	1.25	0.46	0.44	0.2907	0.2819	0.82	0.81
3910-3990	195	1.55	1.28	1.29	0.43	0.43	0.2640	0.2651	0.81	0.82
4110-4124	369	2.53	1.21	1.27	0.98	1.01	0.3386	0.3630	1.16	1.18
4131-4133	467	0.94	0.51	0.51	0.15	0.15	0.1278	0.1263	0.40	0.39
4141-4144	357	1.38	0.40	0.38	0.10	0.09	0.0993	0.0977	0.37	0.36
4150	1298	3.76	1.03	1.02	1.48	1.47	0.2062	0.2007	1.35	1.35
4160	669	3.03	1.09	1.12	1.34	1.38	0.2623	0.2646	1.26	1.27
4170	295	1.49	0.41	0.42	0.47	0.46	0.1056	0.1065	0.80	0.80
4191,4192	423	0.39	0.36	0.36	0.12	0.12	0.0986	0.0990	0.40	0.40
4200	549	6.76	1.64	1.63	1.47	1.46	0.3773	0.3773	1.43	1.42
4211,4212	308	2.57	0.53	0.51	0.14	0.14	0.1199	0.1171	0.47	0.45
4220	180	1.39	0.48	0.49	0.24	0.24	0.1194	0.1205	0.53	0.54
4181-4239	263	1.34	0.65	0.66	0.19	0.18	0.1552	0.1574	0.44	0.44
4241,4242	52	3.42	1.04	1.09	1.33	1.39	0.2553	0.2760	1.18	1.18
4243	139	2.01	1.00	1.05	0.72	0.75	0.2769	0.2933	0.97	1.00
4251-4259	1017	4.14	0.73	0.74	0.65	0.70	0.1608	0.1618	0.89	0.93
4260	14	1.86	2.37	2.36	2.58	2.57	0.7254	0.7205	1.64	1.64
4270	149	1.00	0.78	0.78	0.33	0.34	0.1651	0.1657	0.67	0.68
4281,4282	708	3.30	0.47	0.44	0.09	0.09	0.1154	0.1102	0.32	0.31
4290	123	1.00	0.83	0.82	1.28	1.26	0.1800	0.1778	1.04	1.04
4311-4340	2667	2.73	1.70	1.68	0.61	0.60	0.5132	0.5064	0.93	0.92
4351-4354	414	1.10	1.41	1.42	0.48	0.49	0.3948	0.3996	0.85	0.86
4360	451	2.13	2.15	2.06	0.86	0.79	0.6515	0.6175	1.15	1.11
4371-4399	625	2.47	1.41	1.46	0.49	0.53	0.3261	0.3380	0.88	0.91
4410	253	2.00	1.09	1.08	0.31	0.33	0.2569	0.2558	0.67	0.69
4421-4429	445	3.07	0.76	0.74	0.31	0.30	0.1641	0.1578	0.67	0.66
4510,4520	1337	2.05	1.35	1.34	1.25	1.26	0.3642	0.3585	1.39	1.40
4531-4559	2014	1.70	0.66	0.65	0.12	0.13	0.1428	0.1398	0.36	0.36
4540	434	4.77	0.29	0.31	0.17	0.14	0.0867	0.0899	0.46	0.43
4560	226	5.99	1.11	1.10	0.44	0.39	0.2437	0.2456	0.75	0.71
4610	301	1.80	0.64	0.63	0.60	0.58	0.1574	0.1534	0.88	0.87
4620-4650	1711	1.88	0.43	0.42	0.12	0.12	0.1147	0.1125	0.39	0.39
4660	126	3.31	1.70	1.71	1.09	1.11	0.4101	0.4147	1.18	1.19
4670	94	2.95	1.07	1.10	0.46	0.49	0.2611	0.2755	0.78	0.80
4681-4685	2643	2.45	0.50	0.48	0.10	0.10	0.1227	0.1187	0.37	0.37
4710,4720	969	3.93	0.98	0.93	0.23	0.21	0.2136	0.1970	0.55	0.52
4731-4739	601	1.83	0.80	0.81	0.21	0.22	0.1739	0.1752	0.50	0.52
4741-4759	1063	1.34	0.82	0.82	0.18	0.18	0.1943	0.1939	0.46	0.47
4811-4819	885	2.25	0.82	0.83	0.45	0.48	0.1899	0.1925	0.81	0.83
4821,4822	1360	2.33	0.93	0.98	0.14	0.16	0.2085	0.2216	0.42	0.46
4911,4912	277	2.63	0.93	0.95	0.51	0.52	0.1620	0.1652	0.70	0.72
4920	19	1.95	1.61	1.63	0.84	0.87	0.3869	0.4010	1.06	1.08
4930	148	4.20	0.86	0.86	0.27	0.27	0.1840	0.1775	0.61	0.60
4941,4942	408	3.44	1.41	1.42	0.64	0.66	0.3404	0.3506	0.83	0.85
4951,4959	272	4.23	1.15	1.21	0.34	0.37	0.2779	0.3077	0.63	0.70

Table A3–4— Industries with internal IRS[a]

High IRS	Intermediate IRS	Low IRS	
Rank order for 2-digit industries (from highest to lowest)			
Motor vehicles	Metals	Paper, printing, publishing	Other manufacturing
Other means of transport	Office mach.	Non-metal minerals	Textiles
Chemical industry	Mech. engineering	Metal articles	Timber and wood
Man-made fibres	Electrical engineering	Rubber and plastics	Footwear and clothing
	Instrument engineering	Drink and tobacco	Leather
		Food	
Internal IRS for 3-digit industries — Interpretation of Pratten's table 5.3(a)			
11 Solid fuels	14 Refineries	17 Water supply	424 Alcohol distilling
12 Coke ovens	16 Electricity & gas	223 Drawg., cold rollg.	425 Wine
13 Petroleum, natural gas	224 Non-ferrous metals	231 Building materials	427 Brewing & malting
15 Nuclear fuels	247 Glass	232 Potassium, phosphate	428 Soft drinks
21 Metal ores	248 Ceramic products	243 Concrete	429 Tobacco prod.
221 Iron and steel industry	255 Paint, varnish & ink	244 Asbestos	431 Wool industry
222 Steel tubes	257 Pharmaceuticals	245 Non-met. minerals	432 Cotton
241 Clay prod. for constr.	258 Soap & cleaning prod.	246 Grindstone	433 Silk
242 Cement	311 Foundries	259 Other. chem. prod.	434 Flax, hemp & ramie
251 Basic industr. chemic.	312 Forging	313 Transf. of steel	435 Jute
256 Ind. & agric. chem.	321 Agricult. machinery	314 Struct. metal prod.	436 Knitting industry
26 Man-made fibres	322 Machine tools	315 Boilers & tanks	437 Textile finishing
326 Transmission equipm.	323 Textiles machinery	316 Metal tools	439 Misc. textile ind.
33 Office & comp. mach.	324 Food & chem. mach.	319 Metal nec.	441 Leather tanning
342 Electrical machinery	325 Mach. f. mine, constr.	341 Wires & cables	442 Leather products
344 Communic. equipm.	327 Mach. for spec. use	347 Lamps & lightings	451 Footwear
345 Radio & Tv	328 Mach. & equipment	348 Electr. installation	453 Clothing
351 Motor vehicles	343 Electr. app. & appl.	352 Bodies f. vehicles	455 Household textiles
364 Aircraft	346 Dom. electric. appl.	374 Clocks & watches	456 Furs
371 Profess. instruments	361 Shipbuilding	411 Vegetable	461 Sawing
372 Medical equipment	362 Railway equipment	412 Meat	462 Semi-fin. wood prod.
373 Optical instruments	363 Cycles & motorcycles	413 Dairy prod.	463 Carpentry & parquet
421 Cocoa & chocolate	416 Grain milling	414 Preserving fruits	464 Wooden containers
473 Printing	438 Carpets & coverings	415 Preserving fish	465 Other wood prod.
474 Publishing	471 Pulp & paper	417 Spaghetti etc.	466 Cork, straw etc.
	481 Rubber products	418 Starch	467 Furniture
	483 Plastic products	419 Bread	482 Repair of tyres
	494 Toys, sporting goods	420 Sugar refining	491 Jewellery
	495 Misc. manufact	422 Animal foods	492 Musical instruments
		423 Other food	493 Photograph. lab.

[a] Technical IRS measured by engineering cost functions on the base of estimates by managers, engineers, economists, and accountants; NACE classification.

Source: Pratten (1988).

Table A3–5 — Industries by factor intensities[a]

1. Resource-intensive industries	2. Labour-intensive industries	3. Scale-intensive industries	4. Differentiated goods	5. Science-based industries
31 Food 323 Leather 331 Wood 3411 Pulp and paper 353 Petroleum ref. 354 Petr., coal prod. 369 Non-met min. 372 Non-ferr. met.	321 Textiles 322 Wearing appar. 324 Footwear 332 Furniture 380/1 Metal prod. 39 Other manufact.	341 Paper exc. 3411 342 Printing, publ. 351 Ind. chem. 355 Rubber 356 Plastic 361/2 Pottery, glass 371 Iron and steel 384 Transp.equipm. exc. 3845	382 Mach. exc. 3825 383 Electr. mach. 385 Opt. p., watches exc. 3851	352 Other chem. 3825 Off., comp. mach. 3851 Prof. goods 3845 Aircraft

[a] ISIC-classifications; grouped "on the basis of the primary factors affecting the competitive process in each activity", for OECD countries.

Source: OECD (1987:272;275)

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