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Book Part

European integration, regional structural change and cohesion in Portugal

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 Portugal

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EURECO

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 Portugal about the general topographic, demographic, economic and political conditions as well as about the evolutions of industrial concentration and regional specialization during the last 10 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 Portugal during the time period 1991 to 2001. The captures important milestones of the European integration process, including the completion of the Single Market in 1992 as well as the north enlargement in 1995.[1] The analysis distinguishes 7 Portuguese NUTS 2 regions (value added by 4 sectors: agriculture, manufacturing, construction, services, 1980–1995; and employment by 167 industries within the manufacturing sector, 1991–2001). 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").

The results can be summarized as follows:

[1] The latest milestone, however, the creation of the European Monetary Union in 1999/2002, is too recent for being covered by the present analysis.

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, Portugal 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. In the 1990s, within the manufacturing sector, some industries regarded as being footloose were somewhat more concentrated than other industries. The concentration pattern of manufacturing industries with increasing returns to scale (IRS) 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 since the early 1980s, the concentration patterns changed very slowly both throughout Europe as a whole, and within Portugal. In both the EU as a whole, and in Portugal a weak tendency towards topographic deconcentration of economic activity prevailed.[2] Within the manufacturing sector, the concentration level decreased and became more alike.

3. *Path dependence of industrial concentration*. There is some evidence of significant effects of initial concentration of manufacturing industries onto the subsequent development of these industries in Portugal: Industries that were concentrated comparatively high in the early 1990s tended to exhibit higher job losses during the subsequent decade (1991–2001) than dispersed industries.[3]

4. *Level of regional specialization*. In general, some Portuguese regions exhibited 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 Portuguese economy. In the European context, Portugal was among the countries with the highest degree of specialization. Among the Portuguese NUTS 2 regions, semi-peripheral and peripheral regions were somewhat higher specialized than the other regions.

5. *Evolution of regional specialization*. As to the evolution of economic specialization of Portuguese regions, a weak trend towards de-specialization prevailed among Portuguese regions both at the sectoral level during the 1980s and the early 1990s as well as at the industry level within the manufacturing sector during the 1990s.

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[2] Nonetheless, the EU-wide 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 Portugal. The unification boom increased the concentration differences *between* the EU member states but did not affect the regional concentration patterns *within* Portugal to a notable extent.

[3] There is, however, some evidence of sectors that were comparatively highly concentrated in relative terms (i.e., relative to economic activity as a whole) having performed worse than sectors the spatial distribution of which was similar to that of economic activity as a whole. But this negative correlation is biased by the slow growing agricultural sector. Being located outside the economic centers the agricultural sector appears to be concentrated in relative concentration measures.

6. *Path dependence of regional specialization*: No evidence was found for a path dependence in the degrees of specialization of Portuguese 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*: Similarly, a region's initial degree of specialization at the sectoral or the industrial level (within manufacturing) apparently had no impact to the region's subsequent aggregate value added or employment growth. Nonetheless, there seems to be a negative relationship between initial specialization and subsequent growth within specific industry groups: 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 resouce intensive and concentrated footloose 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 Portugal and its NUTS2 regions

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. 2004). 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 Portuguese regions is one. Others concern Austrian, British, French, German, Greek, Irish, Italian, and Spanish 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 Portuguese 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 Portugal since 1991. Part D summarizes and concludes.

Part B. Stylized characteristics of Portugal

1. Stylized country characteristics

1.1. Population and space

The country of Portugal, situated at the uttermost south west of Europe, covers an area of about 92 thousand square meters and inhibits a population of about 8 ½ million people (table 1-1). The population density varies considerably within the country, declining sharply from the north-west coastal area to the south-east inland.

Portugal is divided into 7 “comissaões de coordenacaõ” (regions at NUTS2 level) two of which are the extremely small, off-shore islands of Madeira and the Açores. The regions vary considerably concerning acreage and population size: The two regions Centro and Alentejo are relatively large yet sparsely populated, whereas the regions Lisboa e Vale do Tejo and Algarve are much smaller yet more densely populated.

Table 1-1: Population and space in Portugal

	Acreage	Population 2001	Population change last decade	Population density	Employment potential (pop15-65)	Participation rate (workforce) 2000
	1000 sqkm	Tsd.	average annual	persons/sqkm	% of pop	% of potential
Norte	21278.3	3638.2	0.35	171	67.6	
Centro	23668.2	1778.3	0.38	75	67.7	
Lisboa e Vale do Tejo	11931.1	3448.8	0.33	289	68.5	
Alentejo	26931.2	526.3	0.37	20	65.5	
Algarve	4988.5	388.5	0.42	78	68.8	
Açores	2323.4	237.9	-0.05	102	62.9	
Madeira	785.3	244.8	1.20	312	66.7	
Portugal	91906.0	10262.9	-0.11	112	65.8	

1.2. Economic geography

The Portuguese regions are characterized by their situation with respect to their distance to the coast. Most part of the inland highlands and the complete southern part of Portugal are subject to a relatively hot and dry climate and owe less fertile soils. Also, in parts, their mountainous landscape resisted the development of transport infrastructure. Accordingly, they remained relatively sparsely populated and less accessible. By contrast, the north-eastern coastal regions traditionally enjoyed a more favorable climate, more fertile soils and easy accessibility thanks to the coast and to large navigable rivers (Douro and Tejo).

With respect to the northern region of Portugal, its short distance to the industrial districts of northern Spain may perhaps have contributed to its emergence as Portugal's industrial district. Even more, the city of Lisboa and its surrounding marks the economic heartland of Portugal.

Portugal lacks almost completely any noteworthy localized resource deposits, with the exception of cork trees that are grown particularly in the region Alentejo. These specific resources, however, did not foster the emergence of a respective industrial district.

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 (table1-2).

Table 1-2: Economic activities in space in Portugal

	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	1996	2000	1996	2000	1986-1996	last decade	Agriculture	Services	Agriculture	Services			
	% of workforce	Mio €	€/ sqkm	€/ population	€/ employment	average annual %	average annual %	%	%	%	%	% of GDP	% of GDP	% of GDP
Norte	3.7	39767	1869	12614		6.97								
Centro	2.4	18817	795	11177		8.46								
Lisboa e Vale do Tejo	5.3	53147	4454	10808		6.02								
Alentejo	5.7	5779	215	15776		9.66								
Algarve	3.6	4444	891	10899		10.41								
Açores	2.2	2178	938	12481		6.82								
Madeira	2.8	2533	3226	9126		8.52								
Portugal	4.0	126666	1378	10191		6.97								

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.

Portugal is one of the economically most backward countries in Europe. Its backwardness can be traced back to the second half of the 18th century and the beginning of the industrial revolution. Especially, technological advance lagged behind other European countries. Portugal's economic development in the 20th century can be separated into three distinct phases. First, the time under authoritarian dictatorship from 1926 until 1974, second a transition phase from the peaceful revolution in 1974 until the accession to the European Community (EC) in 1986, and third the time span since then.

Under the authoritarian regime, especially under the leadership of António de Oliveira Salazar (1932-1968), the time of the so called "Estado novo" (new state), the economic order was characterized by a corporative system, in which private initiative was strangled through administrative barriers to investment. Monopolies and oligopolies prevailed in many sectors, and much of the Portuguese economy was controlled by a circle of few families (Iking, 1997). Main policy goals during the time of the dictatorship were the creation of price stability, balanced foreign accounts through import substitution strategies and state controlled industrial diversification based on self-sufficiency in the agriculture.

After the revolution in 1974, economic development was strained by numerous factors. Returning emigrants and returning soldiers from the colonies posed a heavy burden on labor and housing markets. The independence of the former colonies meant the end to cheap raw material imports and to traditional export markets. Because of the end of cheap oil from the colonies, the 1973/74 oil price shock hit Portugal harder than most other countries. Finally, socialist policies, especially nationalizations of major industries such as banking and insurance, transportation, utilities and basic industries, pursued by the governments following the revolution, threatened international investors as well as domestic businessmen which withdrew their capital. Hence, growth of GDP dropped from 11.2% in 1973 to 1.1% in 1974. In 1975, GDP even contracted by 4.3%. Also, inflation soared from levels below 10% to over 20%.

Since the accession to the EC in 1986, Portugal has been rapidly modernizing and liberalizing its economy. Labor and capital market reforms, re-privatizations of state enterprises, reforms of the taxation system are among the most notable changes. Participation on international trade and foreign direct investment increased remarkably. Since then, Portugal's per capita

GDP has been converging towards the EU average, showing only lower than EU-average growth rates in recent years. From 1986 to 2001, Portugal's GDP converged from 55% to 75% of EU average GDP. In the process of the integration into the EU, inflation and public deficits were brought down, so that Portugal has been among the starting members of the common currency.

2.2. Trade policy

After World War II, Portugal pursued import-substitution strategies, which implied high tariffs and quotas to protect the domestic industry from international competition. First steps towards freer international trade were made in 1960, when Portugal was among the founding members of the EFTA. Subsequently, the country gradually opened up to international trade and investment. Consequently, foreign direct investment poured into the country, attracted by low wages. From 1964 to 1974, Portugal experienced a phase of very high growth rates (GDP grew on average by 7.1%), mainly driven by labor intensive industries, such as the textile industry and paper and metal manufacturing industry. The accession to the EC in 1986 meant further trade liberalization efforts. Within a transition period of seven years, ending in 1992, Portugal had to remove its tariffs with EC-member states. Quotas for "sensitive" industries were removed even faster: quotas for textile products were faded out until 1989, import restrictions for automobiles were abolished in 1987. For non-agrarian imports from non-EC-member states, Portugal had to lower its tariffs from an average of 16% in 1985 to the common EC-tariff of 5% in 1993. These measures of trade liberalization led to increased trade activities, where imports grew stronger than exports. From 1986 to 1993, imports grew annually on average by 10.9%, exports by 6.4%, while GDP growth averaged out to 3.2% (Iking, 1997). Also, flows of foreign direct investment, which were low during the period between the revolution in 1974 and the EC-accession in 1986, grew rapidly. Most of the foreign direct investment went into the service sector, especially into the banking and insurance sector. In the manufacturing industry, the largest share of FDI activity was related to labor-intensive export-oriented products, such as metal manufacturing and the production of electronic parts. During the 1990s, investments of large international car-maker and car-components supplier were the most noticeable FDI activities in the manufacturing sector in Portugal.

2.3. Regional policy

Since Portugal is among the poorest member states of the EU, the whole of Portugal is eligible for EU funds for lagging regions. Moreover, Portugal itself is characterized by a highly uneven spatial distribution of economic activity: there are two industrial centers (Porto and Lisbon) with the highest per capita income within the country and the relatively wealthy coastal stripe of the Algarve, dependent on tourism. The hinterland is characterized by thin population density, low industrial production and restricted access of the population to social and medical services (Yuill 1999). Reflecting its centralized structure, regional incentive programs are centrally administered by the Ministry for Planning and Regional Development.

The incentive system for regional policy SIR (Sistema de Incentivos Regionais) aims at encouraging start-ups and modernization of SMEs in the lagging regions of Portugal. Hence, the program is not available around the three economic centers mentioned above.

Under the scheme, assistance is given mainly to relatively small projects. Eligibility is based on an assessment-score of up to 100 points, which depends on two main criteria: the impact on the regional economy (60% of assessment) and its influence on the specific sector (40% of assessment). Projects achieving 50 or more points, qualify for assistance. Assistance under the program is given as credit-free loans or as investment grants. The height of the assistance granted varies between 40% and 70% of eligible investment sum. Generally, a wide range of activities (industry, services, tourism and trade) is supported. The program is co-financed by the Ministry of Planning and Regional development (25%) and EU structural funds (75%).

2.4. Industrial and technology policy

Until the end of the authoritarian regime, industrial policy was restricted to the protection of the corporative structure of the economy: market entry was hindered through a process of investment regulation in order to protect existing oligopolies (Confraria 1999). Moreover, policy-maker followed market-exit strategies, in which small firms were forced to merge, in order to achieve economies of scale. Even though the actual share of the state in the economy (in terms of state owned enterprises) was relatively low, the state controlled the economic development of the country via the corporative system.

After the revolution in 1974, a wave of nationalizations took place, bringing up the level of state participation in the economy. Most affected of the nationalizations were the banking and insurance sector, the utilities, transportation and basic-industries, such as shipbuilding, refining, petrochemicals, and cement production. State owned enterprises were given a special legal form (empresa pública), which exempted them from bankruptcy rules of the private sector. Also, managements of SOEs were committed to set prices according to wider social objectives, instead of pure profit maximization (Confraria 1999). Also, subsidies mainly went to SOEs. Industrial policy through incentive-based programs for investments was almost absent until the early 1980s. This was mainly because of the political instability following the revolution (from 1974 until 1983, governments changed as often as 14 times) and the strained budget conditions. Until 1986, only two incentive based programs for the promotion of industrial and technological development were implemented, which remained without significant effects on Portugal's industrial structure because of lacking funding.

From 1988, the nationalizations of the previous decade have been reversed. Better coordinated incentive based programs to foster technological progress and industrial development have been set in place since then. Most of these programs are co-financed by

the EU, with the EU providing the major share of funds. The main program for industrial development in this respect is PEDIP (Programa específico de desenvolvimento da indústria portuguesa). Under its framework, grants are given to investments into the technological infrastructure, to training of employees, to direct investments by firms, to investments into the improvement of management capabilities, and to investments into the improvement of quality and industrial design. The largest share of funds under PEDIP between 1988 and 1992 has been given to direct investment by firms (55%). Moreover, PEDIP is designed so as to improve especially the availability of financing for small and medium sized enterprises (SMEs), which account for the largest share of Portugal's economy (Amaral 2003).

Part C. Integration and Structural Change – Descriptive statistics

1. Introduction

1.1. Subject and structure of the work

This part describes and analyses the extent and evolution of industrial specialization of Portuguese regions, and of the spatial concentration of Portuguese 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 Portuguese regions, and of the spatial concentration of Portuguese industries in the 1980s? 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 initial 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 Portuguese regions with respect to large economic sectors as well as to detailed manufacturing industries. The time period covered by

the subsequent investigation, 1991 to 2001, is, however, short due to data restrictions. Yet, it captures some recent evolutions of the EU integration process: the north enlargement in 1995 and the transformation and gradual re-integration of east European countries.[4]

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). Part D concludes.

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 Portuguese regions in the European division of labour, and comparing the extent and evolution of sectoral specialization of Portuguese regions to that of other European regions. In a second step, the two chapters will focus on industries within the Portuguese 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 Portugal before it joined the EU, 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 Portuguese 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 initial year of the observation period, 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.

[4] The latest milestone, however, the creation of the European Monetary Union in 1999/2002, is too recent for being covered by the present analysis.

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 2.1. 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 measure 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//). In the context of industrial specialization of a region, e.g.,[5] 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 with 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 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[6] 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:

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

[5] 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.

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

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.[7]

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 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.[8] 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 Portuguese sectors and industries, as well as of Portuguese regions in the overall European division of labor.

[7] 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.

[8] For a more detailed analysis of the advantages of the Theil indices, cf. Appendix 2.1.

Database

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

- annual real value added by 17 sectors 1980 to 1995 for NUTS 1 regions ("Länder") from the Eurostat database, revised and amended by Hallet (2000).[9]
- census employment data by 122 industries from agriculture to services, 1991 and 2001, for NUTS 2 regions ("regiones") from the Instituto Nacional de Estatística (INE) of Portugal.

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 Portugal and the UK. The sectors include agriculture, 10 manufacturing and energy sectors, and 6 service sectors. The dataset allows us to compare the specialization Portuguese regions and concentration of Portuguese sectors on a European yardstick. The data include, however, data breaks that seem to be due to statistical problems rather then real world evolutions. We do not dispose of any information on the background to these breaks. They will, therefore, largely remain uncommented.

The second database is provided by the Instituto Nacional de Estatística (INE) that offers census data on persons employed. In principle, this source allows for almost any depth of breakdown by regions and sectors (manufacturing sectors as well as services), yet the access to sufficiently detailed data is restricted and requires specific permission. For the purpose of this paper, the data are arranged such to allow for an analysis of sectoral concentration and specialization in a similar break-down as for the other countries of the sample, i.e., for 8 sectors, including agriculture, manufacturing, and 6 service sectors. Within manufacturing, 120 industries are considered to allow for a more detailed analysis.

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

2. Concentration of industries

The purpose of this chapter is to set out the major characteristics of large Portuguese sectors, as well as of Portuguese manufacturing industries, with respect to their concentration pattern and their economic performance, in order to enter the results into the analysis of Portuguese 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 Portuguese 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 Spatial concentration of economic activity in Europe

Spatial concentration in the early 1980s

To get an idea of the spatial concentration of economic activity in Europe, 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.[10]

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 geographic concentration, while agriculture (0.27) was distributed more evenly across space. The

[10] 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.[11]

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
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.[12] 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

[11] 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.

[12] 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.[13] For the other sectors, the shares of the between components in total observed concentration were lower, ranging between 49% and 59%.[14]

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 0.45, Portugal exhibited a above-average intra-national geographic concentration. The same is true for each of the four sectors.

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.

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
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

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

[13] 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. Nonetheless, 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.

[14] 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.

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.

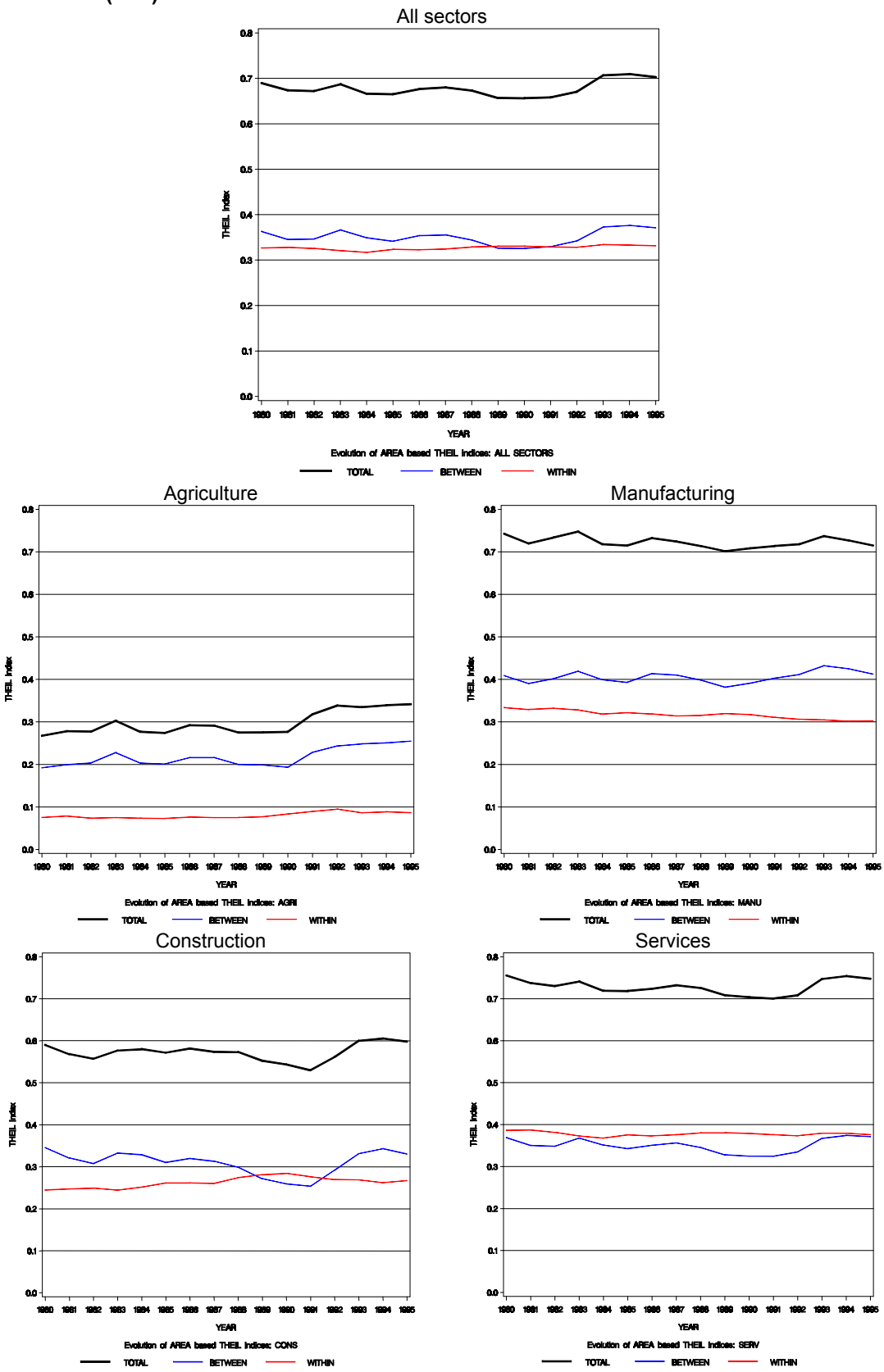
There were, however, some differences between the distributions of sector-specific and total activities within countries, as indicated by the country-specific within components of the Theil index. Among the countries for which regionally disaggregated data are available in the underlying data set, Portugal showed an average degree of spatial concentration in all non-agricultural sectors.

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)

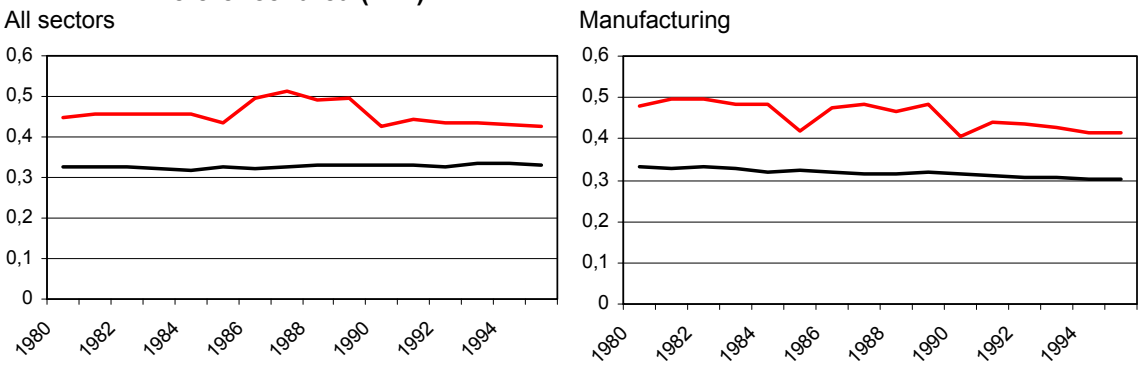


The deconcentration in the 1980s was mirrored by all sectors except agriculture. The services and construction sectors, in particular, were distributed more evenly across space in the late 1980s than they had been in the early 1980s.[16] In both sectors, the driving forces were decreasing inequalities 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.[18] The process can be attributed to the German re-unification to a good deal.

The evolution of the topographic concentration of economic activity within Portugal was characterized by a temporary upswing of concentration in 1986 and 1987 that was, however, reversed in 1990 and 1991 (Figure 2.1-2). This temporary movement was superposed by a secular, very slight decrease of concentration, resulting from similar though more explicit evolutions of manufacturing and services and a contrarious evolution of construction.

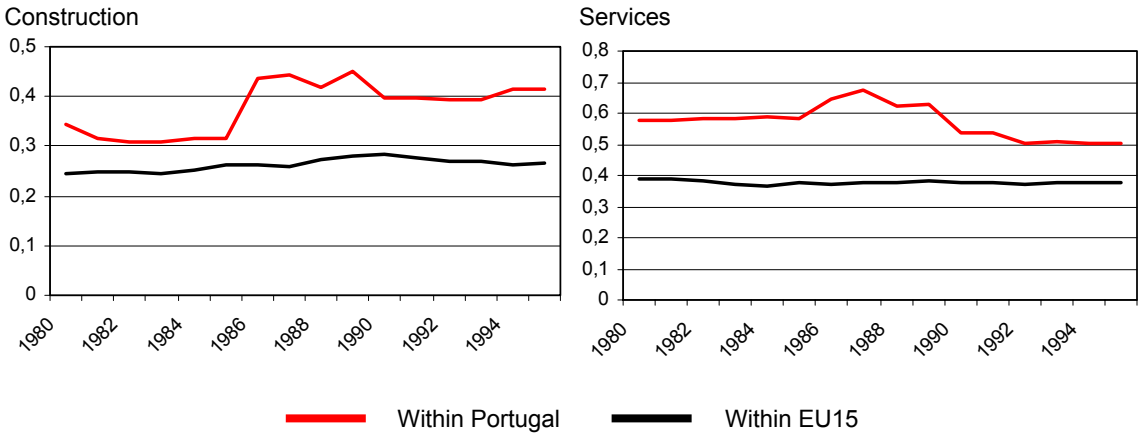
Figure 2.1-2 — Evolution of topographic concentration within Portugal and within EU15 countries 1980–1995: within components of Brülhart/Träger Theil indices, reference: area (km²)



[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).

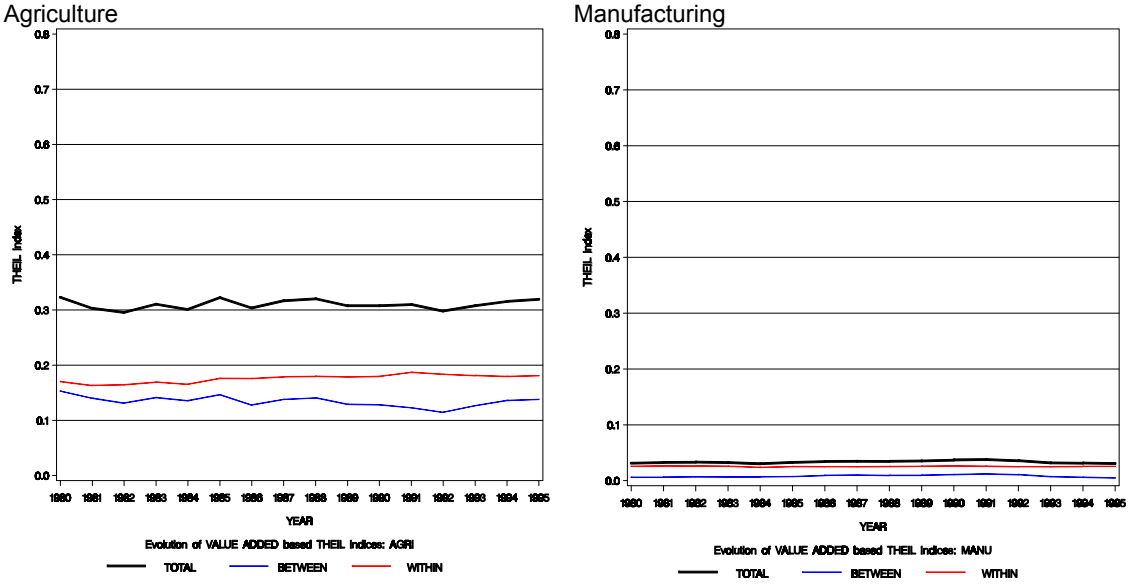
[17] In terms of exports, Brülhart (2001) reported no significant changes in the concentration patterns of industries at the national levels. In terms of employment, however, Brülhart and Torstensson (1998) and Brülhart (2001) reported evidence of an increasing concentration of manufacturing industries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

[18] According to Aiginger and Pfaffermayr (2004), the increase in concentration of manufacturing industries in the early 1990s did, in fact, interrupt the long-term trend towards deconcentration of these industries only temporarily.

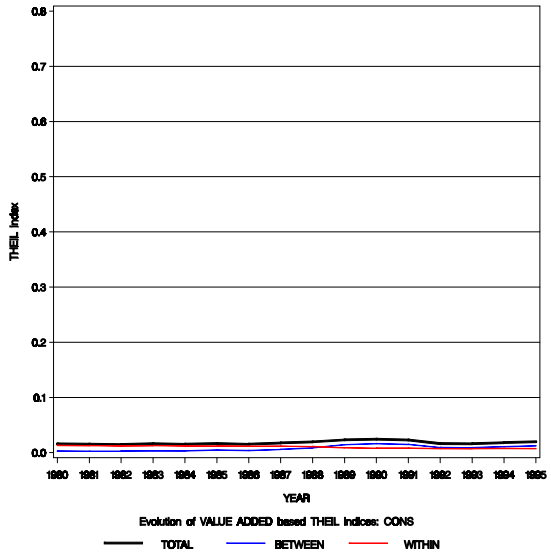


Turning to the evolution of economic concentration in Europe, as evidenced by value added-relative Theil indices (Figure 2.1-3), no significant changes could be observed. The only sector which, according to this measure, exhibits some economic concentration, is agriculture because agricultural production 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.

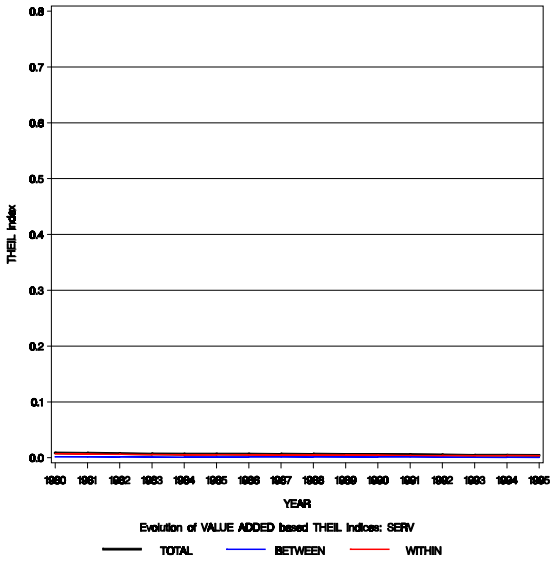
Figure 2.1-3: Evolution of economic concentration across 118 regions in EU15 countries by four sectors 1980–1995: Total, between and within components of Brülhart/Träger Theil indices, reference: total value added



Construction



Services



Summing up, Portugal is found to be among the EU countries exhibiting the highest concentration of sectors in terms of topographic concentration, yet only average concentration in terms of economic concentration. Over time, the concentration of Portuguese sectors decreased slightly while it increased, or decreased at slower pace, for overall European sectors.

2.2. Groups of industries and their characteristics

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 Portuguese economy. Yet, due to insufficiently disaggregated data for other sectors in other countries, the analysis is restricted here to the (120) industries of the manufacturing sector. All the same, some broad concentration characteristics for the other sectors within Portugal 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, services and other market services reveal to be highly concentrated in terms of absolute, relative and topographic concentration,

while manufacturing is highly concentrated in terms of relative concentration. The other services sectors are to be found somewhere between these extremes, yet more resembling the credit and insurance services sector than the agricultural sector. The different messages between these indicators reflect the fact that particularly manufacturing is 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 Portugal to be an industrialized country with a relatively broad dispersion of manufacturing.

Table 2.2-1: Concentration of Portuguese sectors in 1991

Economic sectors	Theil index	Weighted Theil index	Topographic Theil index
Agricultural, forestry and fishery products	0.3204	**0.1154**	0.1418
Manufacturing	**0.7232**	0.0625	0.4405
Building and construction	0.4255	0.0094	0.3008
Recovery, trade, lodging and catering services	0.4572	0.0189	0.3992
Transport and communication services	0.5859	0.0645	**0.5697**
Services of credit and insurance institutions	**0.7147**	**0.0990**	**0.6620**
Other market services	**0.6861**	**0.0937**	**0.6335**
Non-market services	0.4663	0.0230	0.3987

Source: INE, Census data

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 Portuguese 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.

Table 2.2-2: Correlation matrix for concentration measures of Portuguese sectors in 1991 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.28377 (0.4958)	**0.98267** **(<.0001)**	0.50888 (0.1978)	**0.86447** **(0.0056)**
Weighted Theil index		1.00000	0.36175 (0.3786)	**0.94709** **(0.0004)**	0.19167 (0.6493)
Herfindahl index			1.00000	0.60069 (0.1153)	**0.92453** **(0.0010)**
Krugman index				1.00000	0.48414 (0.2241)
Topographic Theil index					1.00000

The *classification* of groups of Portuguese industries is conducted for the year 1991, 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 1991, measured by a weighted Theil index – for comparison, the simple Theil and the topographic Theil index are also presented.[19]

The classification proceeds in three steps yielding four groups of Portuguese manufacturing industries (table 2.2-1):

- *Resource intensive industries*: includes all industries depending on highly localized resources, i.e., petroleum refining, ore and coal mining and coke ovens, iron and steel works, mining, production and transformation of non-ferrous metals and non-metal minerals. 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, office and computing machinery and electronic material industries, some branches of the chemical and machinery industries, automobile industry, professional instruments industries, printing. 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.
- *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, ceramics industries, some automotive, machinery and chemical industries, some food industries, arms and ammunition industry, water and gas supplies, shipbuilding.
    - Other industries are fairly *dispersed*, like several branches of the construction material and glass industries, of the textiles industry, of the rubber and plastic materials industries, foundries and metal finishing, electricity supplies, paper industries, branches of the machinery industry, foods, clothing, wood and other consumption goods industries.

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

Table 2.2-1: Types of industries in Portugal – Results of classification, Theil indices 1991

Ind. Class	Manufacturing industries	Re-source depend.	Internal IRS	Weighted index	Simple index	Topogr. index
	Resource intensive industries					
9	Extracção e aglomeração de linhite	1	high	-	-	-
10	Extracção e aglomeração de turfa	1	medium	2.241	0.906	0.813
19	Extracção e refinação do sal	1	medium	1.646	0.707	0.896
13	Extracção de minérios de urânio e de tório	1	high	1.608	1.715	1.135
18	Extrac.min.para a indúst,quím.para fab.adu	1	medium	1.525	0.872	0.306
15	Ext.prep.min.metál.n/fer,exc.min.urânio,tó	1	high	1.301	0.726	0.161
73	Fab.de outros produtos minerais não metáli	1	high	1.110	1.388	0.848
54	Fabricação de coque	1	high	0.825	0.452	0.390
12	Activ. serv.relac.extrac.petról.gás,exc.pr	1	medium	0.812	1.437	1.479
74	Siderurgia e fabricação de ferro-ligas (ce	1	high	0.609	1.305	1.276
14	Extracção e preparação de minérios de ferr	1	high	0.549	0.630	0.113
20	Outras indústrias extractivas, n.e	1	medium	0.533	0.428	0.064
11	Extracção de petróleo bruto e gás natural	1	medium	0.437	0.990	0.921
55	Fabricação de produtos petrolíferos refina	1	high	0.428	0.843	0.649
8	Extracção e aglom.da hulha (inclui antraci	1	high	0.374	1.365	0.901
76	Out.act.1ªtransf.fer.aço(c/fab.fer-lig.n/c	1	high	0.212	0.948	0.780
75	Fabricação de tubos	1	high	0.152	1.062	0.837
77	Obtenção e 1ª transform. de metais n/ferro	1	high	0.101	0.747	0.368
	High IRS industries					
56	Tratamento de combustível nuclear	0	high	1.309	1.946	2.042
113	Fab. de aeronaves e de veículos espaciais	0	high	1.209	1.837	1.927
63	Fabricação de fibras sintéticas ou artific	0	high	1.050	1.282	0.743
97	Fab. de acumuladores e de pilhas eléctrica	0	high	0.931	1.527	1.585
57	Fabricação de produtos químicos de base	0	high	0.823	1.257	1.222
95	Fab. mat.de distrib.e controlo p/instal.el	0	high	0.770	0.626	0.265
105	Fab. equipam/ controlo processos industria	0	high	0.614	1.049	0.770
70	Fabricação de cimento, cal e gesso	0	high	0.562	0.816	0.604
93	Fab. máq.escrit.e equip.p/trat. automát.in	0	high	0.533	0.954	0.613
101	Fab.apar.emis.rád,telev,ap.telef.,teleg.fi	0	high	0.376	0.937	0.847
110	Fab.compon.e aces.p/veíc.autom.e seus moto	0	high	0.364	0.582	0.242
69	Fab.tij.,telhas e out. prod.barro p/constr	0	high	0.355	0.766	0.603
103	Fab. de material médico-cirúrgico e ortopé	0	high	0.341	1.025	0.963
104	Fab inst,aparel.med,verif.control,nav,out.	0	high	0.303	0.975	0.837
98	Fab.de lâmpadas eléct. e de outro mat.ilum	0	high	0.253	1.137	0.966
102	F ap.r.mat.rá.tel.ap.grav.rep.som imag. ma	0	high	0.232	1.341	0.982
96	Fabricação de fios e cabos isolados	0	high	0.225	1.048	0.883
94	Fab. motores, geradores e transf. eléctric	0	high	0.191	1.099	0.896
99	Fabricação de outro equipamento eléctrico	0	high	0.186	0.901	0.699
107	Fab. de relógios e material de relojoaria	0	high	0.173	1.254	0.834
108	Fabricação de veículos automóveis	0	high	0.160	0.818	0.625
106	Fab. mat. óptico, fotográf. e cinematográf	0	high	0.081	0.820	0.530
109	Fab. de carroçarias, reboques e semi-reboq	0	high	0.036	0.814	0.536
100	Fabricação de componentes electrónicos	0	high	0.024	0.731	0.426
	Footloose industries					
68	Fab.azul,ladril,mosaic. e placas de cerâmi	0	medium	1.648	1.788	1.219
81	Fab.gerad.vapor(exc.cald.para aquecim/cent	0	low	1.518	1.658	1.115
80	Fab.res.,recip.,cald.rad.metál.p/aquec.cen	0	low	1.488	1.669	1.106
114	Fabricação de motociclos e bicicletas	0	medium	1.243	1.467	0.918
30	Indústria do tabaco	0	low	1.163	1.217	1.590
91	Fabricação de armas e munições	0	medium	1.081	1.336	0.881
112	Fab. e rep.de mat.circulante p/caminhos fe	0	medium	0.961	1.483	1.499
58	Fab.pesticidas e de outros prod.agroquímic	0	low	0.838	1.113	0.743
23	Indúst.conserv.frutos e de prod.hortícolas	0	low	0.806	0.713	0.524
38	Confecção de artigos de vestuário em couro	0	low	0.742	0.425	0.672
53	Reprodução de suportes gravados	0	low	0.633	1.354	1.331
127	Captação, tratamento e distribuição de águ	0	medium	0.588	1.102	1.116
60	Fabricação de produtos farmacêuticos	0	medium	0.561	1.266	1.244
125	Produção e distribuição de gás por conduta	0	medium	0.542	1.142	1.155
111	Construção e reparação naval	0	medium	0.532	1.094	1.086
86	Fab máq.eq.prod.ut.energ.m(mot.p/aer,aut,m	0	medium	0.525	0.951	0.607
36	Fabricação de tecidos de malha	0	low	0.492	0.863	0.357
16	Extracção de pedra	0	low	0.435	0.592	0.165
33	Acabamento de têxteis	0	low	0.428	1.622	1.153
51	Edição	0	low	0.414	0.965	1.009
61	Fab.sabões,det,prod.limp,polim,perf,higien	0	medium	0.409	0.932	0.837
43	Indústria do calçado	0	low	0.394	1.592	1.132
87	Fabricação de máquinas de uso geral	0	medium	0.393	1.036	1.008
24	Prod.óleos e gorduras animais e vegetais	0	low	0.369	0.886	0.749
66	Fabricação de vidro e artigos de vidro	0	medium	0.363	0.843	0.528
27	Fabricação de alimentos compostos para ani	0	low	0.345	0.710	0.567
35	Outras indústrias têxteis	0	low	0.321	1.053	0.894
22	Indúst.transf. da pesca e da aquacultura	0	low	0.314	0.381	0.399
25	Indústria de lacticínios	0	low	0.299	0.334	0.297
72	Serragem, corte e acabamento da pedra	0	low	0.289	0.564	0.330
92	Fabricação de aparelhos domésticos, n.e	0	medium	0.281	1.117	0.968
41	Curtimenta e acabamento de peles sem pêlo	0	low	0.280	1.052	0.917
40	Prep.,tingimento e fab.art. de peles com p	0	low	0.272	0.891	0.422
88	Fab.máq.e tract., p/agric, pecuária e silv	0	medium	0.271	0.583	0.277

to be continued

Table 2.2-1 continued

Ind. Class	Manufacturing industries	Re-source depend.	Internal IRS	Weighted index	Simple index	Topogr. index
34	Fab. de artigos têxteis conf.,excep.vestuá	0	low	0.270	1.372	0.930
62	Fabricação de outros produtos químicos	0	low	0.264	1.068	0.900
31	Preparação e fiação de fibras têxteis	0	low	0.259	1.377	0.924
82	Fab.prod.forj.,estamp.elaminados;metal.dos	0	low	0.243	0.983	0.756
119	Fabricação de artigos de desporto	0	low	0.232	0.810	0.421
26	Transf.cereais,leg.;f.de amidos,féc.prod.a	0	low	0.226	0.355	0.159
32	Tecelagem de têxteis	0	low	0.223	1.225	0.757
49	Fab. pasta, de papel e cartão (exc.canelad	0	low	0.221	0.736	0.456
59	Fab.tint.vern.prod.simil;mastiq.tint.impre	0	medium	0.192	1.075	0.897
90	Fab.outras máquinas e equip.p/uso específi	0	medium	0.192	1.117	0.889
21	Ab.de an., prep.e cons.carne prod.base car	0	low	0.185	0.671	0.532
52	Impressão e activ.dos serv.relac.c/a impre	0	low	0.178	0.851	0.726
67	Fab.prod.cerâm.n/refrac.(exc.const.)e refr	0	medium	0.171	0.777	0.585
126	Prod. e dist.vapor e água quente;prod.de g	0	medium	0.159	0.972	0.765
42	Fab.art.viagem,uso pessoal,marroq.,de cor,	0	low	0.150	1.101	0.836
124	Prod.,transporte e distrib. de electricida	0	medium	0.145	0.404	0.378
64	Fabricação de artigos de borracha	0	low	0.142	1.042	0.798
79	Fabricação de elementos de construção em m	0	low	0.141	0.935	0.728
47	Fabricação de embalagens de madeira	0	low	0.140	0.749	0.421
48	Fab.out ob mad.,ob.cest,espart.;indúst.cor	0	low	0.138	0.799	0.622
71	Fab.produtos betão, gesso,cimento e marmor	0	low	0.133	0.511	0.386
37	Fabricação de artigos de malha	0	low	0.131	1.092	0.653
117	Fab. joalharia, ourivesaria e art.similare	0	low	0.128	1.172	0.822
28	Fabricação de outros produtos alimentares	0	low	0.119	0.526	0.377
44	Serração, aplainam. e impregnação da madei	0	low	0.119	0.658	0.321
17	Extracção de areias e argilas	0	low	0.110	0.644	0.343
115	Fab. de outro material de transporte, n.e	0	medium	0.105	0.561	0.404
123	Reciclagem de desperdícios n/ metálicos	0	medium	0.105	0.864	0.482
45	Fab.folh,cont,pain,lam,part,fib.e out.paín	0	low	0.102	0.781	0.412
46	Fabric. obras de carpintaria para a constr	0	low	0.090	0.435	0.262
121	Indústrias transformadoras, n.e	0	low	0.084	0.572	0.323
39	Conf.outros artigos e acessórios de vestuá	0	low	0.077	1.033	0.634
29	Indústria das bebidas	0	low	0.069	0.571	0.428
120	Fabricação de jogos e brinquedos	0	low	0.067	1.037	0.686
65	Fabricação de artigos de matérias plástica	0	low	0.061	0.873	0.637
50	Fab. papel,cartão canelados,art.papel e ca	0	low	0.059	0.942	0.651
122	Reciclagem sucata e desperdícios metálicos	0	medium	0.058	0.887	0.629
118	Fabricação de instrumentos musicais	0	low	0.051	0.760	0.469
85	Fabricação de outros produtos metálicos	0	low	0.049	0.774	0.450
116	Fabricação de mobiliário e de colchões	0	low	0.048	0.975	0.629
78	Fundição de metais ferrosos e não ferrosos	0	medium	0.043	0.923	0.607
84	Fab.de cutelaria, ferramentas e ferragens	0	low	0.040	0.773	0.442
83	Trat.e revest.metais;activ.mecânica em ger	0	medium	0.026	0.768	0.488

Source: INE, Census data.

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.

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 Portugal several of these industries are not, like branches of the 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 ceramic and textiles industries, to be fairly dispersed,

yet again, in Portugal, this is not always the case. Some of these are even quite highly concentrated like production of tiles, and of boilers and tanks. Part of an explanation is that even in a deep sectoral breakdown like in the Portuguese case of 120 manufacturing industries, these industries in some cases are not very homogenously defined. Another part of an explanation is that some industries are extremely narrow defined and are thus highly concentrated simply due to indivisibilities.

Table 2.2-2: Correlation matrix for concentration measures of Portuguese manufacturing industries in 1991 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.45845 (<.0001)	**0.97284 (<.0001)**	0.59973 (<.0001)	**0.85860 (<.0001)**
Weighted Theil index		1.00000	0.49955 (<.0001)	**0.91042 (<.0001)**	0.42630 (<.0001)
Herfindahl index			1.00000	0.65296 (<.0001)	**0.85467 (<.0001)**
Krugman index				1.00000	0.58467 (<.0001)
Topographic Theil index					1.00000

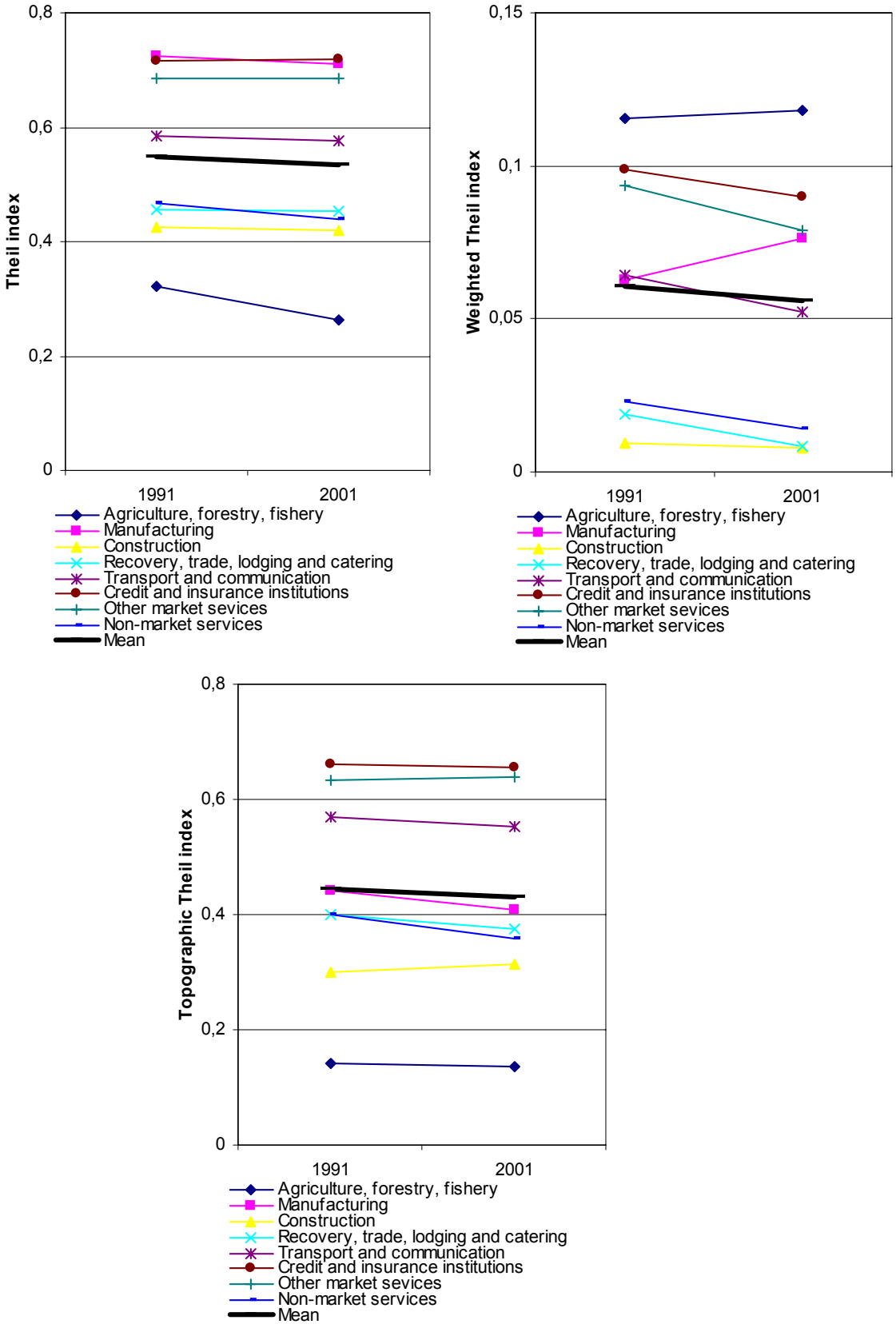
Source: INE, Census data

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, weighted Theil, 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, employment

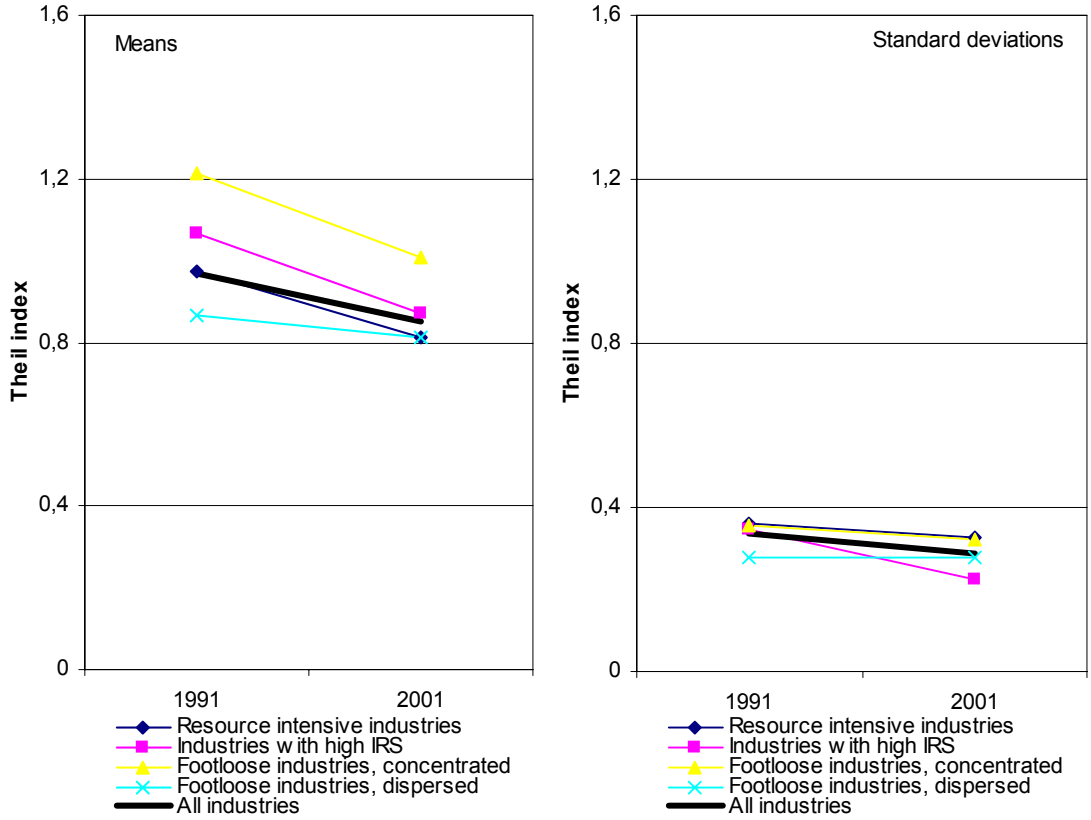


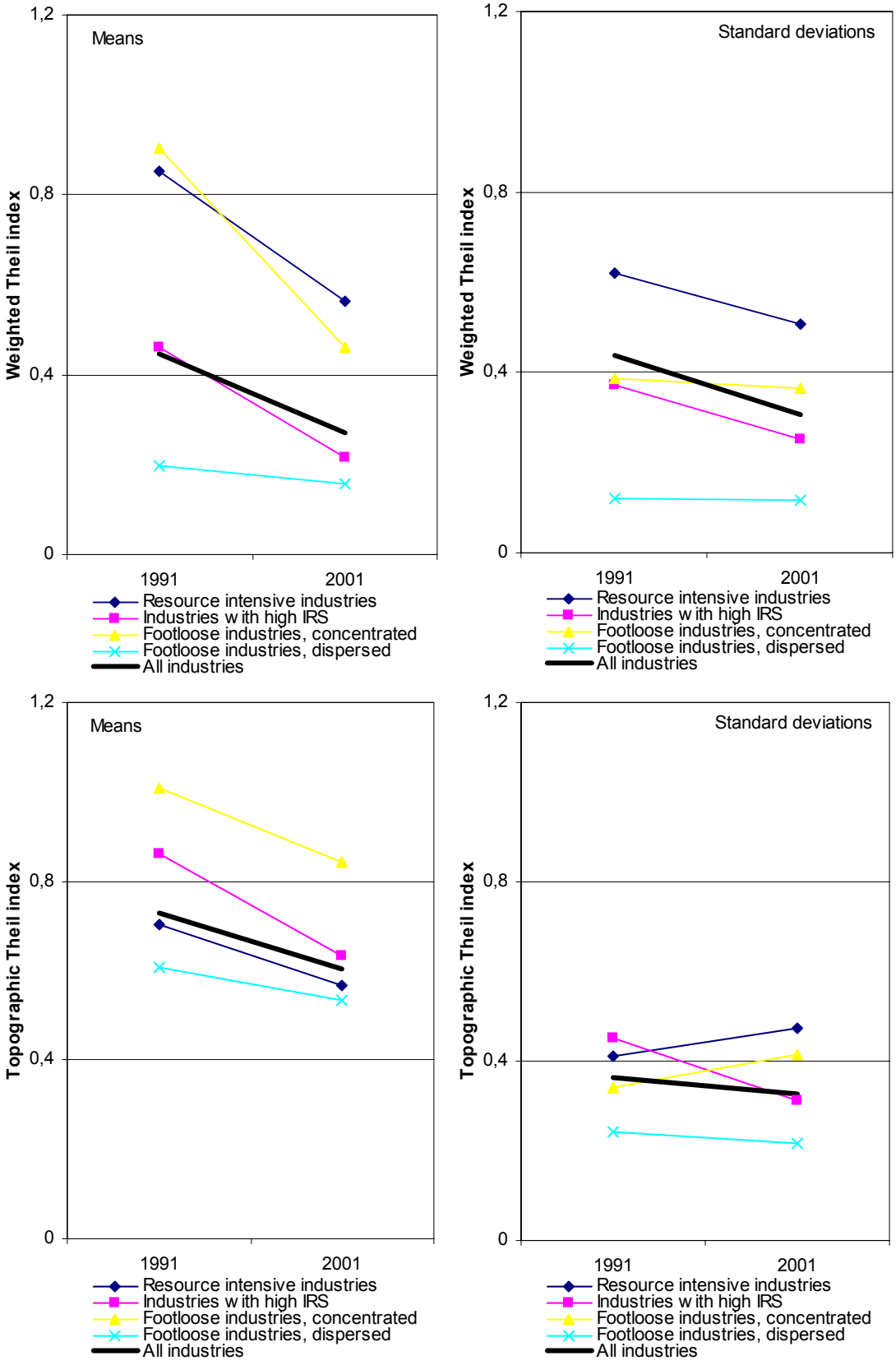
Source: INE, Census data.

Over time, in the 1990s, the message of the three indicators is the same with respect to the evolution of total average yet not of its components: Whereas all three indicators indicate a slight decrease of total average concentration, this is result of a more or less congruent concentration decrease for all sectors in the case of simple and topographic Theil index, and result of concentration increase for agriculture and manufacturing and decrease of all other sectors in the case of the weighted Theil index. Thus, whereas all sectors become increasingly dispersed across the landscape, some of them (agriculture and manufacturing) become more concentrated as compared to overall employment.

The concentration behavior of *manufacturing industries* is also analyzed on the basis of weighted Theil indices in comparison to Theil and topographic Theil indices. To offer a comprehensive view on the evolution of all 120 industries without getting lost in details, means and standard deviations are calculated across industries for each industry group (figure 2.3-2). The figures demonstrate a high average concentration of industries with internal IRS, and a remarkably low average concentration of resource intensive industries (except in terms of economic concentration), the concentration degrees of concentrated and dispersed footloose industries being in accordance to their definition.

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



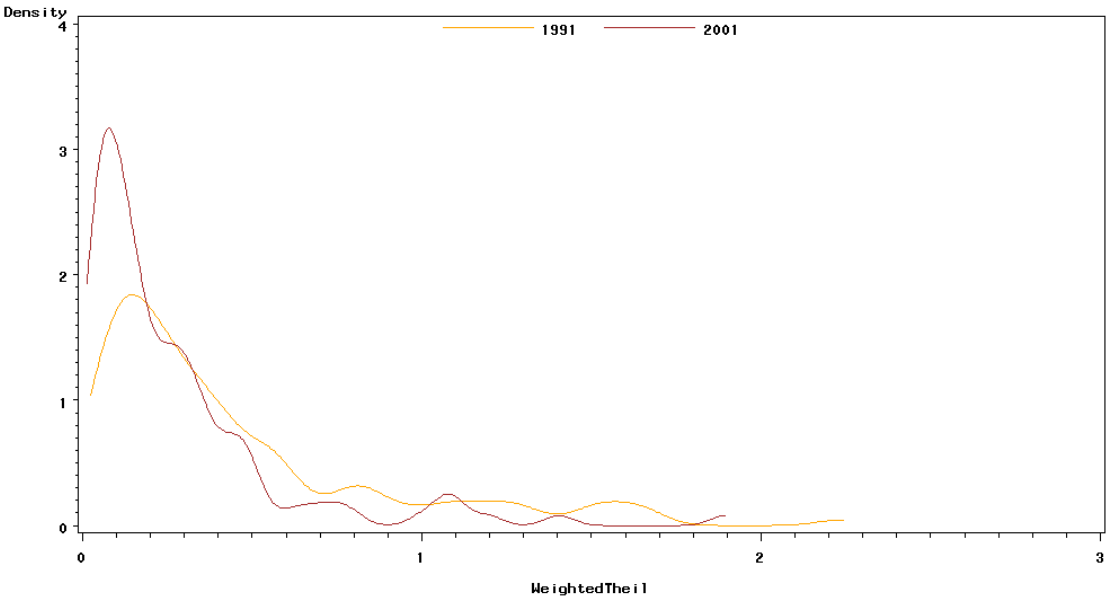


Source: INE, Census data.

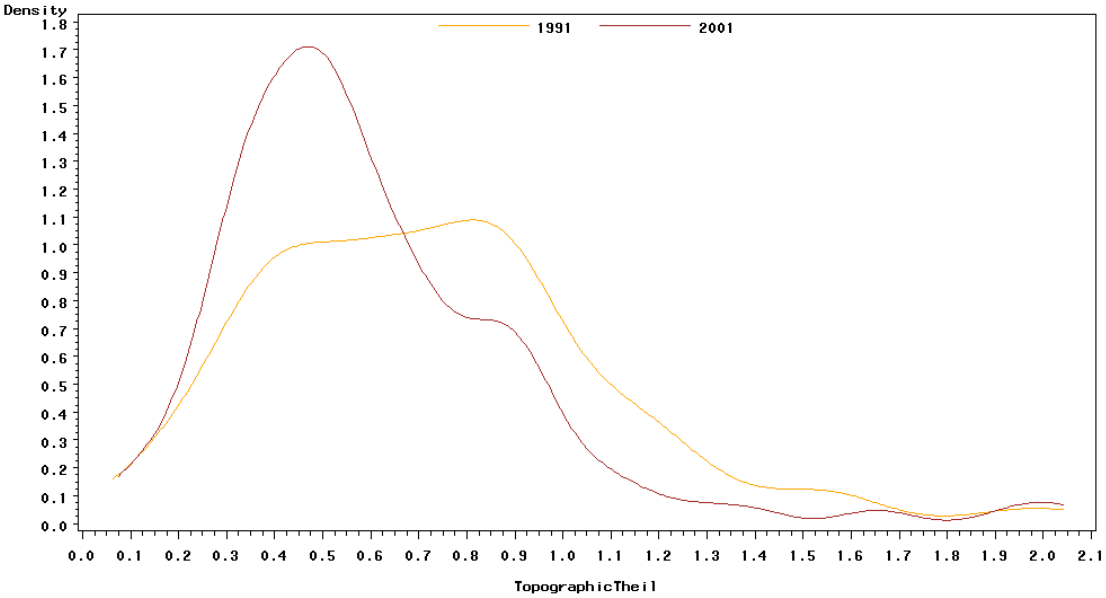
Over time, concentration decreases across all industries and for all industry groups, and this holds true whatever indicator is applied.[20] The decrease seems to be the stronger, the higher the concentration was in the initial year. Also, standard deviations within industry groups seem to decline: Accordingly, the overall impression yields at the same time a decrease and a convergence of industrial concentration in Portugal. No obvious pushing influences of major integration steps can be detected.

This view of concentration decrease and convergence is confirmed by kernel density functions of industrial concentration for several years (figure 2.3-3). According to such function based on the weighted Theil index, the distribution of industrial concentration reveals a peak at a value of about 0.2 points in the initial year. The distribution is skewed as there seem to be a considerable number of industries with higher concentration compared to the peak. Based on the topographic Theil index, the distribution reveals two peaks at a value of about 0.4 and 0.85 points. *Over time*, however, there is a clear change for both indices as to the positions of the peaks: They shift to the left and become steeper at the same time thus indicating a growing number of industries with lower concentration levels.

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



[20] To give an impression of magnitudes: A change of the 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 A-3.3 in appendix).



Source: INE, Census data.

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 Portuguese economy – and may accordingly be also to the detriment or advantage of Portuguese 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 Portugal and their overall performance (table 2.4-1). During the observation period, other market services, non-market services, construction and recovery, trade and lodging services seem to grow quickly or at least noticeably in terms of employment. By contrast, agriculture and manufacturing envisage severe job losses. 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 absolute and relative concentration of sectors, it appears that concentration is not related to any specific direction of employment change. 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 not significant.

Turning to employment figures for manufacturing industries (table 2.4-2), manufacturing as a whole obviously loses employment throughout the observation period. This loss is most dramatic in the case of resource intensive industries and concentrated footloose industries. By contrast, industries with high internal IRS experience a remarkable job growth. In contrast

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 show this trend to be highly significant whatever concentration measure is adopted (table 2.4-2).

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

Economic sectors	Relative concentration in 1991	Shares in 1991	Growth 1991-2001
Agricultural, forestry and fishery products	0.1154	10.79	-6.33
Manufacturing	0.0625	27.15	-0.54
Building and construction	0.0094	10.72	2.57
Recovery, trade, lodging and catering services	0.0189	19.40	2.49
Transport and communication services	0.0645	4.59	0.95
Services of credit and insurance institutions	0.0990	2.13	0.90
Other market services	0.0937	3.06	7.87
Non-market services	0.0230	22.16	2.64
Total economy	.	100.00	1.20
Correlation between initial concentration (1991) and subsequent employment growth (1991-2001)			
Concentration measures	Pearson correlation coefficients	Error probabilities	
Theil index	0.44494	0.2693	
Weighted Theil index	-0.34549	0.4019	
Herfindahl index	0.46897	0.2411	
Krugman index	-0.10709	0.8007	
Topographic Theil index	0.64402	0.0848	

Source: INE, Census data.

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

Groups of industries	Relative concentration in 1991	Shares in 1991	Growth 1991-2001
Resource intensive industries	0.85	1.83	-5.57
Industries with high IRS	0.46	6.60	3.42
Footloose industries, concentrated	0.90	7.78	-5.78
Footloose industries, dispersed	0.20	83.79	-0.44
Total manufacturing	0.45	100.00	-0.54
Correlation between initial concentration (1991) and subsequent employment change (1991-2001)			
Concentration measures	Pearson correlation coefficients	Error probabilities	
Theil index	**-0.28452**	**0.0017**	
Weighted Theil index	**-0.58174**	**<.0001**	
Herfindahl index	**-0.28384**	**0.0018**	
Krugman index	**-0.46141**	**<.0001**	
Topographic Theil index	**-0.25526**	**0.0051**	

Source: INE, Census data.

The general conclusion on industrial concentration is thus: The Portuguese sectors and industries reveal a considerable variation as to their concentration degrees in the initial year. Over the observation period of 10 years, the concentration pattern of sectors remain more or less unchanged whereas the concentration pattern of manufacturing industries seemingly becomes more alike. At the same time, spatially concentrated industries within manufacturing

perform better than spatially dispersed ones whereas there is no comparable correlation in the case of sectors.

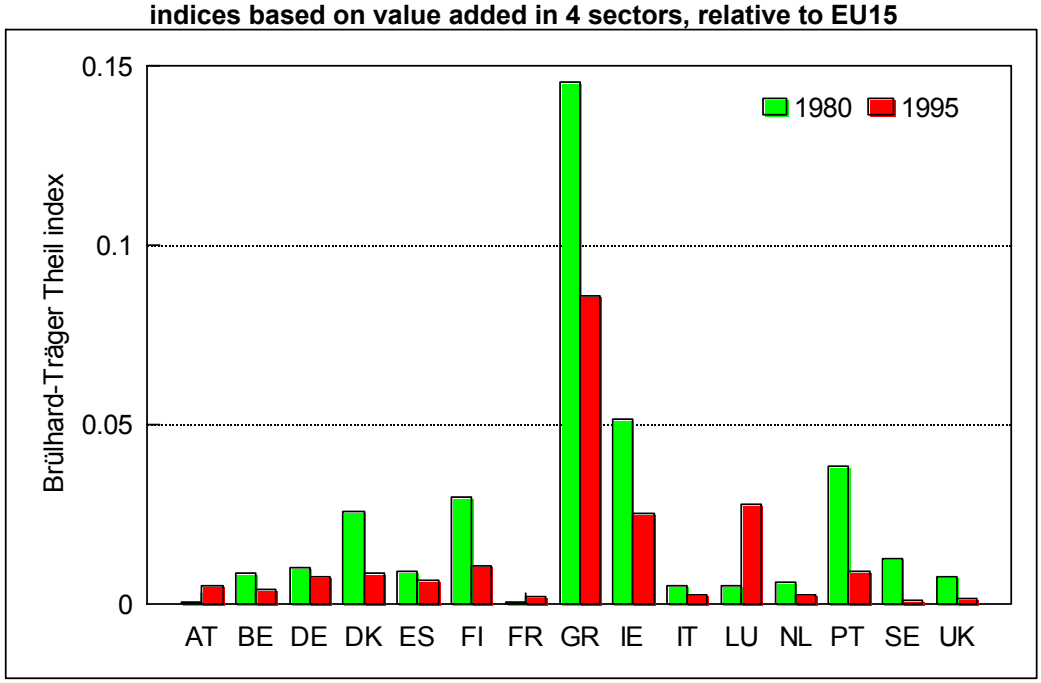
3. Specialization of regions

3.1.1 Position of Portuguese regions in the European division of labour

To put the specialization patterns of Portuguese regions into a broader, European perspective, this section will briefly describe the position of Portugal as a whole, and of the Portuguese 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.

Figure 3.1-1 Specialization of EU15 countries 1980 and 1995 – Brülhart-Träger Theil indices based on value added in 4 sectors, relative to EU15



During the 1980s and early 1990s, the sectoral specialization of most European countries converged towards the EU average of about 0.004 points.[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

[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).

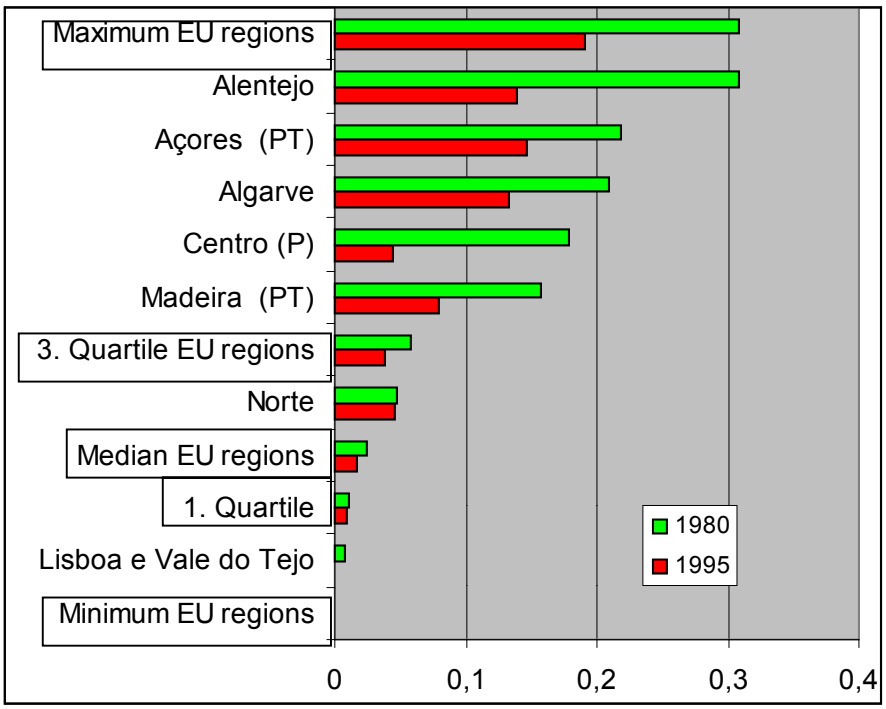
reasons: Neither was the convergence generally stronger for newcomers than for incumbent member states, nor was it generally stronger for poor than for rich countries.

For Portugal, this process of structural convergence implied a more or less continuous decrease of specialization over time (Figure A3-1). These developments were mainly induced by the manufacturing sector.

Specialization of Portuguese regions

To assess the degree of specialization of the 10 NUTS 1 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 Portuguese regions. For comparison, Figure 3.1-2 also reports the quartiles of the distribution of the Theil indices across all 119 EU15 regions. The Figure shows that the majority of the Portuguese regions exhibited a degree of specialization in the upper 4th quartile of EU15 regions. As to the evolution over time, all Portuguese regions experienced decreasing specialization during the period under investigation (1980–1995), as did Portugal and the EU15 as a whole.

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



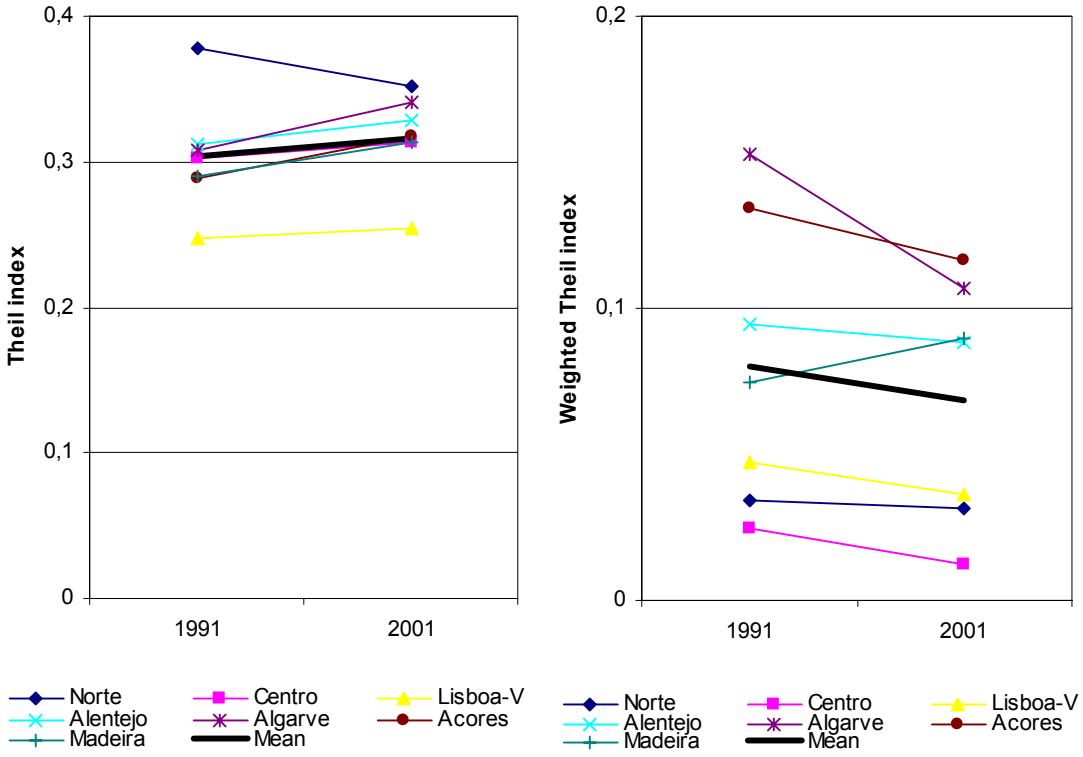
3.1.2 Overview on the specialization of Portuguese regions

As an introduction to the specialization part of the paper, an overview on the specialization pattern of all 7 Portuguese 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 3.1-3 presents the absolute and relative specialization of Portuguese regions referring to the 8 *sectors* aggregated from the INE census data set, as measured by Theil indices and weighted Theil indices. The region of Lisboa e Vale do Tejo appears to be quite diversified both in absolute and relative terms. The region Norte appears to be specialized in absolute and diversified in relative terms which is to say that it seems to be particularly specialized in sectors that are also important for Portugal as a whole (and that are highly localized in Norte). *Over time*, on average, specialization seems to increase in absolute terms and to decrease in relative terms.

Figure 3.1-3: Specialization of Portuguese regions, sectors 1991-2001



Source: INE, Census data.

These results for the Theil and weighted Theil indices are confirmed by similar results for respective other absolute and relative specialization measures. Table 3.1-1 depicts the high and significant correlation between absolute Theil and Herfindahl indices and relative weighted Theil and Krugman indices.

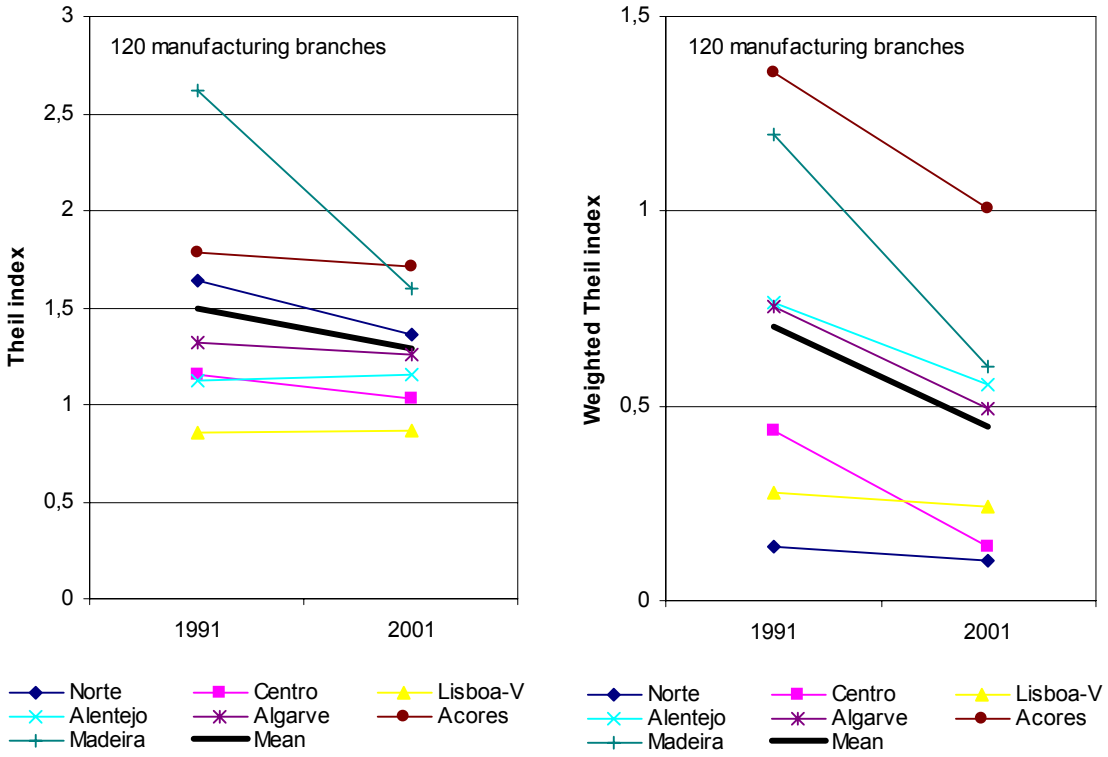
Table 3.1-1: Correlation matrix for measures of sectoral specialization of Portuguese regions in 1991 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	-0.15078 (0.7469)	**0.85785** **(0.0135)**	-0.18949 (0.6841)
Weighted Theil index		1.00000	-0.01477 (0.9749)	**0.96202** **(0.0005)**
Herfindahl index			1.00000	-0.00015 (0.9998)
Krugman index				1.00000

Source: INE, Census data.

The general assessment of the specialization of all Portuguese 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 3.1-4.

Figure 3.1-4: Specialization of Portuguese regions, manufacturing industries 1980-2002



Source: INE, Census data.

The graphs demonstrate a considerable amount of variation of Portuguese regions with respect to specialization, both in absolute and relative terms. Particularly highly specialized are the off-shore regions Açores and Madeira. Norte seems to be specialized in absolute terms, yet diversified in relative terms, which is to say that Norte inhabits industries that

predominate its manufacturing sector and that are also highly localized in the very region Norte. The results are confirmed by high correlations to other absolute and relative measures (Herfindahl and Krugman index; table 3.1-2).

Over time, the specialization of Portuguese regions decreases both in absolute and relative terms.[23] This is in line with the above findings on specialization of Portuguese regions in the European context: It seems to decrease both compared to other European regions and to other Portuguese regions.

Table 3.1-2: Correlation matrix for measures of industrial specialization of Portuguese regions in 1991 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	0.62033 (0.1372)	**0.94636** **(0.0012)**	0.56908 (0.1824)
Weighted Theil index		1.00000	0.50667 (0.2459)	**0.98259** **(<.0001)**
Herfindahl index			1.00000	0.48955 (0.2648)
Krugman index				1.00000

Source: INE, Census data.

To sum up, a cautious conclusion is that specialization of Portuguese regions seems to be relatively high compared to other European regions, yet seems to decrease during the observation period of growing EU integration. Moreover, for neither indicator, a pushing influence of major integration steps on specialization 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 analyze the specialization pattern of Portuguese 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 year 1980, the initial year of the data base, eleven discriminating variables are applied: (i) seven variables characterizing each region's structural composition with respect to broad economic sectors (i.e., each region's employment 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

[23] 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).

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, for details cf. appendix), four types of Portuguese 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 and figure 3.2-1):

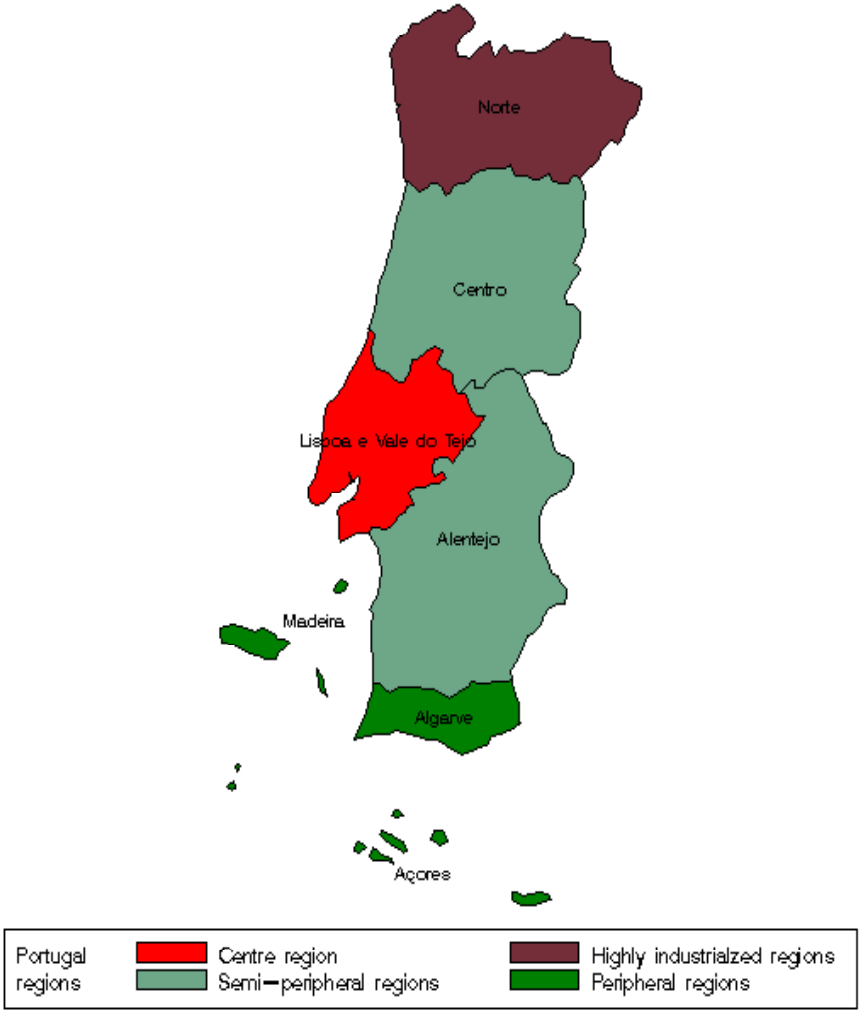
- *Highly industrialized region*: characterized by relatively high shares of manufacturing, with a focus on dispersed footloose industries; contains the region Norte that is situated at the north of Portugal.
- *Centre region*: characterized by relatively high shares of credit and insurance, other market and non-market services, of high IRS and concentrated footloose industries; contains the region Lisboa e Vale do Tejo.
- *Semi-peripheral regions*: characterized by shares close to average for all sectors and manufacturing industries; contains the regions Centro and Alentejo. These regions are situated in the middle of the country.
- *Peripheral regions*: characterized by relatively high share of agriculture, building and construction and recovery, trade and lodging services, with a focus on dispersed footloose industries; contains the holiday region Algarve and the off-shore regions Madeira and Açores. These regions are situated at the utmost periphery of the country.

Table 3.1-1: Classification of Portuguese regions

Regions	Agriculture	Building and construction	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 (employment)								Shares in percent of total manufacturing (employment)			
						Highly industrialized region						
Norte	10.58	11.26	16.37	3.15	1.48	2.15	16.86	**38.15**	0.91	3.84	1.56	**93.68**
						Centre region						
Lisboa-V	5.14	8.94	22.37	6.78	**3.45**	**4.85**	27.24	21.22	2.70	**11.46**	9.46	76.37
						Semi-peripheral regions						
Centro	**17.05**	11.80	16.89	3.44	1.24	1.81	20.77	27.00	2.18	7.17	25.57	65.07
Alentejo	**23.23**	10.56	18.35	2.92	1.39	2.00	26.18	15.37	8.84	10.73	5.14	75.29
						Peripheral regions						
Algarve	**13.51**	**14.22**	**34.11**	4.80	1.50	3.91	20.13	7.82	2.81	4.89	4.17	**88.13**
Acores	**19.37**	**13.66**	**16.01**	5.77	2.01	1.97	31.80	9.42	0.16	2.06	8.24	**89.54**
Madeira	**16.34**	**13.54**	**23.90**	4.90	1.24	1.54	25.42	13.12	0.16	0.84	1.30	**97.70**

Source: INE, Census data.

Figure 3.1-1: Portuguese region classes



3.3. Evolution of specialization over time by region classes

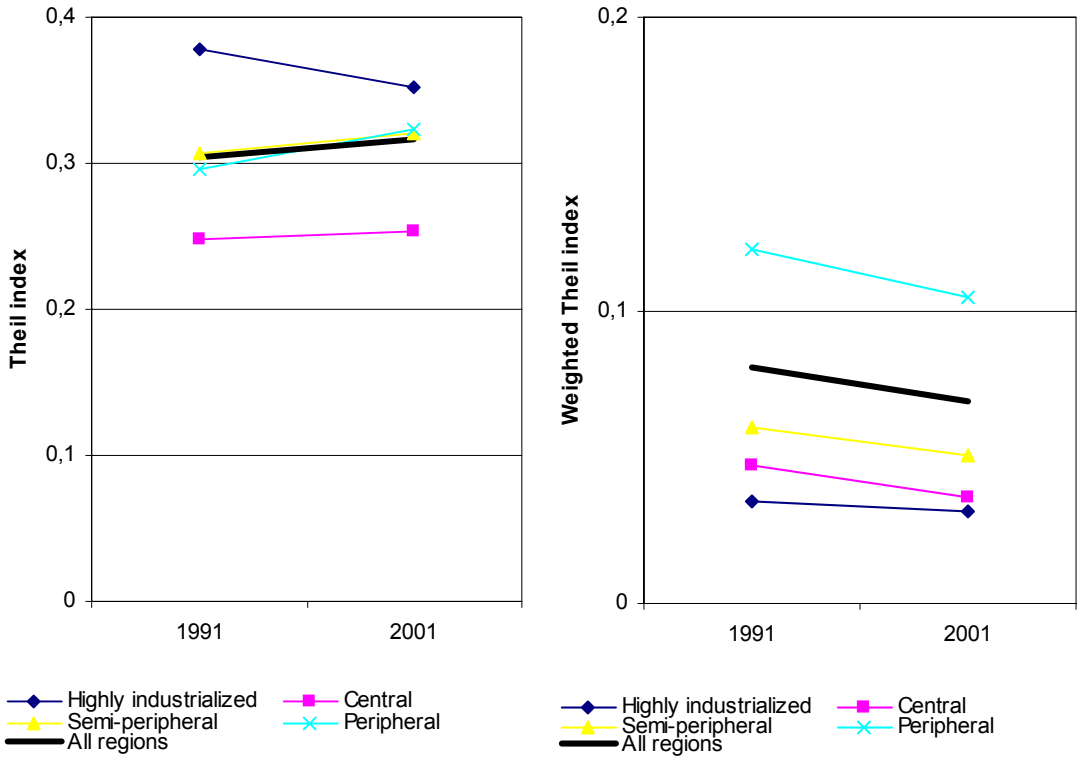
As trade theories hold that the initial structural mix of a region matters for its further economic development, the evolution of regional specialization within these classes of regions should reveal similar characteristics. Questions are, what region classes get more specialized, what more diversified, over the observation period of more than 20 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 referring to *sectors*. Accordingly:

- the highly industrialized region exhibits the highest specialization degrees in absolute terms, yet the lowest in relative terms, which is due to the specialization on the large and comparably localized manufacturing sector; the centre region appears to be highly diversified;
- both, absolute and relative specialization seem to converge between region classes as the highly specialized become more diversified and the others do not change much; in absolute terms this evolution is accompanied by an overall specialization decrease, in relative terms by an overall maintenance of the specialization degree.

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



Source: INE, Census data.

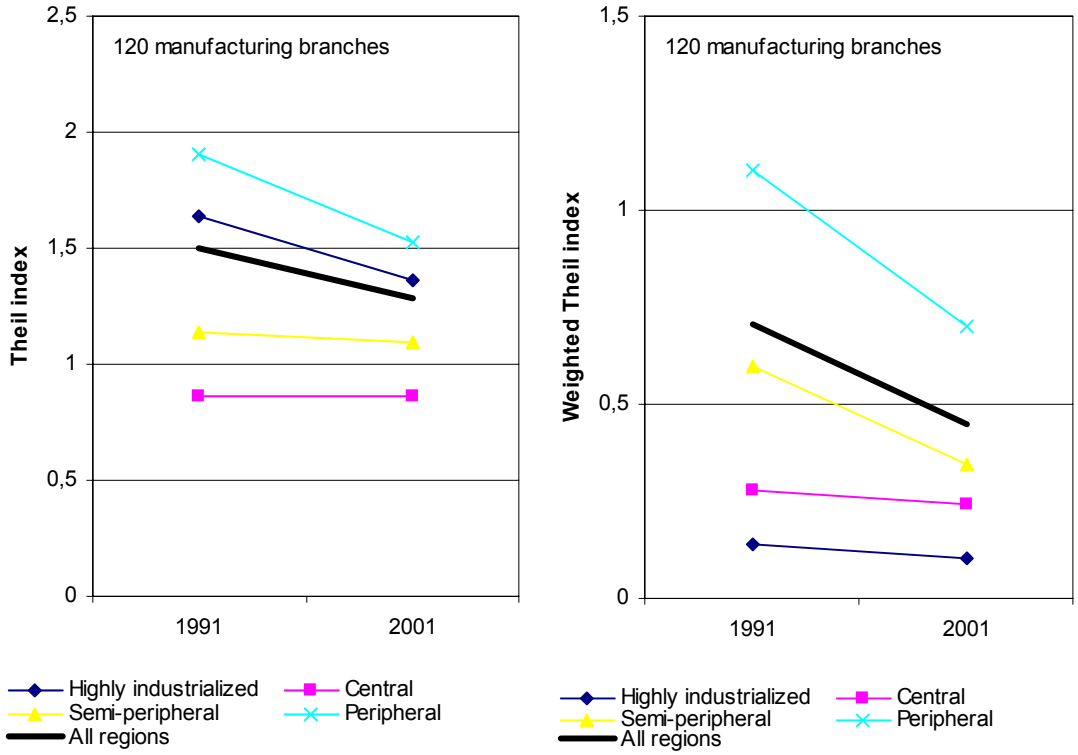
To complete the pattern of specialization for region classes, figure 3.3-2 presents means and standard deviations of specialization measures referring to *manufacturing industries*. Quite broadly, the results are here:

- The peripheral regions reveal the highest specialization, both in absolute and relative terms. 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 old industrialized and core regions

ahead, the latter peripheral and semi-peripheral regions. The standard deviations of these region classes are low, indicating the homogeneity of the classes.

- The specialization of most region classes decreases both in absolute and relative terms. The region classes converge, in that the specialization of the more specialized classes decreases towards that of the less specialized region classes.

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



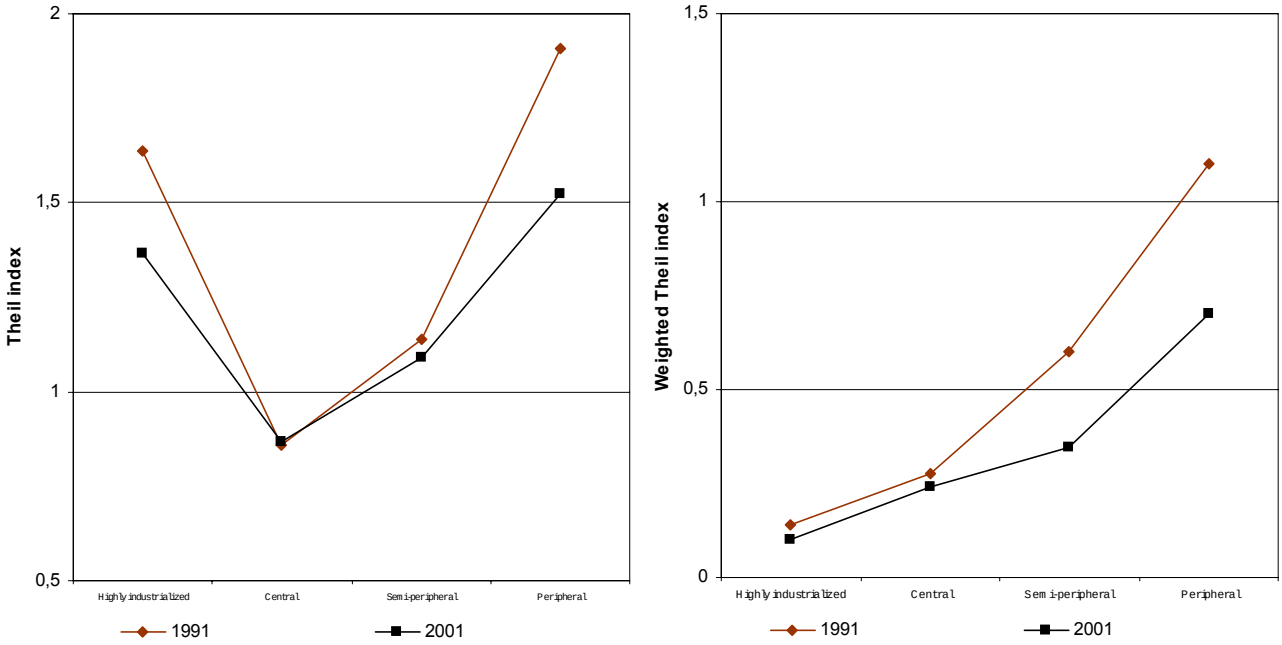
Source: INE, Census data.

The same problem 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 situation on an axis stretching from the north east to the south west: from the highly industrialized region via the center region and the semi-peripheral regions to the peripheral regions. According to this illustration, regional specialization is high at the peripheries (highly industrialized and peripheral regions) and low at the centre of the country, whereas it is at medium level for regions in-between center and periphery.[24] In terms of

[24] This pattern for Portugal differs from what can be observed for German, French and Spanish regions: In that cases, not only the peripheries (highly industrialized and peripheral regions) but also the central regions reveal an elevated specialization degree, whereas the in-betweens tend to be more diversified. This pattern complies to some NEG models that suggest a high specialization of the center (on IRS industries) and of the peripheries (on non-IRS industries), and a low specialization for the in-between space.

relative specialization, the pattern differs only with respect to the highly industrialized region. Over time, specialization of all regions decreases.

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



Source: INE, Census data.

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 Portuguese 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 Portuguese 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 employment. By contrast, the highly industrialized and the semi-peripheral regions seem to drag behind. Relating this information to the above notations on the concentration of sectors, it appears that specialization is not related to any direction of the regional employment change. 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 insignificant for whatever indicator on initial specialization.

Table 3.4-1: Specialization and average annual rates of change of total regional employment

Region types	Absolute specialization in 1991	Shares in 1991	Employment change 1991-2001
Highly industrialized regions	0,378	36.37	0.98
Central regions	0,247	16.41	1.38
Semi-peripheral regions	0,307	39.42	1.07
Peripheral regions	0,295	7.81	1.68
Total	.	100.00	1.20
Correlation between initial specialization (1991) and subsequent employment change (1991-2001)			
Specialization measures	Pearson correlation coefficients	Error probabilities	
Theil index	-0.12726	0.7857	
Weighted Theil index	0.55462	0.1963	
Herfindahl index	0.19727	0.6716	
Krugman index	0.43767	0.3261	

Source: INE, Census data.

Turning to manufacturing employment, we find this sector to register overall job losses in Portugal throughout the observation period. The highest job losses occur to peripheral and center regions (table 3.4-2). By contrast, the highly industrialized and semi-peripheral regions perform relatively well. Again, no relation to the initial specialization can be detected.

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

Region types	Absolute specialization in 1991	Shares in 1991	Employment change 1991-2001
Highly industrialized regions	1.637	51.09	0.57
Central regions	0.858	16.31	-1.49
Semi-peripheral regions	1.138	29.76	-0.46
Peripheral regions	1.908	2.83	-1.54
Total	.	100.00	-0.54
Correlation between initial specialization (1991) and subsequent employment change (1991-2001)			
Specialization measures	Pearson correlation coefficients	Error probabilities	
Theil index	-0.50804	0.2444	
Weighted Theil index	-0.03653	0.9380	
Herfindahl index	-0.72492	0.0653	
Krugman index	-0.05253	0.9110	

Source: INE, Census data.

To sum up: the regions, identified by cluster analysis, reveal considerable differences with respect to their specialization, yet the ranking differs whether drawing on absolute or relative specialization measures. Over time, Portuguese regions become more similar both with respect to their sectoral specialization and their industrial specialization. The initial specialization of regions does not seem to influence their subsequent performance regarding job gains or losses.

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.

The analysis is restricted to manufacturing industries here. 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. Obviously, there is no correlation between localization on any specific industry group and the subsequent change of specialization in the region concerned, as all correlation coefficients are highly insignificant. By contrast, significant correlations can be detected between localization on resource intensive industries or on concentrated footloose industries and the subsequent performance of the respective sector in each respective region. These correlations are all negative, which is to say the more a these industry groups are already localized in a specific region, the more they tend to register job losses in the very region. However, 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.

Finally, in order to detect whether the specialization of the Portuguese 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

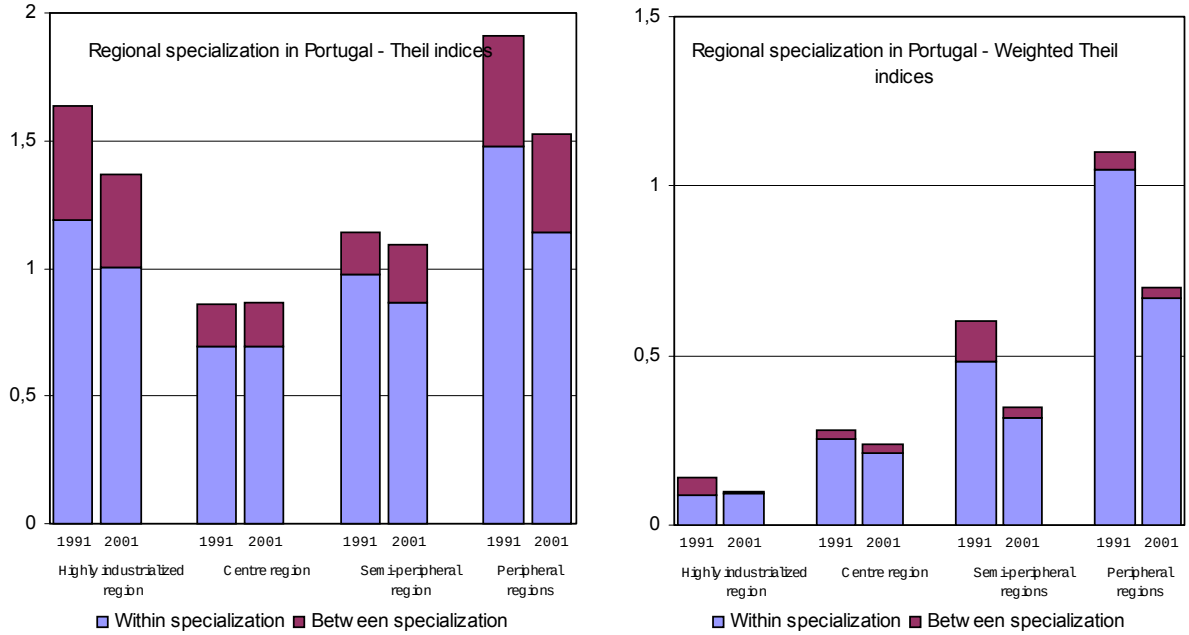
component describing the specialization degree on the four groups of industries (between index), and a component describing the specialization degree within these type classes of industries (within index). The results for the different region classes are clear: most variation of total specialization stems from specialization within the industry types; specialization with respect to the four industry types offers not much explanation for total specialization. This result holds when applying the relative specialization measure.

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						
All regions	0.49483 (0.2589)	0.29320 (0.5234)	041592 (0.3534)	0.28048 (0.5424)	**-0.97504 (0.0002)**	0.11949 (0.7986)
Industries with high IRS						
All regions	0.66381 (0.1040)	0.63607 (0.1246)	0.58632 (0.1665)	0.44646 (0.3153)	0.32375 (0.4787)	0.03906 (0.9337)
Concentrated footloose industries						
All regions	0.34401 (0.4499)	0.03709 (0.9371)	0.34565 (0.4476)	-0.32342 (0.4792)	**-0.97135 (0.0003)**	0.31206 (0.4956)
Dispersed footloose industries						
All regions	-0.60632 (0.1489)	-0.32529 (0.4765)	-0.56003 (0.1911)	0.00259 (0.9956)	-0.55305 (0.1978)	-0.26764 (0.5617)

Source: INE, Census data.

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



Source: INE, Census data.

Part D. Conclusion: Results for the Portuguese case

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

- Portugal is found to be among the EU countries exhibiting the highest concentration of sectors in terms of topographic concentration and this holds for all sectors of the Portuguese economy. Yet, the Portuguese sectors and manufacturing industries reveal a considerable variation as to their concentration degrees in the initial year. Thus, credit and insurance and other market services and some manufacturing industries regarded footloose are highly concentrated. The regions classified as semi-peripheral or peripheral are much specialized as compared to other European regions, the centre region of Lisboa e Vale do Tejo is highly diversified. The region Norte looks highly specialized in absolute and lowly specialized in relative terms, which indicates a specialization on highly localized sectors and industries. Moreover, the regions situated at the country's peripheries tend to be higher specialized than the regions in-between.
- Integration, which can be said to be growing during the observation period of 10 years, changes concentration and specialization pattern in Portugal. The concentration of Portuguese sectors remains more or less unchanged whereas the concentration of Portuguese manufacturing industries decreases and becomes more alike. Also, Portuguese regions seem to become more diversified and more similar with respect to their sectoral and industrial specialization.
- Initial concentration degrees seem to exert little influence on the subsequent evolution of concentration of industries. Initial specialization degrees, however seem to exert an influence on the subsequent specialization of regions: the higher the specialization the more pronounced its subsequent decrease.
- Initial concentration seems to influence the performance of manufacturing industries: (Spatially) concentrated industries seem to perform worse than (spatially) dispersed ones. The initial specialization of regions does not seem to influence their subsequent performance regarding job gains or losses.
- A high initial localization of resource intensive or of concentrated footloose industries in a specific region seems to influence the employment change of these industry groups in this region: The more localized such industry groups are in a region the higher seem to be the job losses to that industry group in that very region.

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 Portugal and the UK. The sectors are agriculture, construction, 9 manufacturing and energy industries, and 6 services industries.

The second database is provided by the Instituto Nacional de Estatística (INE) that offers census data on persons employed. In principle, this source allows for almost any depth of breakdown by regions and sectors (manufacturing sectors as well as services), yet the access to sufficiently detailed data is restricted and requires specific permission. For the purpose of this paper, the data are arranged such to allow for an analysis of sectoral concentration and specialization in a similar break-down as for the other countries of the sample, i.e., for 8 sectors, including agriculture, manufacturing, and 6 service sectors. Within manufacturing, 120 industries are considered to allow for a more detailed analysis.

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.[25] 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

[25] 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:[26] 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.[27] 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.[28] As a consequence, the measure would be biased. The bias would be

[26] 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.

[27] 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).

[28] 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.[29] 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.[30] 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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[29] 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.

[30] 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.[31] 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.[32] 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

[31] 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.

[32] 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.[33] 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.

[33] 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]	$\sum_{i=1}^{I}(a_i(j))^2$	$\dfrac{\dfrac{\sum_{i=1}^{I}(a_i(j)-a_i)^2}{\left(1-\sum_{i=1}^{I}a_i^2\right)}-H}{1-H}$	$\dfrac{\dfrac{\sum_{i=1}^{I}(a_i(j))^2-\sum_{i=1}^{I}a_i^2}{\left(1-\sum_{i=1}^{I}a_i^2\right)}-H}{1-H}$
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

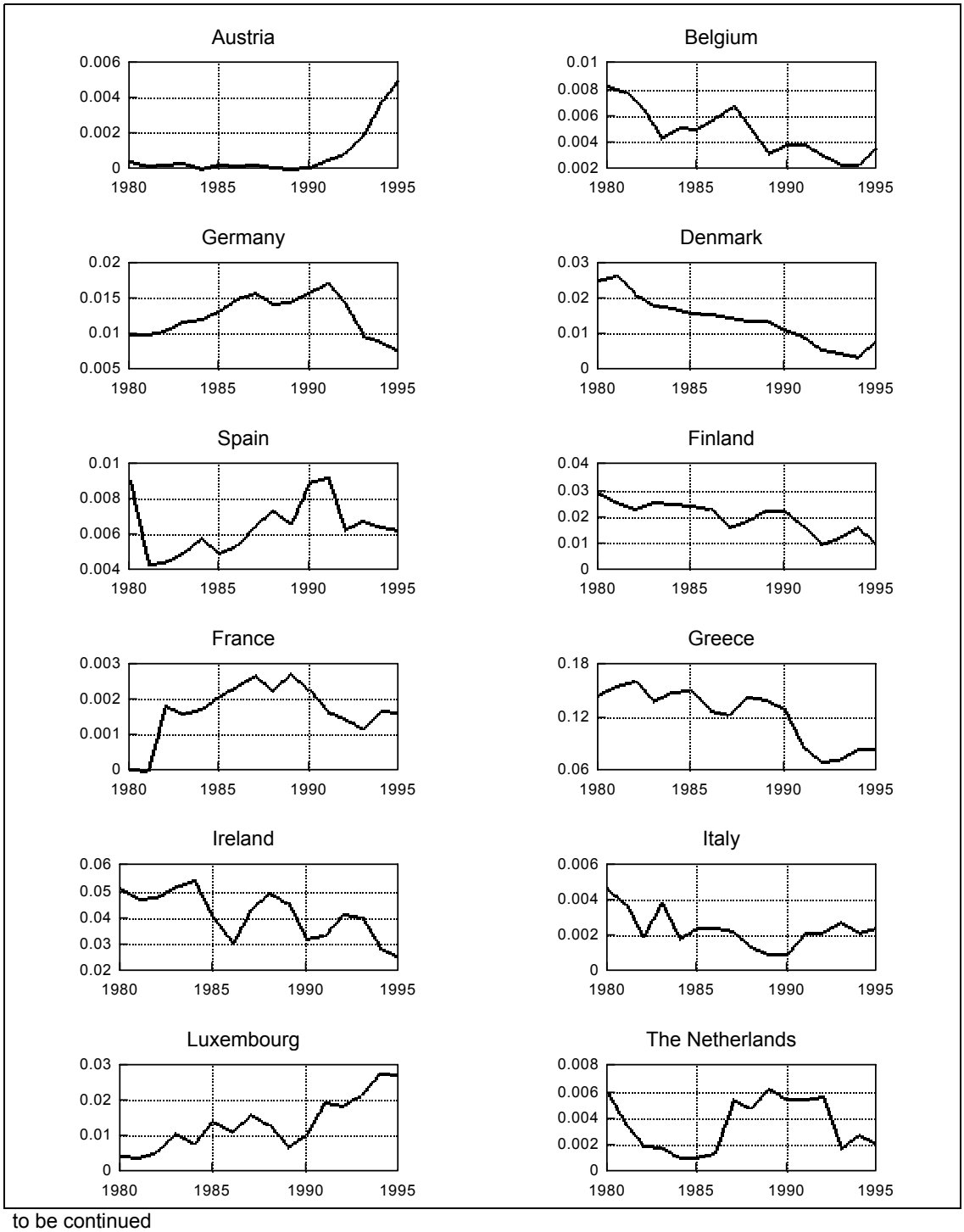
Table A3–1 — Geographic concentration of four sectors across 118 regions in EU15 countries: Absolute changes in total, between and within components of Brülhart/Träger Theil indices 1980-1995, reference: total area

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

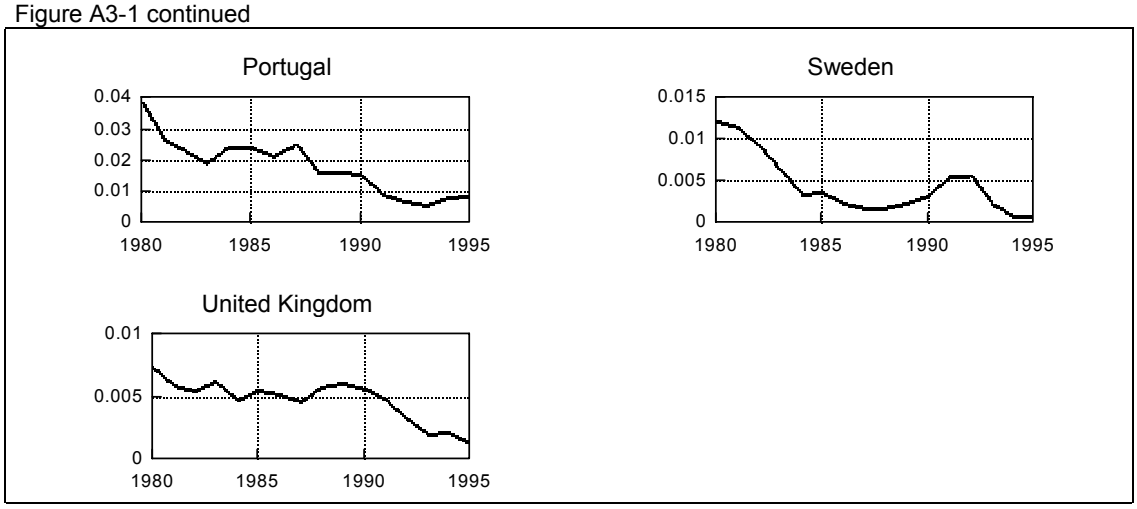
Index-component/ Country-specific within	All sectors	Agriculture	Manufac-turing	Construction	Services
Total	—	–0.004	–0.000	+0.004	–0.005
Between	—	–0.015	–0.001	+0.010	–0.002
Within	—	+0.011	+0.001	–0.006	–0.003
Austria	—	—	—	—	—
Belgium	—	–0.040	+0.028	+0.002	–0.000
West-Germany	—	–0.009	–0.000	+0.001	–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



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