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European Integration, regional structural change and cohesion in Germany

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 Germany

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EURECO

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Executive Summary

The present country study summarizes stylized facts for West Germany[1] about the general topographic, demographic, economic and political conditions as well as about the evolutions of industrial concentration and regional specialization during the last about 20 years. The study summarizes the results of the initial phase of Workpackage 2 within the EURECO project "The impact of European integration and enlargement on regional structural change and cohesion". The main purpose of the EURECO project is to assess the relevance of European integration in general, and the recent eastern enlargement of the EU in particular, derogating the process of economic cohesion among European regions. On the background of new trade theories and theories of new economic geography, the project analyses empirically (i) the impact of European integration on the specialization of regions, and (ii) the impact of regional specialization on regional income, employment and growth. Workpackage 2 within this project, focusing on the incumbent EU Member States, summarizes and analyzes the experiences to be drawn from the European integration process so far, laying particular emphasis onto previous EU enlargements. Subsequent phases of Workpackage 2 will analyze the links between economic integration and regional specialization more rigorously.

The present paper analyses regional specialization and spatial concentration in Germany during the time period 1980 to 2002. The period is sufficiently long for capturing important milestones of the European integration process, including several enlargement rounds as well as the completion of the Single Market in 1992.[2] The analysis distinguishes 10 West German NUTS 1 regions (value added by 4 sectors: agriculture, manufacturing, construction, services; value added; 1980–1995), respectively 31 West German NUTS 2 regions (employment by 167 industries within the manufacturing sector; 1980, 1987–2002). Several statistical concentration and specialization measures are employed. The concentration of a sector or industry is measured either relative to land surface (reference: uniform distribution across space; labelled "topographic concentration"), or relative to the uniform distribution (reference: uniform distribution across regions; labelled "absolute concentration"), or relative to the distribution at the EU15 or the country level (reference: aggregate average distribution; labelled "relative concentration"). Similarly, the specialization of a region is measured either relative to a uniform distribution (reference: uniform distribution across sectors or industries within a region; labelled "absolute specialization"), or relative to the specialization pattern at the EU15 or the country level (reference: aggregate average specialization; labelled "relative specialization").

[1] Since this country sudy focuses on the long-term evolutions of concentration and specialization patterns, East Germany was excluded. Structural data for East Germany are not available for the period before the fall of the iron curtain in the late 1980s, and are not representative for the first half of the 1990s when the East German economy unterwent a process of fundamental reconstruction.

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

The results can be summarized as follows:

1. *Levels of industrial concentration*: On the backdrop of a generally low degree of topographic concentration of population and economic activity in the EU as a whole, Germany was among the EU countries exhibiting the lowest topographic concentration of economic activity in the early 1980s at both the aggregate as well as the sectoral levels. In contrast to other member states like France, the UK or Spain, Germany is polycentral. There is no single dominating economic center. Within the manufacturing sector, resource dependent industries, located predominantly the Ruhr and the Saar area, 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 dipersed.

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 West Germany. In both the EU as a whole, and in West Germany a weak tendency towards topographic deconcentration of economic activity prevailed.[3] The deconcentration was slightly more pronounced in West Germany, however, although the initial level of topographical concentration had already been very low. Within the manufacturing sector, no clear-cut tendencies towards increasing or decreasing concentration could be observed at the level of groups of industries (resource-intensive, IRS, other industries). The only exception were highly concentrated resource-intensive industries whose concentration increased slightly.

3. *Path dependence of industrial concentration*. There is some evidence of significant effects of initial concentration of sectors and industries onto the subsequent development of these sectors and industries at the national level in West Germany: Sectors that were concentrated comparatively high in topographic terms in the early 1980s tended to exhibit higher employment growth rates during the subsequent 2 decades (1980–2002) than topographically dispersed sectors.[4] The main reason for this positive correlation was the service sector which was comparatively highly concentrated and grew comparatively fast. Within the manufacturing sector, by contrast, a negative correlation is observed between the initial concentration of industries and their subsequent employment growth.

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[3] 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 Germany. The unification boom increased the concentration differences *between* the EU member states but did not affect the regional concentration patterns *within* West Germany to a notable extent.

[4] 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.

4. *Level of regional specialization*. In general, West German regions did not exhibit 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 West German economy. In the European context, West Germany was among the countries with the lowest degree of specialization. Among the West German NUTS 2 regions, the small city-states of Hamburg and Bremen as well as the Saarland were somewhat higher specialized than the other regions.

5. *Evolution of regional specialization*. As to the evolution of economic specialization of West German regions during the 1980s and the early 1990s, a weak trend towards de-specialization prevailed among West German regions both at the sectoral level as well as at the industry level within the manufacturing sector. After the mid-1990s, however, a weak trend towards increasing specialization can be observed which has been driven mainly by peripheral and semi-peripheral regions.

6. *Path dependence of regional specialization*. No evidence was found for a path dependence in the degrees of specialization of West German 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 almost all industry groups, including IRS industries. The region-industry specific negative effect of initial specialization was, however, limited in sectoral scope. In most cases, there is no indication of a region's specialization in a single industry group having significantly shaped the region's aggregate manufacturing employment growth. Only the sharp decline of the resource dependent coal mining and iron-and-steel producing in the Ruhr and the Saar area involved the whole respective regions significantly.

Map of Germany and its NUTS1 regions (“Bundesländer”)

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 West-German regions is one. Others concern Austrian, British, French, Greek, Irish, Italian, Portuguese, 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 German 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 West-Germany since 1980. Part D summarizes and concludes.

Part B. Stylized characteristics of Germany

1. Stylized country characteristics

1.1. Population and space

The country of Germany, situated at the center of Europe, yet, until the recently accomplished first round of the east enlargement, also at the east border of the European Union, covers an area of about 350 thousand square meters and inhibits a population of about 82 million people (table 1-1; former West Germany: 68 million people). It is a very densely populated country, with the density decreasing from the west and south-west to the north-east, and with a particularly high density stretching in a bow from the Stuttgart area along the Rhine river via Frankfort and the Ruhr area, then further via Hannover and Leipzig to Chemnitz in the south east.

Germany is divided into 31 “Regierungsbezirke” (regions at NUTS2 level) that are part of 14 “Bundesländer”, three of which are so-called Stadtstaaten, i.e., they are constituted as Länder although they are only cities without hinterland (Hamburg, Bremen, Berlin). Apart from these three regions, all other German regions vary much less with respect to population density than most other European countries. Moreover, densely and sparsely populated regions are much more scattered across the country than in other countries. Thus on the one hand, there are sparsely populated regions in each part of the country, like Mecklenburg-Vorpommern, Brandenburg, Lüneburg, Magdeburg, Oberpfalz and Niederbayern. On the other hand, there are also densely populated regions and major urban centers in each part of the country, like Hamburg, Bremen, Berlin, Düsseldorf, Köln, Darmstadt, Arnsberg and Saarland.

German Bundesländer enjoy considerable autonomy given the federal organization of the German constitution. This is, however, not true for Regierungsbezirke: As far as the Länder are subdivided into Regierungsbezirke (which does not apply to all Länder), these are mere administrative units under the governance of the Länder. The affiliations of Regierungsbezirke:

Bundesland	**Regierungsbezirke**	**Bundesland**	**Regierungsbezirke**
Schleswig-Holstein	-	Bayern	Oberbayern, Niederbayern, Oberpfalz, Oberfranken, Mittelfranken, Niederfranken, Schwaben
Hamburg	-		
Niedersachsen	Braunschweig, Hannover, Lüneburg, Weser-Ems		
Bremen	-	Saarland	-
Nordrhein-Westfalen	Düsseldorf, Köln, Münster, Detmold, Arnsberg	Berlin	-
		Brandenburg	-
		Sachsen	Chemnitz, Dresden, Leipzig
Hessen	Darmstadt, Gießen, Kassel	Sachsen-Anhalt	Dessau, Halle, Magdeburg
Rheinland-Pfalz	Koblenz, Trier, Rheinhessen-Pfalz	Thüringen	-
Baden- Württemberg	Stuttgart, Karlsruhe, Freiburg, Tübingen		

Table 1-1: Population and space in Germany

	Acreage	Population 2000	Population change last decade	Population density	Employment potential (pop15-65)	Participation rate (workforce) 2000
	1000 sqkm	Mio.	average annual	persons/sqkm	% of pop	% of potential
Schleswig-Holstein	15.8	2.8	0.7	176	67.6	70.5
Hamburg	0.8	1.7	0.5	2257	69.8	92.7
Braunschweig	8.1	1.7	0.3	206	66.8	73.6
Hannover	9.0	2.2	0.6	238	67.1	75.9
Lüneburg	15.5	1.7	1.2	107	66.8	61.4
Weser-Ems	15.0	2.4	1.1	161	66.5	72.2
Bremen	0.4	0.7	-0.2	1641	67.9	92.9
Düsseldorf	5.3	5.3	0.2	995	67.3	75.9
Köln	7.4	4.3	0.7	579	68.2	74.5
Münster	6.9	2.6	0.7	378	66.6	69.3
Detmold	6.5	2.0	1.0	314	65.6	78.0
Arnsberg	8.0	3.8	0.3	477	66.8	71.7
Darmstadt	7.4	3.7	0.6	500	69.2	79.2
Gießen	5.4	1.1	0.8	198	67.4	67.6
Kassel	8.3	1.3	0.7	153	66.1	75.6
Koblenz	8.1	1.5	1.0	188	65.7	70.0
Trier	4.9	0.5	0.7	104	65.8	68.8
Rheinhessen-Pfalz	6.9	2.0	0.8	292	67.4	69.1
Stuttgart	10.6	3.9	0.8	371	68.0	79.5
Karlsruhe	6.9	2.7	0.7	387	68.1	77.6
Freiburg	9.4	2.1	0.9	227	67.0	75.5
Tübingen	8.9	1.8	1.0	197	67.2	74.8
Oberbayern	17.5	4.0	0.8	230	69.0	83.2
Niederbayern	10.3	1.2	1.0	113	67.0	74.2
Oberpfalz	9.7	1.1	0.8	111	66.9	77.7
Oberfranken	7.2	1.1	0.5	154	66.4	78.4
Mittelfranken	7.2	1.7	0.7	232	67.6	81.2
Unterfranken	8.5	1.3	0.8	156	66.8	75.6
Schwaben	10.0	1.7	0.9	175	66.5	75.3
Saarland	2.6	1.1	0.1	417	67.2	75.8
Berlin	0.9	3.4	0.0	3799	72.1	73.1
Brandenburg	29.5	2.6	-0.2	88	71.1	68.2
Mecklenburg-Vorpommern	18.4	1.8	-0.9	77	71.0	70.3
Chemnitz	6.1	1.6		269	68.2	73.8
Dresden	7.9	1.7		217	69.2	75.9
Leipzig	4.4	1.1		250	70.0	75.3
Dessau	4.3	0.6	-1.1	129	69.8	65.8
Halle	4.4	0.9	-1.9	198	69.6	73.3
Magdeburg	11.7	1.2	-0.5	104	67.7	70.0
Thüringen	16.2	2.4	-0.9	151	70.3	72.3
Germany	357.0	82.2	0.4	230	68.1	74.9

1.2. Economic geography

Most prominently, Germany is characterized by its polycentric settlement structure. Relatively fertile soils are widespread, the climate is mild, and almost all parts of the country are easily accessible due to the lack of mountainous barriers, and due to the availability of several large, navigable rivers. Accordingly, all parts of Germany became densely populated.

Also, the situation at the center of Europe plays a major role in shaping the economic landscape of Germany. As Germany was always a transit country with many borders in all directions, there was no area that was particularly favored by its proximity to another country. All these factors worked in shaping the economic landscape of Germany very homogenously.

With respect to specific resource facilities shaping the economic landscape, most obvious are the coal deposits to be found in the Ruhr area (regions Düsseldorf, Münster, Arnsberg) and in Saarland (close to the French coal and iron deposits). As iron ores could easily be exported via the Rhine river (Ruhr area) or were available in close neighborhood (Saarland), the geographic conditions favored the emergence of the German iron-and-steel industry in these areas. Moreover, there are some oil and gas deposits in the regions of Weser-Ems, Hannover and Braunschweig, and some lignite deposits in the regions of Köln, Leipzig and Dresden. All other deposits are of minor significance.

1.3. Economic activities in space

The density of economic activities quite closely follows along the lines alleged by the conditions of geography and the spatial distribution of the population. The polycentric and quite homogenous structure is also a result of German history: For long, the country remained divided in lots of autonomous principalities, each with an own center that each sovereign tried to boost in competition to other principalities. It was not before the 19th century that unification made headway. Even then there did not emerge one large administrative, economic and cultural center as in the case of, e.g., France or Spain, but rather a number of almost equally large and important centers, i.e., Berlin, Hamburg, Munich (in region Oberbayern), Köln, Frankfurt (in region Darmstadt), Stuttgart, and several others.

Accordingly, the economic density is much more homogenous than in other countries (table1-2). Also, the structural composition of sectors is very homogenous. For, whereas in several countries the characteristic division of labour between urban centers and rural land also shapes the division of labour between the major economic center and the rest of the country, in Germany, this urban/rural division of labor occurs within each region rather then between them.

Table 1-2: Economic activities in space in Germany

	Unemployment rate	GDP	Economic density	Per-capita income	Productivity	Growth rate	Employment change	Sectoral structure GVA 2000		Sectoral structure employment 2000		Export rate	Investment	Foreign direct investment
	2001	2000	2000	2000	2000	last decade	last decade	Agriculture	Services	Agriculture	Services			
	% of workforce	Mio €	€/ sqkm	€/ population	€/ employment	average annual %	average annual %	%	%	%	%	% of GDP	% of GDP	% of GDP
Schleswig-Holstein	7.1	62104	3939	22361	50368	3.8				3.5	73.9			
Hamburg	6.5	72044	95384	42262	69120	3.8				0.5	82.2			
Braunschweig	9.2	41077	5072	24603	54624	4.1				2.1	64.7			
Hannover	7.9	54180	5989	25167	52957	3.6				2.1	73.5			
Lüneburg	6.7	30353	1958	18277	48232	4.3				5.3	70.4			
Weser-Ems	7.3	50590	3381	20942	46782	3.9				4.9	66.9			
Bremen	10.7	21936	54269	33081	56755	2.8				0.4	75.7			
Düsseldorf	7.8	147870	27952	28088	59096	3.7				1.1	71.9			
Köln	7.0	114432	15538	26839	56401	4.4				1.1	74.5			
Münster	7.6	53148	7697	20373	47535	3.4				2.6	68.2			
Detmold	6.8	50238	7707	24523	50931	4.4				2.3	62.8			
Arnsberg	8.1	88155	11017	23112	52280	3.2				1.2	65.3			
Darmstadt	4.7	128691	17286	34600	66114	3.1				1.0	75.3			
Gießen	5.7	23439	4356	22040	51674	4.0				2.3	65.4			
Kassel	7.6	29816	3597	23493	50681	3.7				2.9	66.3			
Koblenz	5.4	31531	3906	20796	47861	3.9				2.6	68.2			
Trier	5.2	10122	2056	19789	46177	3.9				5.1	66.8			
Rheinhessen-Pfalz	6.1	48776	7119	24351	55757	3.8				2.8	67.5			
Stuttgart	3.8	122237	11578	31204	60014	3.6				2.0	59.7			
Karlsruhe	4.7	78025	11277	29154	57826	4.1				1.3	66.3			
Freiburg	4.1	52022	5560	24476	50511	3.7				3.1	61.1			
Tübingen	3.7	45022	5049	25624	52967	3.8				3.1	60.1			
Oberbayern	3.1	145301	8289	36023	64777	4.7				2.6	71.2			
Niederbayern	4.3	26478	2563	22627	47562	5.0				6.8	56.8			
Oberpfalz	5.0	26933	2779	25071	50617	5.7				5.0	59.2			
Oberfranken	6.4	26770	3703	24026	48939	4.1				3.9	57.9			
Mittelfranken	5.2	49407	6820	29352	56209	4.5				2.8	65.9			
Unterfranken	4.8	32116	3765	24078	50048	4.5				3.8	62.3			
Schwaben	3.8	43663	4370	25013	51930	4.4				4.2	61.0			
Saarland	7.9	24040	9354	22436	47314	2.7				0.9	68.1			
Berlin	12.5	75113	84264	22179	48036					0.5	81.1			
Brandenburg	13.8	41912	1422	16112	39528					4.1	67.4			
Mecklenburg-Vorpommern	15.0	28707	1239	16044	38164					4.8	71.2			

Chemnitz	13.6	24949	4092	15223	35439			3.0	61.5	
Dresden	14.3	28573	3603	16567	36897			2.9	67.0	
Leipzig	14.3	19046	4343	17376	38710			2.3	71.5	
Dessau	16.9	8164	1907	14779	40296			4.3	64.1	
Halle	16.9	14136	3191	16135	38717			3.1	68.4	
Magdeburg	15.4	19484	1660	15968	39771			3.7	67.6	
Thüringen	12.3	39403	2436	16089	36602			3.3	64.6	
Germany	7.8	2030000	5686	24707	52447			2.5	68.4	

2. Stylized policy characteristics

2.1. General economic policy orientation

The administrative structure of Germany is that of a federal republic. The principle of subsidiarity is anchored in the constitution-like basic law ("Grundgesetz"). However, during the last decades, the lower tiers of administration, i.e. the federal states ("Bundesländer"), lost many of their direct powers to the federal government and in return gained controlling power over the federal government by an increasing number of laws subject to approval of the provincial (Länder) governments. This practice led to deadlocks in urgent needed structural reforms. Currently a debate about a reform of the federal structure of administration is going on.

In the field of economic policy, post-war German governments, unlike other European states (e.g. France, Italy, Spain), generally did not resort to overly interventionistic policies, nor implemented systems of indicative structural planning5. Economic policy in Germany has been relying on the assumptions that well functioning markets and free trade tend to maximize the welfare of an economy. Furthermore, it is understood that governments do not have superior knowledge over private enterprises about future economic developments and therefore should not interfere with the private sector in the allocation of capital and goods.

This underlying economic philosophy gives rise to a framework-orientated approach of structural policy. Policies aiming at the underlying order of the economy, the so called "Ordnungspolitik" combined with competition and market policy are main parts of this approach. Characteristic of this policy is the commitment to an independent central bank (whose successful anti-inflation policy served as role model for the European Central Bank) and unrestricted international trade. However, without rejecting this general concept, the degree of interventionist measures by governments varied throughout the last five decades.

Koopmann et. al. (1997) identify three main stages of industrial policy in Germany. The period from the founding of the state in 1949 until the mid 60s was characterized by rapid growth and international integration of Germany and the German economy. Interventionist measures were relatively rare. Structural policy concentrated on providing a framework for the proper functioning of markets. The 1957 Law Against Restraints of Competition reflects the competition-orientated policy stance of that time and can be seen as the "constitution" of the German market economy.

After the first recession in 1966/67, the policy stance became more interventionistic. Keynesian thought influenced the 1967 Law on Stability and Growth, which in turn changed

[5] The following is based on Koopmann, Kreienbaum and Borrmann: „Industrial and Trade Policy in Germany", 1997

structural policy towards more formative intervention. Structural change and the loss of employment in contracting industries gave way to reactive structural conservation programs, especially applied in agriculture and coal-mining. After the recession following the oil-price-shock in 1973, proactive policies for the promotion of sectors which were expected to show strong future growth were set up.

After the second oil-price shock in 1979/80 priorities changed back to a more remote role of the state. Deregulation of the economy and the attempt of bringing down the level of subsidies became priorities of economic policy. These issues are still on top of the political agenda. The fall of the Berlin Wall and the following reunification posed a heavy burden on the German economy. Huge financial transfers from western-Germany to the newly acceded states are being made since then. Nevertheless growth remained low and unemployment did not decline.

2.2. Trade policy

With a share of exports on GDP of over one third, free international flow of capital and goods is essential for the German economy. As a founding member of the EU, the OECD and the WTO, Germany commits itself to free international trade and hence has been calling for the reduction of tariffs, quotas and other trade restricting measures in past WTO/GATT trade rounds. Concerning the trade in labor intensive services, Germany takes a more restrictive stance, trying to protect domestic businesses and employment from foreign competition.

Regarding export promotion policy, Germany mostly resorted to policies aiming at removing barriers for German companies accessing foreign markets. This strategy is also embedded in the EU trade policy, which tries to open foreign markets for European companies through bilateral and multilateral agreements. More direct forms of export promotion, such as export subsidies, are constrained through EU and WTO agreements. Nevertheless, there exist several forms of veiled export subsidies which have been used by the federal and provincial governments. They include reduced social contribution payments for employers, interest payment subsidies and state securities and guarantees. However, the overall effect of these policies seems to be rather slim (Donges, 1992). More market conform measures of export promotion is the information provision by the Chambers of Foreign Trade (Außenhandelskammern) and the Federal Office for Foreign Trade Information (Bundesstelle für Außenhandelsinformation).

2.3. Regional policy

Germany is characterized by a high degree of regional disparities. This is particularly true since the reunification of Germany in 1990. Germany contains regions which are among the richest in Europe (Hamburg) as well as some which are among the poorest (Thüringen) (Yuill

et. al.,1999). The aim of creating equivalent living conditions throughout the republic, which is anchored in the Basic Law, therefore gives rise to active regional policy. Regional planning in Germany reflects the federal structure of the country and the principle of subsidiarity, since planning is organized on the local level, however, each plan has to confirm to higher tier plans. A financial equalization scheme (Länderfinanzausgleich) between the provincial states aims at facilitating convergence between advanced and lagging regions. Also, a tax financed transfer system for the development of the five eastern states has been set up in 1993. Under its regime, 94.5 billion Euros have been transferred from west to east until 2004. The amended plan from 2004 provides 156.5 billion Euros assistance from 2005 until 2019 (http://www.bundesregierung.de/dokumente/-,413.634080/Artikel/dokument.htm).

Main policy instrument for regional economic development and convergence is the investment grant for lagging regions. It is equally financed by the federal state and the provincial states but solely administered by the provincial governments. Eligibility of projects depends mainly on the so called 'primary effect' which exists when firms export at least 50% of their goods and services, produced with assistance of the investment grant beyond a radius of 50 km (30 km for the eastern states) from the local authority area in which it is situated (Yuill et. al., 1999). This criterion is chosen in order not to give assistance to projects which only produce for the regional market, because it is feared that this might distort intra regional competition and would not have positive effects on job creation. A 'positive list' defines activities which usually fulfill the 'primary effect'. Roughly most manufacturing activities and some services are included. During the period 1999-2002, manufacturing activities accounted for 80% of the 32,5 billion Euros granted under the scheme. Eligible projects receive between 50% and 18% of investment sum, depending on the location of investment and the size of the firm. Small and medium sized enterprises generally receive higher awards than large enterprises. Target areas are divided into three groups A, B, and C. Only projects in A-regions may receive maximum award rates, whereas projects in C-regions only receive the lowest rates. Most of the five eastern states fall into group A, metropolitan areas in the eastern states into B and the lagging regions of the western states into C. (Yuill, p.237).

2.4. Industrial and technology policy

Despite Germanys framework oriented approach of industrial policy, direct government interventions in the economy have been a common feature of its post-war economic history. The degree of influence taken by different governments has been varying, yet the instruments remained the same. The main instruments of government interventions in Germany have been subsidies of different forms and, to a lesser extend, public ownership of enterprises. In order to account for the effect of government interventions on the process of structural

change, the most important question to answer is, whether industrial policy has been acting in favor of growing industries (formative structural policy) or rather in favor of declining industries (structural conservation policy).

In the field of subsidies, two main types can be distinguished. First, direct financial aid for enterprises, and second, tax exemptions. The size of subsidies in percent of GDP increased from a negligible level in the 1950s to almost 2.5% in the late 1970s. Since then, the size of subsides has been decreasing, even though not in a continuous fashion (Feldenkirchen, 1999). According to OECD calculations, subsidies in Germany amounted to 1.6% of GDP in 2001 (OECD, 2002)6 or € 22.8 billion (19 Subventionsbericht der Bundesregierung, 2003) and have been slowly decreasing in 2002 and 2003. The single most important recipient of direct financial aid is the coal mining sector. It receives over € 2 billion in 2004. The most benefited sector of tax relieves is the construction sector with tax relieves of over € 11 billion in 2004. Taking together, the three most promoted sectors are construction with 28.6%, coal mining with 10% and agriculture with 7.2% of all subsidies. These sectors can be clearly classified as traditional and hence the subsidies as structural conserving. Compared to these three sectors, the share of subsidies for R&D activities, which could be considered of a more formative nature, is with 1.9% of all subsidies in 2004 rather slim. The most visible target of formative industrial policy, the aerospace sector, only receives € 37 million or 0.2% of all subsidies in 2004.

Government officials often emphasis the importance of small and medium sized enterprises (SMEs) for growth, job creation, and technology diffusion, and hence their overall importance for the German economy. Together with assumed capital market imperfections for SMEs, this gives rise to numerous assistance programs for SMEs. However, the size of subsidies attracted by SMEs does not mirror the official rhetoric. It is estimated that SMEs attracted only 1% of all subsidies in 1989 (Krakowski et. al. 1993) or less than € 1 billion in 2004 (19. Subventionsbericht der Bundesregierung, 2003).

Unlike in many other European states, there were no major postwar nationalizations in Germany. There has not been an attempt by governments to use large scale public ownership as a means of industrial policy to reshape the economic environment, even though governments sporadically resorted to nationalizations to safe defaulting enterprises (as in the case of Salzgitter Stahlwerke 1998). Public ownership has been mainly inherited from the German Reich and the state of Prussia, or arose from enterprises set up by the government for reconstruction purposes after the end of World War II. Former national enterprises in the newly acceded eastern states have been privatized or shut down by the Treuhandgesellschaft

[6] The government states this figure with 1.1 percent. The difference is due to different calculations of subsidies.

in the years after the reunification. Public ownership on the federal state level has been most noticeable in highly regulated sectors like communication and transportation in which the state held monopoly positions through the Bundespost (postal services and telecommunication) and the Bundesbahn (railway services). However, during the last twenty years, steps towards deregulation and privatization of these former state monopolies have been undertaken. The companies have been restructured and became stock corporations (Deutsche Telekom AG, Deutsche Post AG and Deutsche Bahn AG). However, the process of privatization of these three companies is not yet fully concluded.

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 German regions, and of the spatial concentration of German 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 German regions, and of the spatial concentration of German industries in the 1970s, before the south enlargement and further EU integration steps took place? 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 (West-)German regions with respect to large economic sectors as well as to detailed manufacturing industries. The time period covered by the subsequent investigation, 1980 to 2002, is sufficiently long for capturing important milestones of the EU integration process: the south enlargement in 1981/1986, the completion of the Single Market in 1992, and the north enlargement in 1995.[7] It also captures the intra-German integration process after the re-unification in 1990. For the time being, the analysis concentrates on the experience of West-German regions with this integration process, due to the longer time period available.

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 German regions in the European division of labour, and comparing the extent and evolution of sectoral specialization of German regions to that of other European regions. In a second step, the two chapters will focus on industries within the German 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 Germany 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 German 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

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

their further increase or decrease of specialization, as well as to their economic performance relative to other regions. The main goal is to help formulate hypotheses about causal relationships between specialization and regional performance, which are to be tested in subsequent phases of the EURECO project.

1.2. Methodology and database

Methodology

For measuring industrial concentration or regional specialization, a large number of measures has been used in the literature, including the Herfindahl, Theil and Gini indices, the coefficients of variation and of specialization, and the "dartboard" measures (Ellison-Glaeser, Maurel-Sédillot coefficients). Appendix 2.1. 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/*I*). In the context of industrial specialization of a region, e.g.,[8] 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.

[8] 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.

Relative measures are based on localization coefficients or analogues[9] that refer "local shares" to "global shares" (this is the usual procedure) or to any other reference shares. One example, besides the Brülhart/Träger Theil index, is the Krugman index:

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

The relative measures allow for specifying explicitly of what size an industry is expected to be. They thus allow for dealing appropriately with arbitrary statistical definitions by tailoring the benchmark. As a consequence, however, information from the sheer absolute size of industries is lost: Relative measures assign regional deviations from (nationally) small industries essentially the same value than deviations of similar magnitude from big industries. As to the analysis of the evolution of specialization patterns over time, relative measures allow for netting out national trends. This may be helpful if the national trends should be assumed exogenous, or if the focus is on regional evolution within the country. It may be helpful as well when different regions are compared because the same global trend is removed everywhere. But if the focus is on absolute changes, relative measures tend to draw an incomplete picture.[10]

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.[11] 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

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

[10] 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.

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

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 German sectors and industries, as well as of German regions in the overall European division of labor.

Database

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

- annual real value added by 17 sectors 1980 to 1995 for NUTS 1 regions ("Länder") from the Eurostat database, revised and amended by Hallet (2000).[12]
- annual employment data (more specifically: employment subject to social insurance contributions) by 294 industries from agriculture to services, 1980 and 1987-2002, for NUTS 2 regions ("Regierungsbezirke") from the Bundesanstalt für Arbeit.

For the first database, Hallet (2000) completed the Eurostat dataset, reporting gross value added at current prices in ECU from national sources, to cover 17 sectors for NUTS 2 regions in Belgium, Spain, France, Italy, Netherlands, and Portugal, and for NUTS 1 regions in Germany and the UK. The sectors include agriculture, 10 manufacturing and energy sectors, and 6 service sectors. The dataset allows us to compare the specialization German regions and concentration of German 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 Bundesanstalt für Arbeit that offers data on persons employed that are subject to social insurance contributions. 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, 165 industries are considered to allow for a more detailed analysis.

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[12] 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 German sectors, as well as of German manufacturing industries, with respect to their concentration pattern and their economic performance, in order to enter the results into the analysis of German 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 German 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.[13]

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

[13] 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.[14]

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

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

About one half of the observed total topographic concentration of economic activity can be attributed to concentration at the country level: The ‘between’ component of the Theil index is 0.36, which is 53% of the total value. That is, given the regional grid used in the present investigation, only half of the observed topographic concentration of activities within Europe was due to the co-existence of city- and peripheral regions within the countries. The other half was due to differences in country-average densities of economic activity.[15] 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

[14] 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.

[15] 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.[16] For the other sectors, the shares of the between components in total observed concentration were lower, ranging between 49% and 59%.[17]

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 0.20, West-Germany exhibited a below-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
West-Germany	**—**	**0.17**	**0.01**	**0.00**	**0.00**	**13.2**
Denmark	—	—	—	—	—	—
Spain	—	0.26	0.05	0.02	0.01	12.0
Finland	—	—	—	—	—	—
France	—	0.31	0.02	0.02	0.01	13.0
Greece	—	—	—	—	—	—
Ireland	—	—	—	—	—	—
Italy	—	0.14	0.06	0.04	0.01	12.7
Luxembourg	—	—	—	—	—	—
The Netherlands	—	0.10	0.07	0.03	0.02	11.6
Portugal	—	0.14	0.03	0.04	0.01	9.8
Sweden	—	—	—	—	—	—
United Kingdom	—	0.20	0.03	0.01	0.01	12.7

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

[16] 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.

[17] 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.

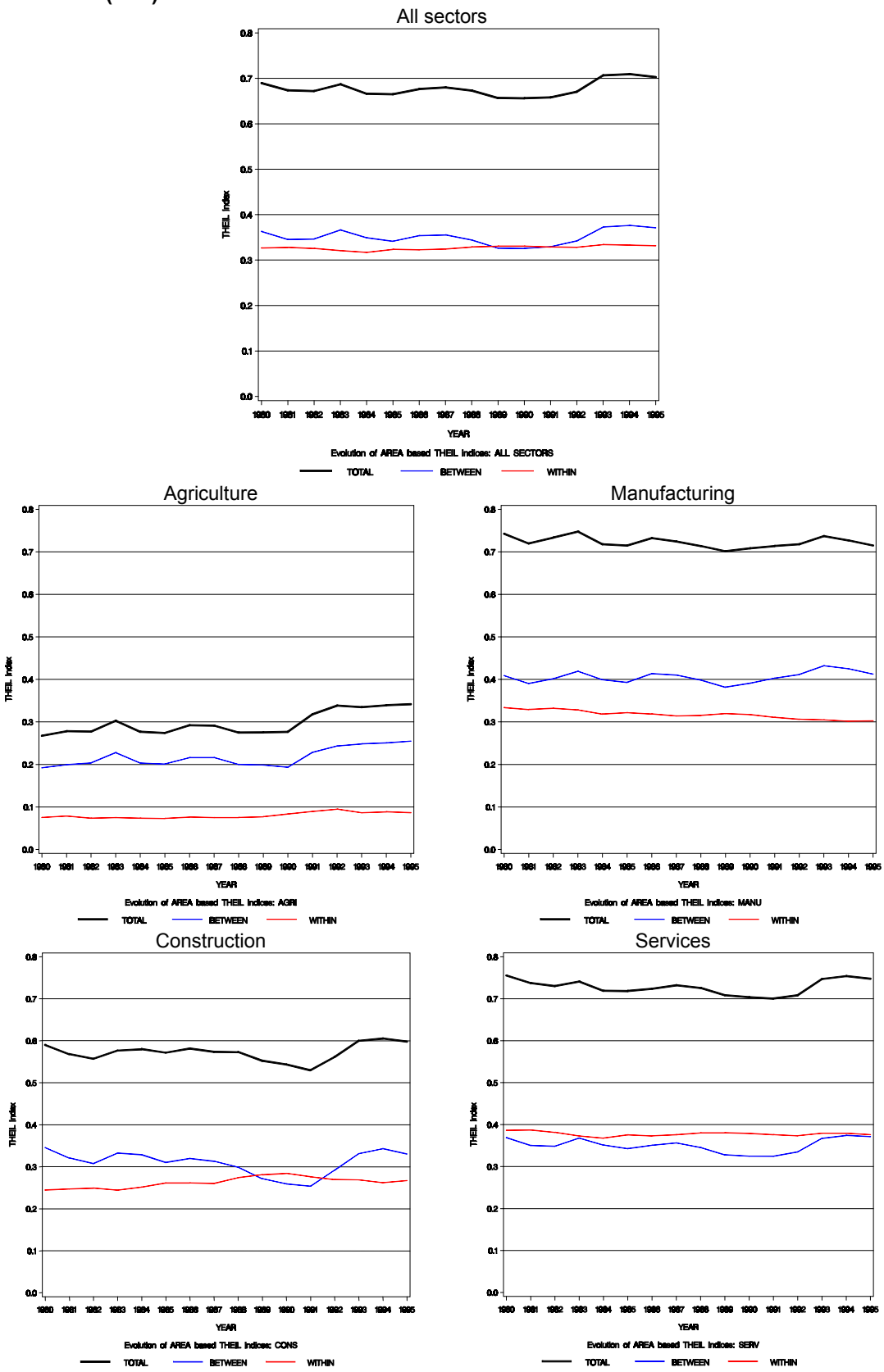
There were, however, some differences between the distributions of sector-specific and total activities within countries, as indicated by the country-specific within components of the Theil index. Among the countries for which regionally disaggregated data are available in the underlying data set, West Germany showed the lowest 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).[18] 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.

[18] 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 concentrationacross 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.[19] 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.[20] 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.[21] The process can be attributed to the German re-unification to a good deal. Experiencing a re-unification boom in the early 1990s, the (West-) German economy disconnected temporarily from the international business cycle which shows up as a rising concentration at the national level, as measured by the index.

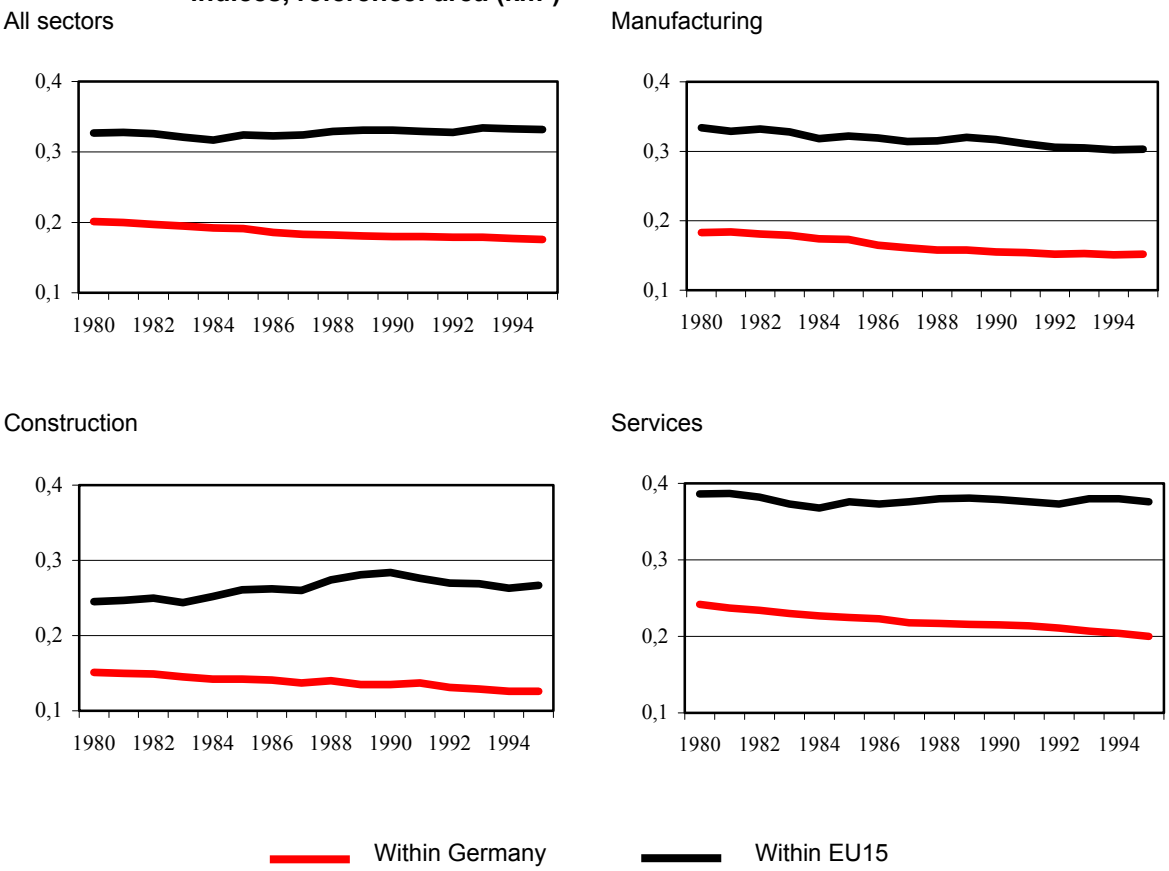
The evolution of the topographic concentration of economic activity within Germany was characterized by a continuously decreasing concentration during the whole period under consideration. (Figure 2.1-2). This was true even for the construction sector which, on average, experienced an increasing concentration within countries.

[19] 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).

[20] 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.

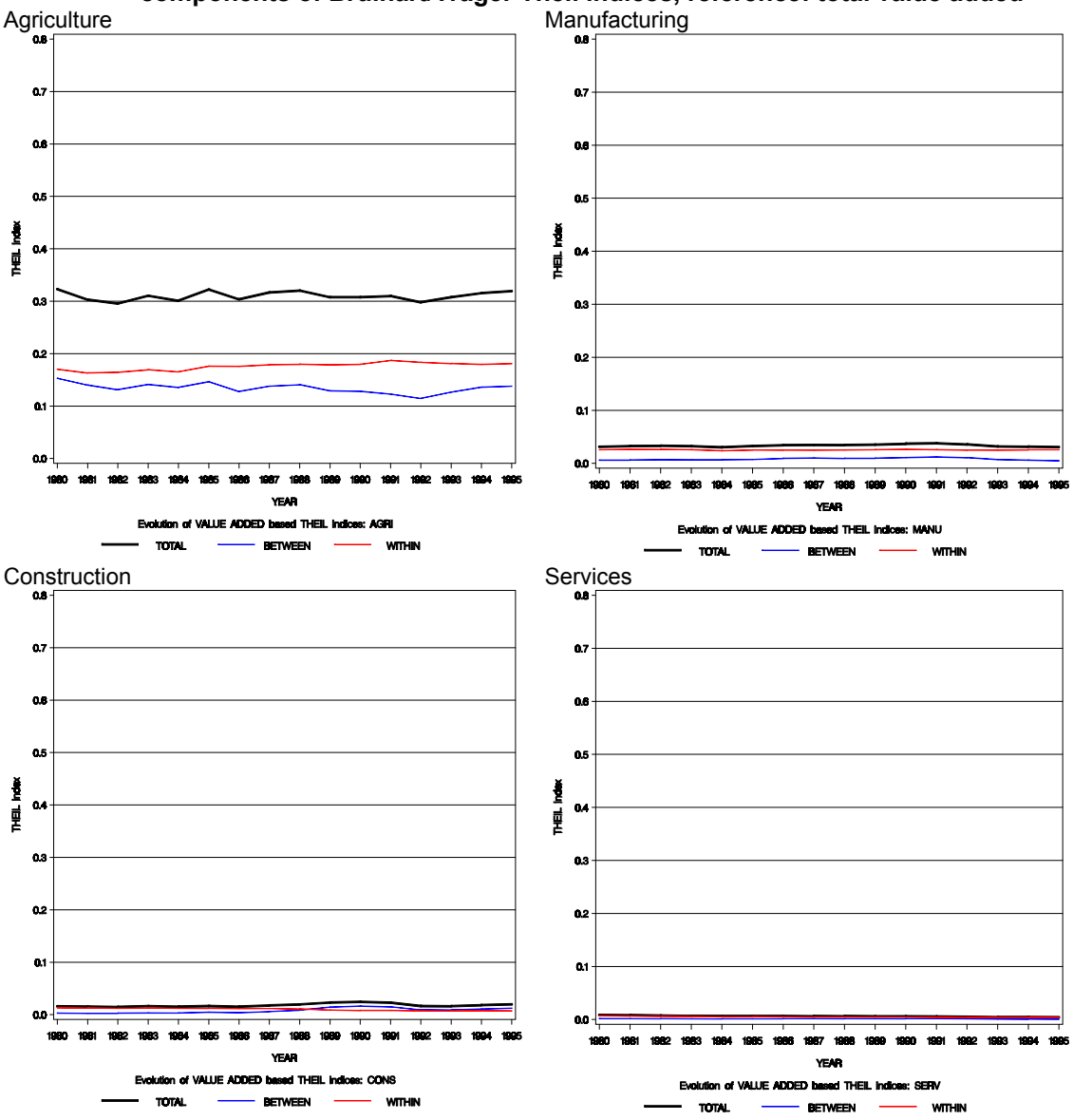
[21] According to Aiginger and Pfaffermayr (2004), the increase in concentration of manufacturing industries in the early 1990s did, in fact, interrupt the long-term trend towards deconcentration of these industries only temporarily.

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



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

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



Summing up, Germany is found to be among the EU countries exhibiting the lowest concentration of sectors, particularly so in terms of topographic concentration. In particular, the agricultural and the manufacturing sector are much more dispersed than in most other EU countries. Over time, the concentration of German sectors decreased remarkably 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 German economy. Yet, due to insufficiently disaggregated data for all other sectors, the analysis is restricted here to the (88) industries of the manufacturing sector.

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, other market services, transport and communication services, and recovery, trade and lodging services reveal to be highly concentrated in terms of absolute and topographic concentration, not in terms of relative concentration. The other services sectors and the manufacturing sector are to be found somewhere between these extremes, yet more resembling the other market services sector than the agricultural sector. The different messages between these indicators reflect the fact that manufacturing and services are where the people are (in urban areas with higher population densities), whereas agriculture is where the land is. Referring to the employment of people (i.e., to the relative concentration measures), the results show Germany to be an industrialized country with an extreme broad dispersion of manufacturing, and also of sectors complementary to manufacturing or necessary for supplying basic needs like construction and most services sectors.

Table 2.2-1: Concentration of German sectors in 1980

Economic sectors	Theil index	Weighted Theil index	Topographic Theil index
Agricultural, forestry and fishery products	0.1329	0.1440	0.0846
Manufacturing	0.1774	0.0146	0.2879
Building and construction	0.1145	0.0158	0.2067
Recovery, trade, lodging and catering services	0.2490	0.0752	0.6559
Transport and communication services	0.2845	0.0458	0.4908
Services of credit and insurance institutions	0.1651	0.0065	0.3681
Other market services	0.3021	0.0524	0.6096
Non-market services	0.1625	0.0172	0.3535

Source: BAA.

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 German 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 German sectors in 1980 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.05510 (0.8969)	**0.99739** **(<.0001)**	0.20768 (0.6216)	0.87394 (0.0045)
Weighted Theil index		1.00000	0.06348 (0.8813)	**0.96730** **(<.0001)**	-0.16050 (0.7042)
Herfindahl index			1.00000	0.20710 (0.6227)	0.88157 (0.0038)
Krugman index				1.00000	-0.08446 (0.8424)
Topographic Theil index					1.00000

The *classification* of groups of German industries is conducted for the year 1978, the initial year of the database. It is based on three characteristics: (i) the dependency on *highly localized resource deposits* (drawing on an OECD, 1987, classification of resource intensive industries, yet applying it only to those industries where resources are localized and not ubiquous; cf. table A3-5 in Appendix 3), (ii) the existence of *internal IRS* (drawing on Pratten, 1988, who identified industries with different levels of technical IRS; cf. table A3-4 in Appendix 3), (iii) the *observed concentration* in the initial year 1978, measured by a weighted Theil index – for comparison, the simple Theil and the topographic Theil index are also presented.[22]

The classification proceeds in three steps yielding four groups of German 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.

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

Table 2.2-1: Groups of German industries – Results of classification

Ind. Class	Manufacturing industries	Re-source depend.	Inter-nal IRS	Weight Theil index 1980	Theil index 1980	Topogr. Theil index 1980
	Resource intensive industries					
070	Erdoel, Erdgas	1	high	1.999	1.793	1.445
060	Erzbergbau	1	high	1.853	1.960	1.964
051	Braunkohlenbergbau	1	high	1.727	2.136	2.232
050	Steinkohlenbergbau	1	high	1.445	1.900	2.189
171	Schmiedewerke	1	high	1.200	1.748	1.818
170	Hochoefen,Stahlwerke	1	high	1.022	1.510	1.871
110	Mineraloelverarbeitung	1	medium	0.953	1.085	1.638
181	NE-Metallhalbzeugwerke	1	medium	0.631	1.030	0.982
200	Kaltwalzwerke,Zieherei	1	low	0.616	0.971	1.152
180	NE-Metallhuetten	1	medium	0.560	0.797	1.162
210	Stahlverformung	1	low	0.414	0.793	0.909
	High IRS industries					
099	Kohlenwertstoffindustrie	0	high	2.262	2.461	2.514
320	Luftfahrzeugbau	0	high	1.296	1.349	1.570
331	Hst./Rep.v.Bueromaschinen	0	high	0.999	1.000	0.971
093	Duengemittelherstellung	0	high	0.957	1.244	1.117
100	Chemiefaserherstellung	0	high	0.917	1.002	0.991
090	Herst.chem.Grundstoffe	0	high	0.848	1.177	1.236
332	Hst./Rep.v.EDV-Einrichtungen	0	high	0.753	1.102	1.156
343	Hst.v.Grossgeneratoren	0	high	0.716	0.776	1.443
351	Hst.v.optischen Erzeugnisssen	0	high	0.658	0.822	0.766
280	Hst.v.Kraftwagen, Motoren	0	high	0.611	0.908	0.863
142	Zementherstellung	0	high	0.474	0.596	0.530
347	Hst.v.Radio-,Fernsehgeraeten	0	high	0.391	0.431	0.701
550	Suesswarenhersteller	0	high	0.378	0.493	0.956
095	Chem.Spezialerzeugnisse	0	high	0.375	0.521	0.567
342	Hst.v.Starkstromausruestungsg.	0	high	0.317	0.511	0.539
348	Mess-,Regeltechnik	0	high	0.215	0.437	0.612
433	Buchbinderei	0	high	0.215	0.392	0.553
350	Hst.feinmech.Erzeugnisse	0	high	0.125	0.277	0.345
146	Hst.v.Kalksandstein,Beton	0	high	0.105	0.108	0.139
440	Druckerei	0	high	0.086	0.281	0.403
	Footloose industries					
150	Porzellanherstellung	0	medium	2.342	1.941	1.982
470	Wollwaescherei	0	low	2.318	1.996	3.033
310	Schiffbau	0	medium	2.204	1.730	2.706
543	Fischverarbeitung	0	low	2.164	1.570	2.278
472	Zwirnerei	0	low	1.970	1.845	1.782
360	Hst.v. Uhren	0	low	1.932	2.103	2.044
092	Farbstoffherstellung	0	medium	1.863	2.824	3.182
373	Hst.v.Waffen,Munition	0	low	1.817	1.747	1.714
580	Zigarettenherstellung.	0	low	1.797	1.377	2.858
474	Woll-Spinnweberei	0	low	1.659	1.765	1.671
481	Baumwollzwirnerei	0	low	1.561	1.653	1.479
483	Baumwoll-Spinnweberei	0	low	1.547	1.483	1.382
290	Hst.v.Kraftraedern,Motoren	0	medium	1.473	1.627	2.021
390	Hst.v.Schmuck	0	low	1.455	1.616	1.677
291	Hst.v.Fahrraedern,Kinderw.	0	medium	1.441	1.372	1.280
372	Hst.v.Schneidewaren,Messern	0	low	1.388	1.961	2.679
131	Hst.v.Bereifungen	0	medium	1.376	1.295	1.611
133	Asbestverarbeitung	0	low	1.361	1.129	0.940
581	Tabak,Zigarren	0	low	1.342	1.184	1.279
546	Hst.v.Speiseoel,-Fetten	0	low	1.302	1.368	2.112
151	Hst.v.Steing.,Toepferwaren	0	medium	1.240	0.969	1.078
482	Baumwollweberei	0	low	1.194	1.148	1.179
160	Flachglasherstellung	0	medium	1.192	1.451	1.510
080	Kali-,Salzbergbau	0	low	1.155	1.167	1.093
381	Hst.v.Spielwaren	0	medium	1.136	1.216	1.204
480	Baumwollspinnerei	0	low	1.088	1.148	1.032
490	Verarb.Textil.grundst.(Seide)	0	low	1.060	1.375	1.557
374	Hst.v.Heiz-,Kochgeraeten	0	medium	1.048	1.054	1.232
145	Hst.v.Grobkeramik	0	medium	1.006	1.041	1.137
377	Hst.v.Feinblechpackungen	0	low	0.991	0.941	0.896
473	Wollweberei	0	low	0.967	1.517	1.639
511	Wirkerei,Strickerei	0	low	0.964	1.010	0.941
510	Seilerei	0	low	0.930	0.889	1.281
340	Allgem.Elektrotechnik	0	low	0.920	1.266	1.098
268	Hst.v.Waeschereimaschinen	0	medium	0.919	0.920	0.879

to be continued

Table 2.2-1 continued

Ind. Class	Manufacturing industries	Re-source depend.	Inter-nal IRS	Weight Theil index 1980	Theil index 1980	Topogr. Theil index 1980
311	Boots-,Jachtbau	0	medium	0.888	0.837	0.755
460	Serienfertigung v.Schuhen	0	low	0.845	0.956	0.993
540	Zuckerindustrie	0	low	0.804	0.829	0.778
341	Hst.v.Batterien, Akku	0	low	0.767	1.162	1.268
161	Hohlglasherstellung	0	medium	0.735	0.729	0.733
551	Dauerbackwaren	0	low	0.718	0.777	0.876
152	Hst.v.Kacheln,Keramik	0	medium	0.715	0.556	0.863
500	Verarb.Textil.grundst.(Leinen)	0	low	0.699	0.691	0.743
512	Textilveredelung	0	low	0.698	0.958	1.040
270	Zahnraederherstellung	0	medium	0.670	0.678	0.696
471	Wollspinnerei	0	low	0.656	0.987	0.926
240	Wagenbau	0	medium	0.651	0.884	0.989
401	Holzspanplattenwerke	0	low	0.650	0.653	0.671
091	Kunststoff-,Kautschukherst.	0	medium	0.641	0.830	0.963
097	Hst.v.Kosmetika	0	medium	0.631	0.998	1.494
382	Hst.v.Turn-Sportgeraeten	0	medium	0.629	0.716	0.587
096	Hst.v.Pharmazeutika	0	medium	0.616	0.867	1.040
371	Schloesser-,Beschlaegehst.	0	low	0.592	1.204	1.407
521	Herrenmassschneiderei	0	low	0.574	0.498	0.490
098	Hst.sonst.chem.Erzeugn.	0	low	0.571	0.688	0.664
267	Hst.v.Papier-,Druckereimasch.	0	medium	0.554	0.845	0.978
526	Hst.v.Bettwaesche	0	low	0.546	0.563	0.534
266	Hst.v.Holzbearbeit.Maschinen	0	medium	0.532	0.804	0.761
411	Holzmoebelherstellung	0	low	0.524	0.560	0.592
520	Herrenoberbekleidung	0	low	0.518	0.480	0.431
292	Hst.v.Gespannfahrzeugen	0	medium	0.501	0.811	0.765
450	Gerbereien	0	low	0.499	0.853	0.804
376	Hst.v.Stahlrohrmoebeln	0	low	0.495	0.641	0.661
451	Sattlerwaren,Lederhandschuhe	0	low	0.472	0.625	0.644
542	Molkerei	0	low	0.455	0.393	0.215
346	Hst.v.Lampen,Leuchten	0	low	0.455	0.706	0.902
263	Rep.v.Landmaschinen	0	medium	0.452	0.321	0.099
560	Schlachthaeuser	0	low	0.435	0.388	0.426
370	Hst.v.Werkzeugen	0	low	0.433	0.914	1.061
380	Hst.v.Musikinstrumenten	0	low	0.431	0.557	0.586
132	Vulkanisierung	0	medium	0.429	0.466	0.514
231	Kesselbau	0	low	0.428	0.846	1.068
571	Alkoholbrennerei	0	low	0.424	0.515	0.637
190	Eisen-,Stahlgiesserei	0	medium	0.423	0.591	0.776
524	Serienfert.v.Arbeitskleidung	0	low	0.414	0.356	0.269
344	Hst.v.Draehten,Kabeln	0	low	0.413	0.636	0.882
281	Hst.v.Kraftfahrzeugteilen	0	medium	0.411	0.606	0.599
265	Hst.v.Textilmaschinen	0	medium	0.397	0.757	0.829
345	Hst.v.Elektr.verbraucherger.	0	medium	0.383	0.732	0.753
262	Hst.v.Landwirtsch.Maschinen	0	medium	0.381	0.506	0.456
525	Hst.v.Leibwaesche	0	low	0.374	0.445	0.419
547	Naehrmittelhersteller	0	low	0.370	0.379	0.752
143	Gewinnung sonst.Steine	0	low	0.366	0.396	0.440
527	Hst.v.Hueten,Muetzen	0	low	0.348	0.587	0.813
379	Hst.v.Kfz.teilen,Zubehoer	0	low	0.345	0.655	0.798
191	NE-Metallgiesserei	0	medium	0.344	0.664	0.768
144	Ziegelei	0	low	0.343	0.317	0.223
522	Damenoberbekleidung	0	low	0.338	0.292	0.368
548	Mahlmuehlen	0	medium	0.310	0.332	0.427
130	Gummiwarenherstellung	0	medium	0.305	0.437	0.656
282	Hst.v.Karosserien,Anhaenger	0	low	0.302	0.389	0.307
260	H.v.Metallbearbeitungsmasch.	0	medium	0.274	0.690	0.716
528	Verarb.v.Fellen,Pelzen	0	low	0.274	0.468	0.579
544	Brotindustrie	0	low	0.264	0.415	0.511
529	Hst.v.Bettwaren	0	low	0.260	0.408	0.543
221	Schmiederei	0	low	0.256	0.362	0.329
378	Allgem.Metallwarenherst.	0	low	0.256	0.605	0.736
162	Glasfaserherstellung usw.	0	medium	0.252	0.363	0.379
513	Sonst.Textilgewerbe	0	low	0.249	0.428	0.504
094	Lacke,Farbenherstellung	0	medium	0.246	0.621	0.801
541	Obst-Gemueseverarbeitung	0	low	0.238	0.307	0.338
421	Flechtwaren,Besenherstellung	0	low	0.222	0.261	0.256
441	Chemigrafisches Gewerbe	0	low	0.219	0.494	0.757
400	Saegewerke,Furnierwerke	0	low	0.216	0.146	0.107

to be continued

Table 2.2-1 continued

Ind. Class	Manufacturing industries	Re-source depend.	Inter-nal IRS	Weight Theil index 1980	Theil index 1980	Topogr. Theil index 1980
431	Papierverarbeitung	0	medium	0.212	0.458	0.594
523	Damenmassschneiderei	0	low	0.209	0.287	0.321
140	Gewinnung v.Natursteinen	0	low	0.202	0.210	0.215
430	Papierherstellung	0	medium	0.199	0.435	0.381
141	Gewinnung v.Sand und Kies	0	low	0.191	0.330	0.309
375	Hst.v.Blechwaren	0	low	0.182	0.359	0.395
211	Oberflaechenveredelung	0	low	0.176	0.466	0.592
420	Verpackungsmittel(Holz)	0	low	0.175	0.284	0.396
261	Hst.v.Schwermaschinen	0	medium	0.167	0.501	0.599
361	Reparatur von Uhren	0	low	0.165	0.394	0.418
570	Brauerei,Maelzerei	0	low	0.150	0.214	0.396
572	Hst.v.Mineralwasser	0	low	0.136	0.171	0.296
264	Masch.f.Nahrungsindustrie	0	medium	0.134	0.344	0.435
410	Bautischlerei,Holzbauelemente	0	low	0.132	0.071	0.090
530	Polsterei,Dekorateurgewerbe	0	low	0.131	0.268	0.386
561	Kom.Schlachthoefe	0	low	0.108	0.242	0.304
230	Leichtmetall-,Stahlbau	0	low	0.105	0.273	0.467
432	Verpackungmittel(Papier)	0	low	0.102	0.275	0.318
412	Moebeltischlerei	0	low	0.094	0.221	0.296
349	Elektrotechnik (Mont./Rep.)	0	low	0.085	0.201	0.340
301	Lackierung Kfz.usw.	0	low	0.073	0.154	0.253
271	Sonst.Maschinenbauerzeugn.	0	medium	0.069	0.235	0.398
461	Masschuhmachereien,Rep.v.Sch.	0	low	0.066	0.188	0.446
120	Kunststoffverarbeitung	0	medium	0.062	0.203	0.247
040	Energiewirtschaft	0	medium	0.056	0.220	0.476
562	Fleischerei	0	low	0.055	0.088	0.120
300	Kfz.-Reparaturen	0	low	0.052	0.102	0.140
250	Mont.,Rep.v.Lueft.anlagen	0	low	0.034	0.149	0.312
545	Baeckerei,Konditorwaren	0	low	0.034	0.104	0.210
220	Schlosserei,Schweisserei	0	low	0.019	0.189	0.347
341	Hst.v.Batterien, Akku	0	low	0.767	1.162	1.268
161	Hohlglasherstellung	0	medium	0.735	0.729	0.733

Source: BAA, Sozialversicherungspflichtig Beschäftigte

- *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, shipbuilding, several textiles industries, clock production, some automotive and machinery industries, rubber industries, footwear industry.

- Other industries are fairly *dispersed*, like several branches of the ceramic, construction material and glass industries, of the textiles industry, of the automotive and the pharmaceutical industries, of the rubber and plastic materials industries, gas supplies, foundries and metal finishing, water and electricity supplies, paper industries, branches of the machinery industry, foods, clothing, wood and other consumption goods industries.

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

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

	Theil index	Weighted Theil index	Herfindahl index	Krugman index	Topographic Theil index
Theil index	1.00000	0.93304 (<.0001)	**0.92256 (<.0001)**	0.93755 (<.0001)	0.93667 (<.0001)
Weighted Theil index		1.00000	0.82409 (<.0001)	**0.96207 (<.0001)**	0.88919 (<.0001)
Herfindahl index			1.00000	0.79033 (<.0001)	0.85975 (<.0001)
Krugman index				1.00000	0.87770 (<.0001)
Topographic Theil index					1.00000

Source: BAA, Sozialversicherungspflichtig Beschäftigte

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 Germany several of these industries are not, like branches of the chemical, machinery industries, optical and professional instruments industry, automobile and electro-technical industry. On the other hand, drawing on Heckscher-Ohlin theory, one might expect such footloose industries as the ceramic and textiles industries, to be fairly dispersed, yet again, in Germany, this is not always the case. Some of these are even quite highly concentrated like production of china, and some textiles industries – and this concentration is in some cases even more pronounced if referring to topographic areas instead of employed workers. Part of an explanation is that even in a deep

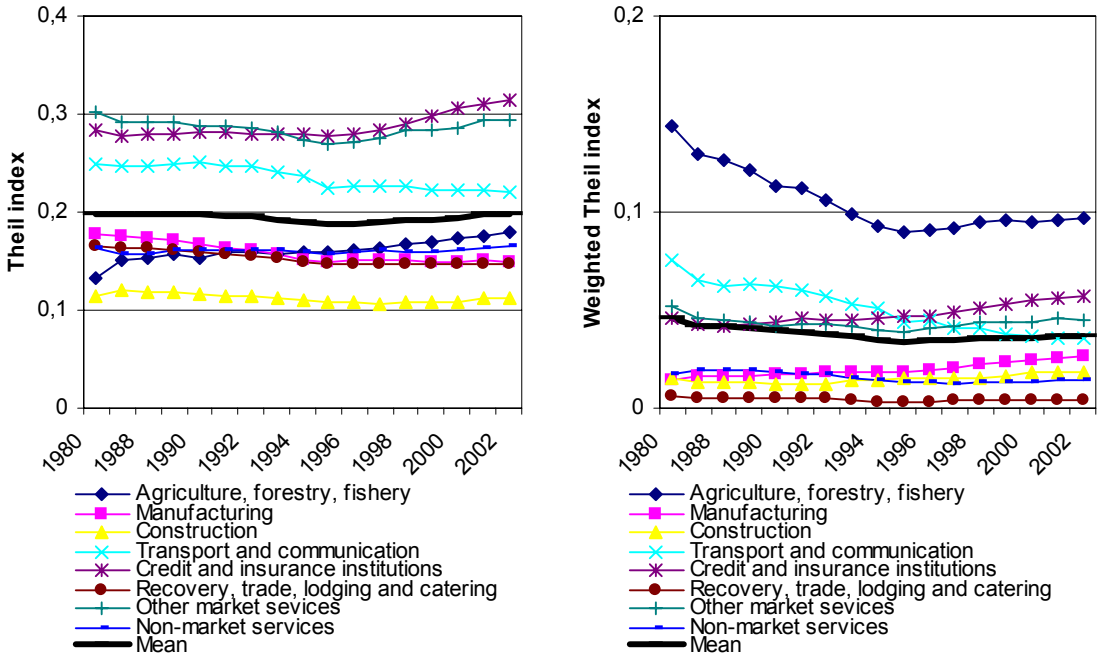
sectoral breakdown like in the German case of 165 manufacturing industries, these industries in some cases are not very homogenously defined. Another part of an explanation is that some industries are extremely narrow defined and are thus highly concentrated simply due to indivisibilities.

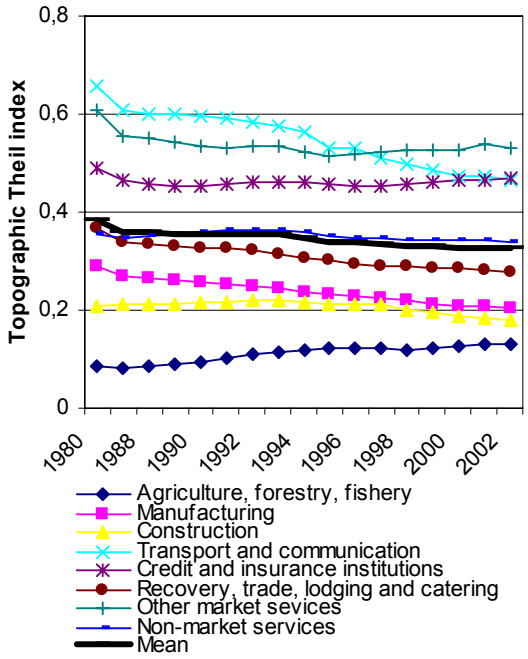
2.3. Evolution of concentration over time by sectors /industry types

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



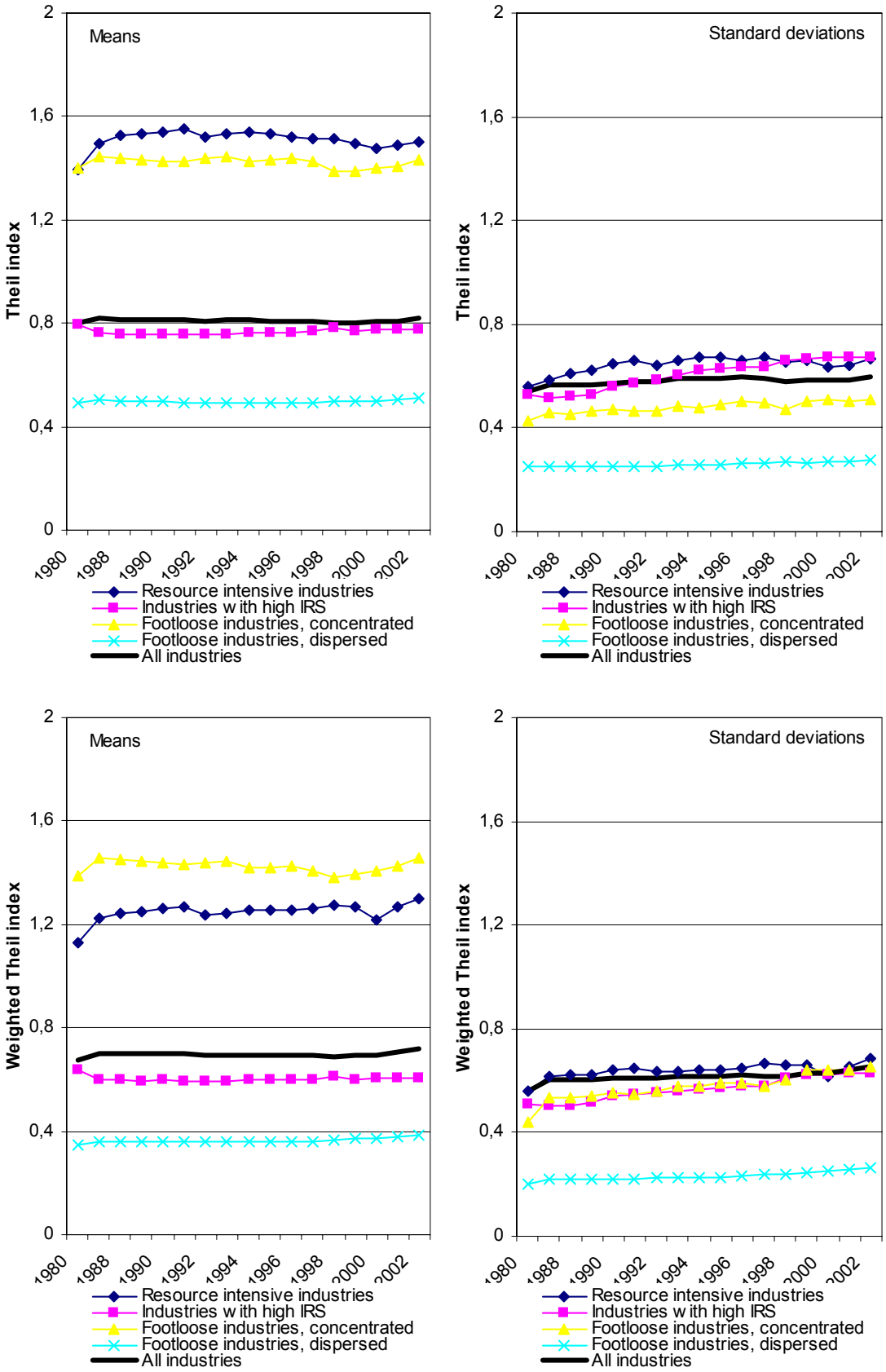


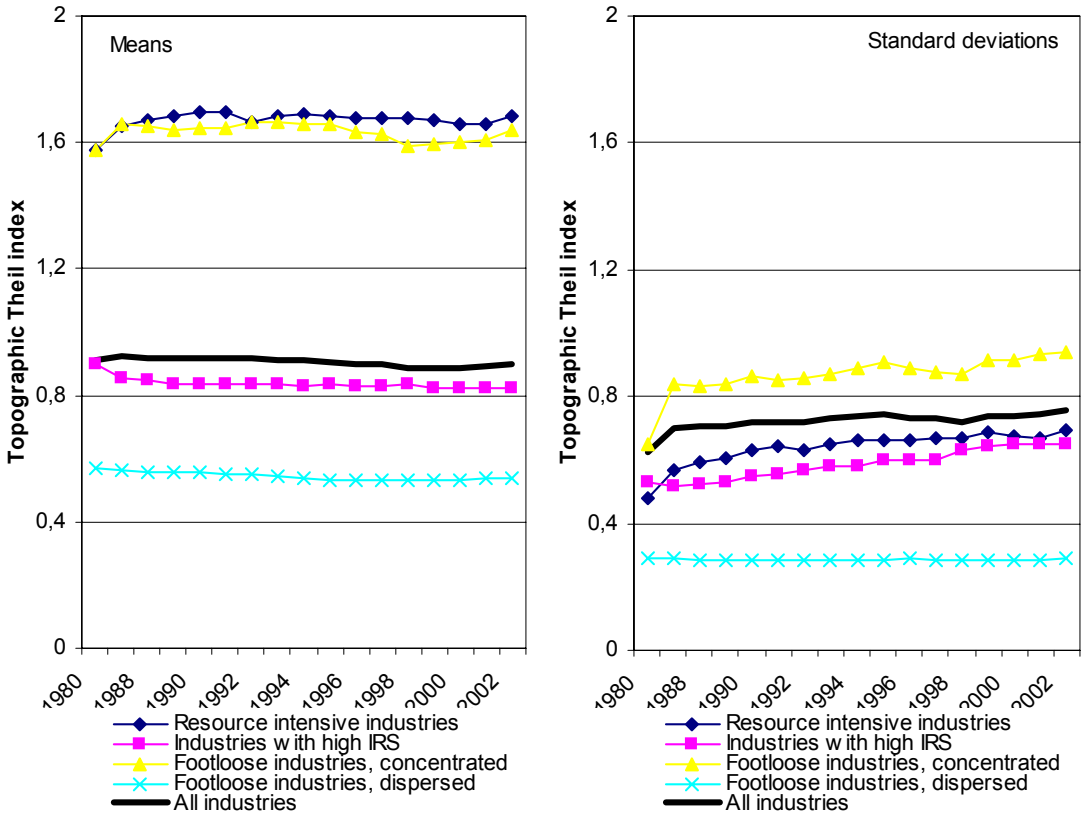
Source: BAA Sozialversicherungspflichtig Beschäftigte.

Over time, the message of the three indicators also varies considerably: Whereas the Theil index indicates almost no movement at all, the weighted Theil index indicates a concentration decrease of the highly concentrated agricultural and transport and communication services sector and a maintenance of most other sectors, and the topographic Theil index indicates a convergence of concentration degrees (based inter alia on the concentration increase (!) of the less concentrated agricultural sector).

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 165 industries without getting lost in details, means and standard deviations are calculated across industries for each industry group (figure 2.3-2). As discussed in the previous section, the figures demonstrate the high average concentration of resource intensive industries, the low average concentration of industries with internal IRS, the concentration degrees of concentrated and dispersed footloose industries in accordance to their definition, and the respective within-group variations of the industry groups.

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





Source: BAA Sozialversicherungspflichtig Beschäftigte.

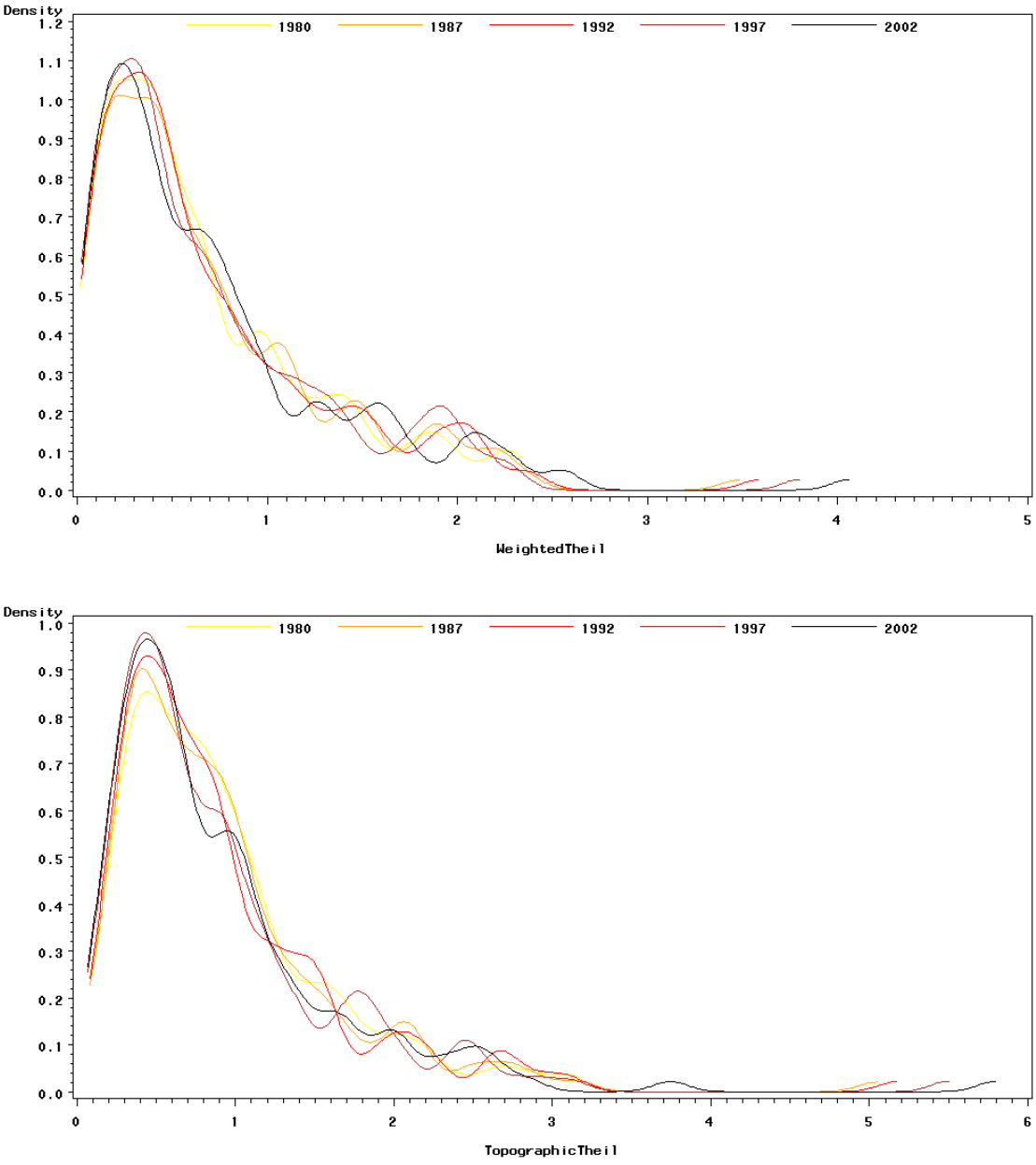
Over time, the average change across all industries is small, as is the average change in most industry groups, and this holds true whatever indicator is applied.[23] Resource intensive industries reveal the clearest direction of change, their high concentration seems to increase slightly. The largest movement is to be observed for standard deviations: Apart from dispersed footloose industries they seem to increase markedly indicating a tendency for within-group divergence. No obvious pushing influences of major integration steps can be detected.

The impression of a broad band of industries with differing concentration degrees 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 0.25 points. 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 impression is more or less similar: the distribution is skewed, with a peak at a value of about 0.35 points. *Over time*, there is not much change as to the positions of the peaks. In the case of the weighted Theil index, the

[23] 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).

peak moves up and down without any clear direction, in the case of the topographic Theil index, it gets higher almost throughout. Yet this change is small, too.

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



Source: BAA Sozialversicherungspflichtig Beschäftigte.

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 German economy – and may accordingly be also to the detriment or advantage of German 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 Germany and their overall performance (table 2.4-1). During the observation period, other market services seem to grow quickly in terms of employment. A relatively high growth can also be observed for credit and insurance services, and recovery, trade and lodging services. By contrast, manufacturing, construction and agriculture envisaged 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 when drawing on relative specialization measures, but coincides with employment increase when drawing on absolute or topographic measures. 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 positive and significant (at the 5% level) when applying absolute concentration measures (weighted Theil index or Krugman index), though highly insignificant when applying the relative measure. Accordingly, sectors common to urban areas (=spatially concentrated) grow faster then sectors common to rural areas (=spatially dispersed; e.g., in particular agriculture).

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

Economic sectors	Rela-tive concent ration in 1980	Shares in 1980	1980-1987	1987-1992	1992-1997	1987-2002	1980-2002
Agricultural, forestry and fishery products	0.144	1.05	0.48	-0.48	-2.15	0.08	-0.86
Manufacturing	0.015	43.51	-0.73	0.92	-3.80	-0.89	-1.28
Building and construction	0.016	8.10	-2.46	1.88	-1.72	-3.83	-1.25
Recovery, trade, lodging and catering services	0.075	4.76	0.14	3.54	-1.65	1.60	1.14
Transport and communication services	0.046	3.64	1.48	2.32	-0.17	0.74	0.96
Services of credit and insurance institutions	0.007	22.98	0.73	3.64	0.33	1.36	1.77
Other market services	0.052	4.62	2.59	6.94	3.14	6.39	5.47
Non-market services	0.017	11.34	1.63	1.46	0.31	1.07	0.94
Total economy	.	100.00	-0.08	2.18	-1.26	0.69	0.53

Correlation between initial concentration (1980) and subsequent employment change (1980-2002)		
Concentration measures	Pearson correlation coefficients	Error probabilities
Theil index	**0.74775**	**0.0329**
Weighted Theil index	0.00262	0.9951
Herfindahl index	**0.70727**	**0.0498**
Krugman index	0.12164	0.7742
Topographic Theil index	0.70405	0.0513

Source: BAA Sozialversicherungspflichtig Beschäftigte.

Turning to employment figures for manufacturing industries (table 2.4-2), manufacturing as a whole obviously loses employment throughout the observation period. Yet this downward trend seems to be most dramatic since the period of Germany's reunification (and only West-German figures are provided here). Dispersed footloose industries and industries with high

internal IRS experience the weakest job losses. 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 2.4-2: Concentration and average annual rates of change of industrial employment

Groups of industries	Rela-tive concent ration in 1980	Shares in 1980	1980-1987	1987-1992	1992-1997	1987-2002	1980-2002
Resource intensive industries	1.15	8.05	-2.56	-2.00	-6.05	-2.29	-3.46
Industries with high IRS	0.63	22.61	0.14	0.82	-3.66	0.05	-0.95
Footloose industries, concentrated	1.37	9.31	-2.58	-2.26	-7.18	-3.09	-4.20
Footloose industries, dispersed	0.35	60.03	-0.57	1.67	-3.30	-0.95	-0.88
Total manufacturing	.	100.00	-0.73	0.92	-3.80	-0.89	-1.28

Correlation between initial concentration (1980) and subsequent employment change (1980-2002)		
Concentration measures	Pearson correlation coefficients	Error probabilities
Theil index	**-0.45598**	**<.0001**
Weighted Theil index	**-0.48744**	**<.0001**
Herfindahl index	**-0.41230**	**<.0001**
Krugman index	**-0.49380**	**<.0001**
Topographic Theil index	**-0.38835**	**<.0001**

Source: BAA Sozialversicherungspflichtig Beschäftigte.

The general conclusion on industrial concentration is thus: The German sectors and industries reveal a considerable variation as to their concentration degrees in the initial year. Over the observation period of more than 20 years, the concentration pattern of sectors seemingly becomes more alike whereas the concentration pattern of manufacturing industries remain more or less unchanged. At the same time, spatially concentrated sectors perform better than spatially dispersed ones whereas, within manufacturing, concentrated industries perform worse than dispersed ones.

3. Specialization of regions

3.1.1 Position of German regions in the European division of labour

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

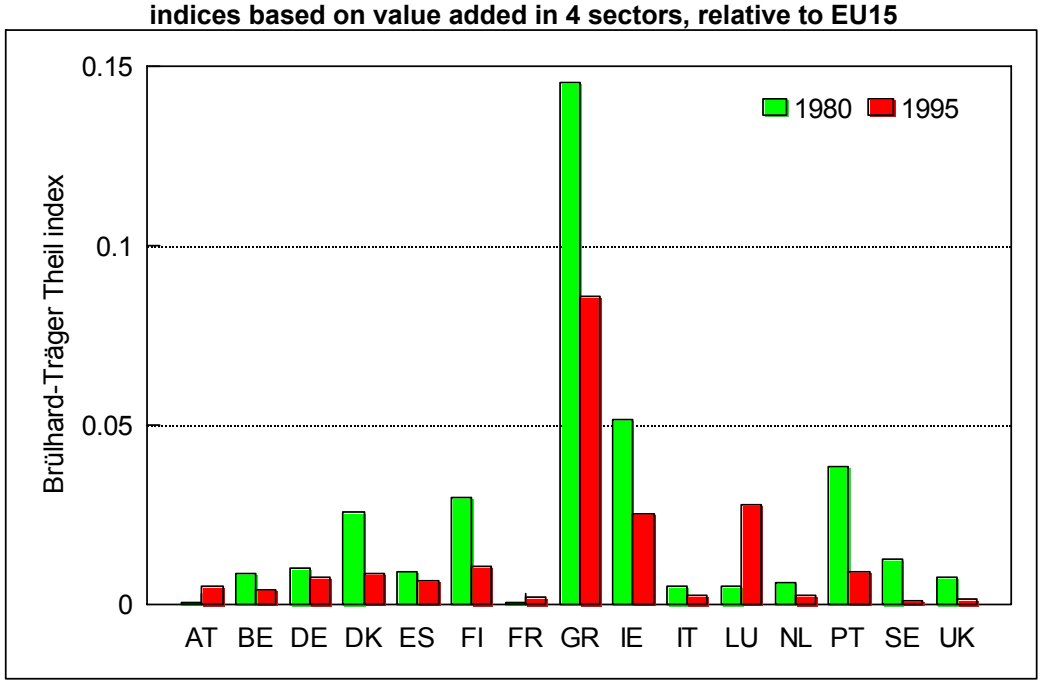
During the 1980s and early 1990s, the sectoral specialization of most European countries converged towards the EU average.[24] The only notable exception is Luxembourg (LU) which witnessed significant losses in manufacturing industries. The structural convergence towards the EU average seems to have been a general tendency in the 1½ decades under consideration.[25] The results do not unambiguously point to specific reasons: Neither was the convergence generally stronger for newcomers than for incumbent member states, nor was it generally stronger for poor than for rich countries.

The process of structural convergence did, however, not evolve continuously over time in West Germany (Figure A3-1). During almost the entire 1980s, the specialization increased considerably, before it decreased sharply from the early 1990s onward. These developments were mainly induced by the manufacturing sector.

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

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

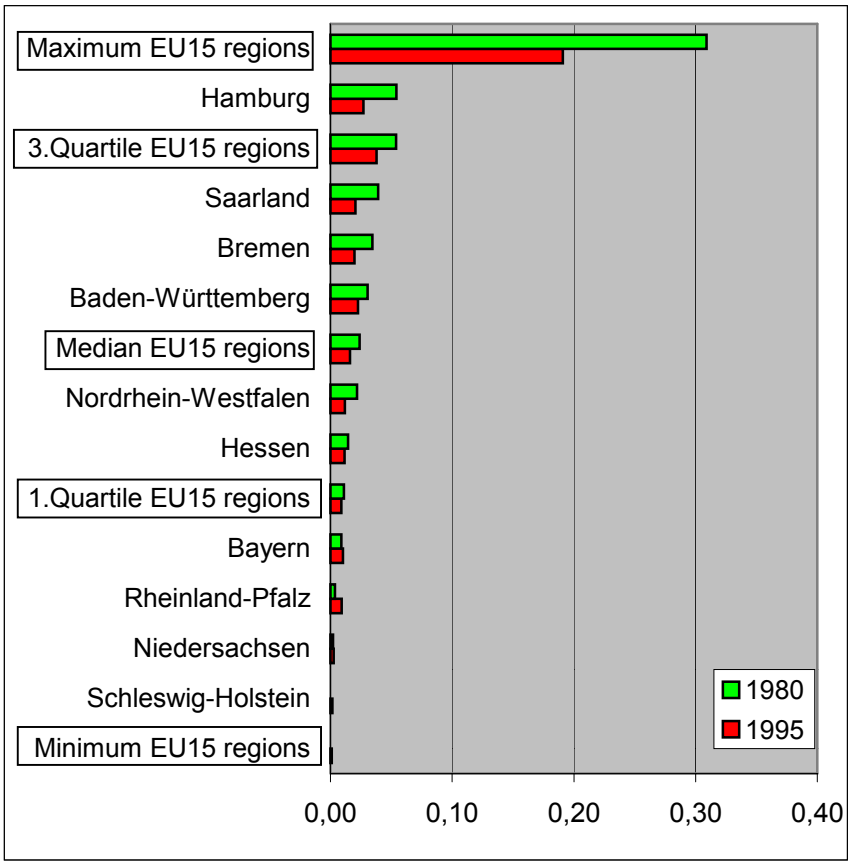
Figure 3.1-1 Specialization of EU15 countries 1980 and 1995 – Brülhart-Träger Theil indices based on value added in 4 sectors, relative to EU15



Specialization of West German 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 West German regions. For comparison, Figure 3.1-2 also reports the quartiles of the distribution of the Theil indices across all 118 EU15 regions. The Figure shows that the majority of the West German regions exhibited a degree of specialization below the EU15 median. Only the small regions of Hamburg, Bremen and Saarland as well as Baden-Württemberg showed a higher degree of specialization. As to the evolution over time, most German regions experienced decreasing specialization during the period under investigation (1980–1995), as did West Germany and the EU15 as a whole.

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

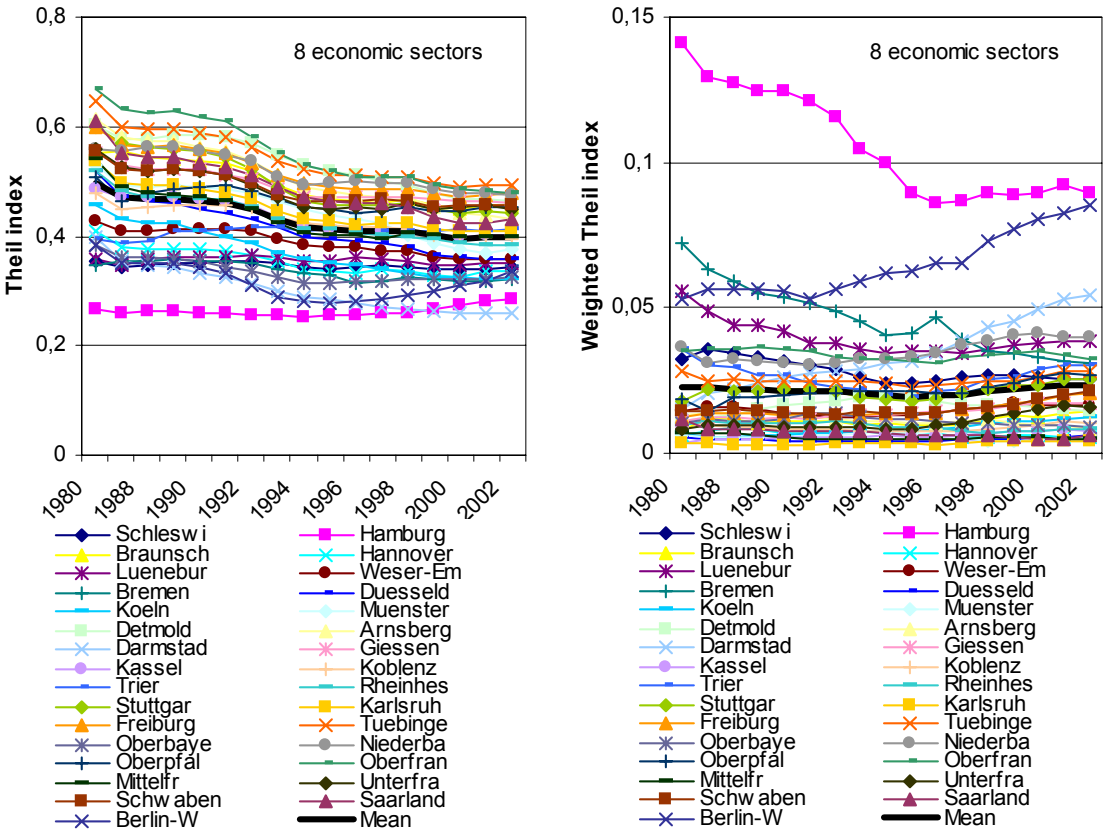


3.1.2 Overview on the specialization of German regions

As an introduction to the specialization part of the paper, an overview on the specialization pattern of *all* 31 German 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 German regions referring to the 8 *sectors* aggregated from the BAA data set, as measured by Theil indices and weighted Theil indices. The figure indicates a high similarity of all regions with respect to specialization. Only the region Hamburg, and, to a lesser extent, Berlin and Bremen stand out, as they reveal to be highly diversified in absolute terms yet highly specialized in relative terms. That is to say, that these urban regions, zoned without their respective hinterland, are shaped by a high localization of some sector in the very region while they are diversified with respect to all other sectors. *Over time*, on average, specialization seems to decrease in absolute terms while remaining constant in relative terms. Moreover, as the specialization of specialized regions decreases, and that of others remains constant, a convergence of the specialization pattern between regions is indicated.

Figure 3.1-3: Specialization of German regions, sectors 1980-2002



Source: BAA, Sozialversicherungspflichtig Beschäftigte.

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.

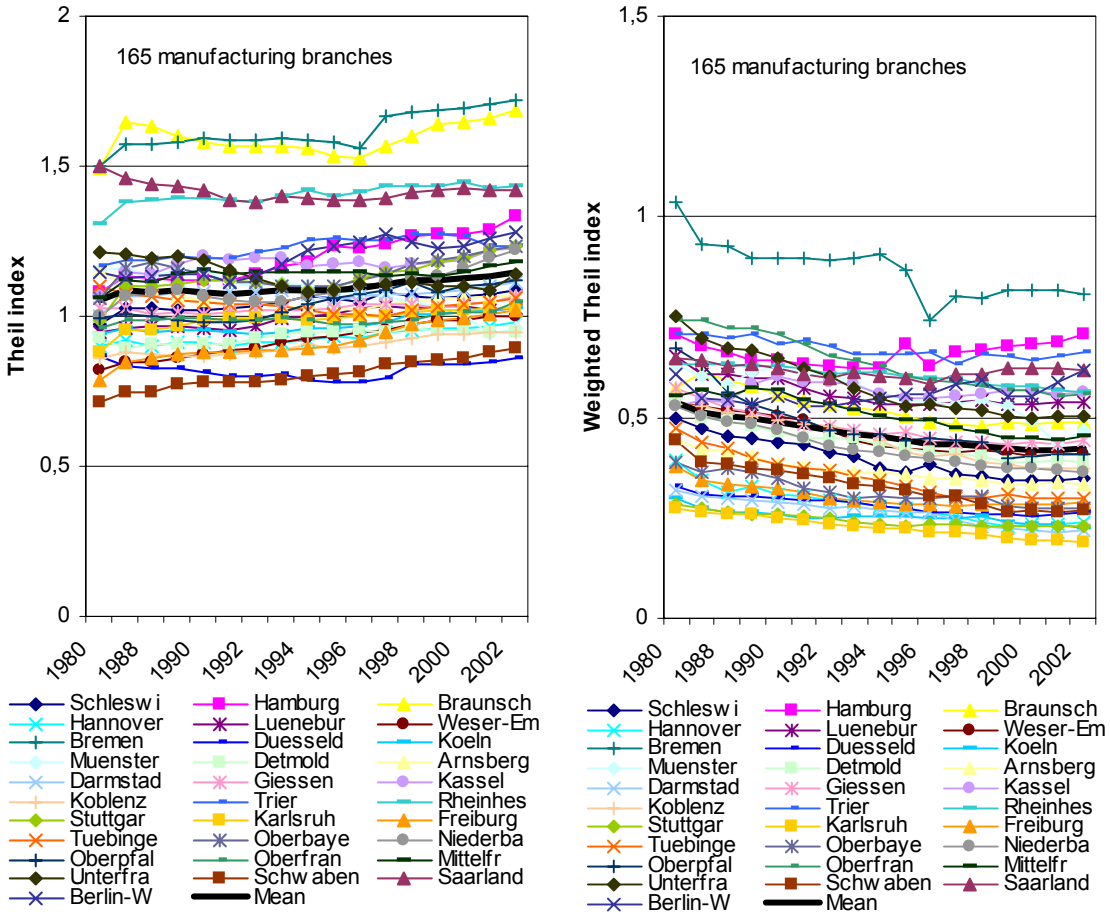
Table 3.1-1: Correlation matrix for measures of sectoral specialization of German regions in 1980 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	-0.55734 (0.0011)	**0.99284** **(<.0001)**	-0.43865 (0.0136)
Weighted Theil index		1.00000	-0.52014 (0.0027)	**0.93684** **(<.0001)**
Herfindahl index			1.00000	-0.39802 (0.0266)
Krugman index				1.00000

Source: BAA, Sozialversicherungspflichtig Beschäftigte.

The general assessment of the specialization of all German 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 German regions, manufacturing industries 1980-2002



Source: BAA, Sozialversicherungspflichtig Beschäftigte.

The graphs again demonstrate the high similarity of German regions with respect to specialization, both in absolute and relative terms. Some regions are, however, considerably higher specialized, e.g., Bremen, Braunschweig, Saarland and Rheinhessen (the latter three only in absolute terms). This is to say that all four regions inhabit industries that predominate their manufacturing sector, but only in the case of Bremen these industries are also highly localized in the very region Bremen. The results are confirmed by high correlations to other absolute and relative measures (Herfindahl and Krugman index; table 3.1-2).

Table 3.1-2: Correlation matrix for measures of industrial specialization of German regions in 1980 – Pearson correlation coefficients (error probabilities in parentheses)

	Theil index	Weighted Theil index	Herfindahl index	Krugman index
Theil index	1.00000	0.58280 (0.0006)	**0.86927 (<.0001)**	0.51981 (0.0027)
Weighted Theil index		1.00000	0.32132 (0.0780)	**0.93544 (<.0001)**
Herfindahl index			1.00000	0.26531 (0.1492)
Krugman index				1.00000

Source: BAA, Sozialversicherungspflichtig Beschäftigte

Over time, again, the message of absolute and relative specialization measure differs.[26] On average, regional specialization very slightly increase when drawing on relative measures whereas it clearly decreases when drawing on relative measures. Also, the standard deviation across all regions does not change much. This could be interpreted to indicate an increase of specialization of the average German region as to the EU and the rest of the world, yet an increase of coherence among German regions.

To sum up, a cautious conclusion is that specialization of German regions seems to be low and that the similarity of regions even seems to increase 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 German 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 employment shares of resource intensive, high IRS, concentrated footloose, and dispersed footloose industries).

[26] 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).

Applying a Ward's minimum cluster analysis (based on standardized values for each variable, for details cf. appendix), five types of German 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):

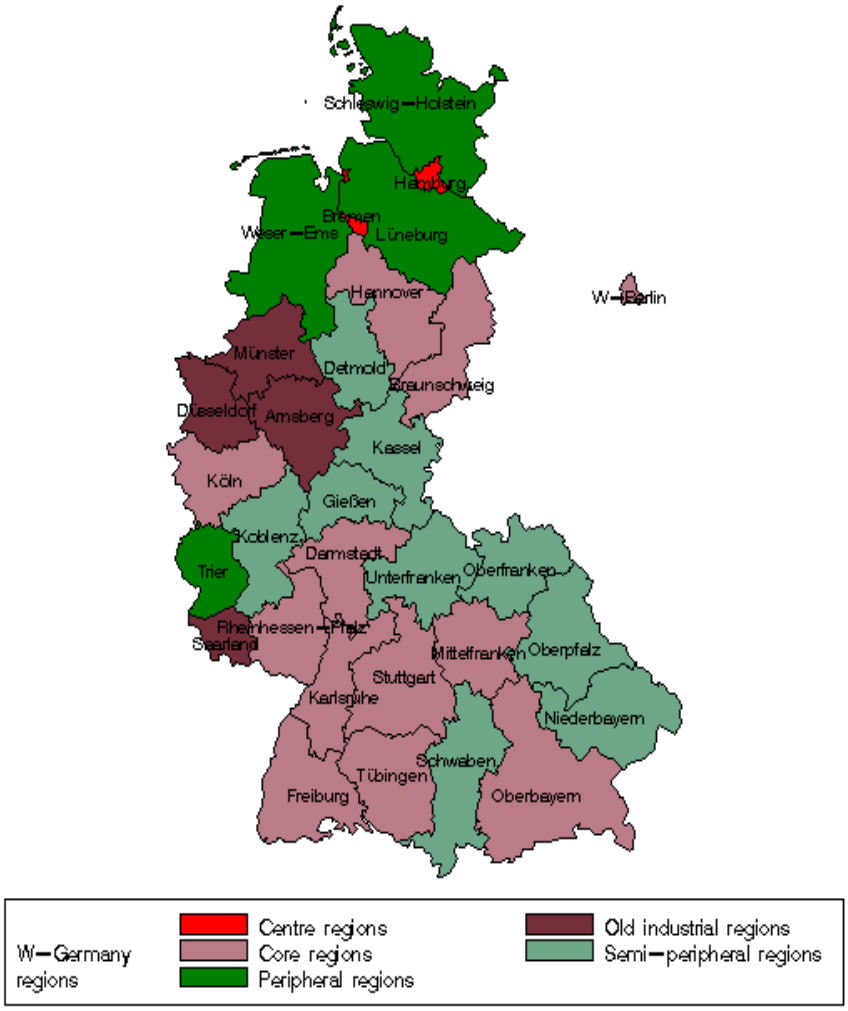
- *Old industrialized regions*: characterized by relatively high shares of manufacturing, with a focus on resource dependent and on high IRS industries; contains the Ruhr area regions Düsseldorf, Münster and Arnsberg and the region Saarland. These regions are situated at the west and south-west of Germany, close to the border of the Netherlands and France.
- *Central regions*: characterized by relatively high shares of recovery, trade and lodging, credit and insurance, and other market services, of high IRS and concentrated footloose industries; contains the cities Hamburg and Bremen that are zoned without their hinterland.
- *Core regions*: characterized by shares close to average for all sectors and a focus on high IRS industries; contains Braunschweig, Hannover Köln, Darmstadt (with Frankfurt), Rheinhessen, Stuttgart, Karlsruhe, Freiburg, Tübingen, Oberbayern (with München), Mittelfranken and West-Berlin. These regions are scattered across Germany with a focus on south Germany.
- *Semi-peripheral regions*: characterized by shares close to average for all sectors and manufacturing industries; contains Detmold, Gießen, Kassel, Koblenz, Niederbayern, Oberpfalz, Oberfranken, Unterfranken, and Schwaben. These regions are situated in the middle and the south of the country.
- *Peripheral regions*: characterized by relatively high share of agriculture, building and construction and non-market services, with no very explicit focus on a specific industry group; contains Schleswig-Holstein, Lünebürg, Weser-Ems and Trier. These regions are usually situated in the north and /or at the utmost periphery of the country.

Table 3.1-1: Classification of German 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)			
						Old industrialized regions						
Duesseldorf	0.61	6.57	5.10	3.51	23.64	5.51	9.51	**45.55**	**21.19**	12.63	7.32	58.85
Muenster	1.16	9.18	3.29	3.18	22.12	3.57	11.31	**46.19**	**19.73**	14.89	10.15	55.24
Arnsberg	0.59	7.75	3.78	2.43	21.38	3.89	9.42	**50.77**	**30.77**	12.96	2.65	53.62
Saarland	0.40	7.41	3.88	3.03	22.05	3.32	10.00	**49.90**	**32.45**	11.16	3.05	53.34
						Central regions						
Hamburg	0.47	6.26	**13.25**	6.76	**28.91**	**9.21**	10.83	24.32	7.93	**21.26**	**16.63**	54.18
Bremen	0.64	6.46	**12.94**	3.82	**26.81**	**5.73**	11.82	31.79	8.09	**27.73**	**23.10**	41.08
						Core regions						
Braunschweig	1.33	7.65	3.43	2.84	21.58	3.52	11.95	47.69	10.25	**41.58**	3.57	44.60
Hannover	1.14	8.26	5.04	4.75	24.84	4.80	12.58	38.59	2.69	**25.70**	10.51	61.09
Koeln	0.59	6.94	4.51	4.49	22.43	5.22	14.00	41.82	10.25	**28.49**	4.32	56.94
Darmstadt	0.60	6.86	6.53	5.73	23.42	6.28	11.18	39.39	2.20	**29.09**	6.61	62.11
Rheinhessen	1.37	7.63	3.70	3.03	20.47	3.58	14.30	45.92	1.06	**33.45**	10.18	55.32
Stuttgart	0.86	7.01	3.55	4.04	18.65	4.03	9.49	52.38	2.53	**30.60**	5.53	61.34
Karlsruhe	0.67	7.76	3.86	3.54	21.64	4.12	11.57	46.83	1.99	**29.08**	8.97	59.96
Freiburg	1.03	8.43	3.48	2.48	21.59	3.04	10.22	49.74	6.09	**24.34**	11.68	57.89
Tuebingen	1.43	8.15	3.02	2.44	18.43	2.78	9.77	53.98	2.32	**22.16**	16.99	58.54
Oberbayern	0.99	8.79	4.79	5.19	24.60	6.15	11.73	37.76	1.40	**33.20**	13.88	51.52
Mittelfranken	0.87	7.58	4.56	3.37	21.67	5.03	8.68	48.26	1.92	**26.42**	15.68	55.98
Berlin-West	0.56	6.95	5.42	2.85	27.84	7.70	17.76	30.92	1.93	**37.01**	5.51	55.55
						Semi-peripheral regions						
Detmold	0.88	7.61	3.29	2.52	23.83	3.65	9.41	48.80	4.56	12.02	4.46	**78.96**
Giessen	0.85	9.39	3.78	2.32	22.72	2.73	12.54	45.66	6.00	17.79	7.91	**68.29**
Kassel	1.37	9.23	4.71	3.00	23.52	3.39	11.31	43.46	1.45	12.96	12.21	**73.38**
Koblenz	1.40	9.66	3.45	2.84	24.76	3.36	13.74	40.78	5.34	11.04	12.75	**70.87**
Niederbayern	2.49	11.83	3.27	2.59	19.05	2.14	9.35	49.28	0.65	27.13	5.23	**66.99**
Oberpfalz	1.57	12.18	4.47	2.67	20.48	2.71	10.23	45.70	7.24	17.72	9.96	**65.09**
Oberfranken	1.05	8.72	3.64	2.96	18.13	2.49	7.72	55.29	0.89	12.33	24.08	**62.70**
Unterfranken	1.17	9.17	3.98	2.54	21.41	3.44	10.12	48.18	0.26	13.66	1.97	**84.10**
Schwaben	1.83	9.49	3.50	2.79	22.41	3.35	8.58	48.06	3.60	17.16	11.14	**68.10**
						Peripheral regions						
Schleswig-Holstein	**2.66**	**10.41**	4.62	3.41	27.41	4.46	**14.02**	33.00	1.54	21.86	12.39	**64.21**
Lueneburg	**3.41**	**12.90**	3.87	2.69	26.80	3.57	**14.60**	32.17	2.30	16.75	10.12	**70.83**
Weser-Ems	**2.04**	**10.69**	4.47	2.74	24.32	3.46	**13.26**	39.01	8.00	17.44	11.87	**62.68**
Trier	**2.61**	**10.99**	5.01	2.88	26.65	2.63	**14.59**	34.64	4.39	8.57	9.49	**77.56**

Source: BAA Sozialversicherungspflichtig Beschäftigte.

Figure 3.1-1: German region classes



3.3. Evolution of specialization over time by region classes

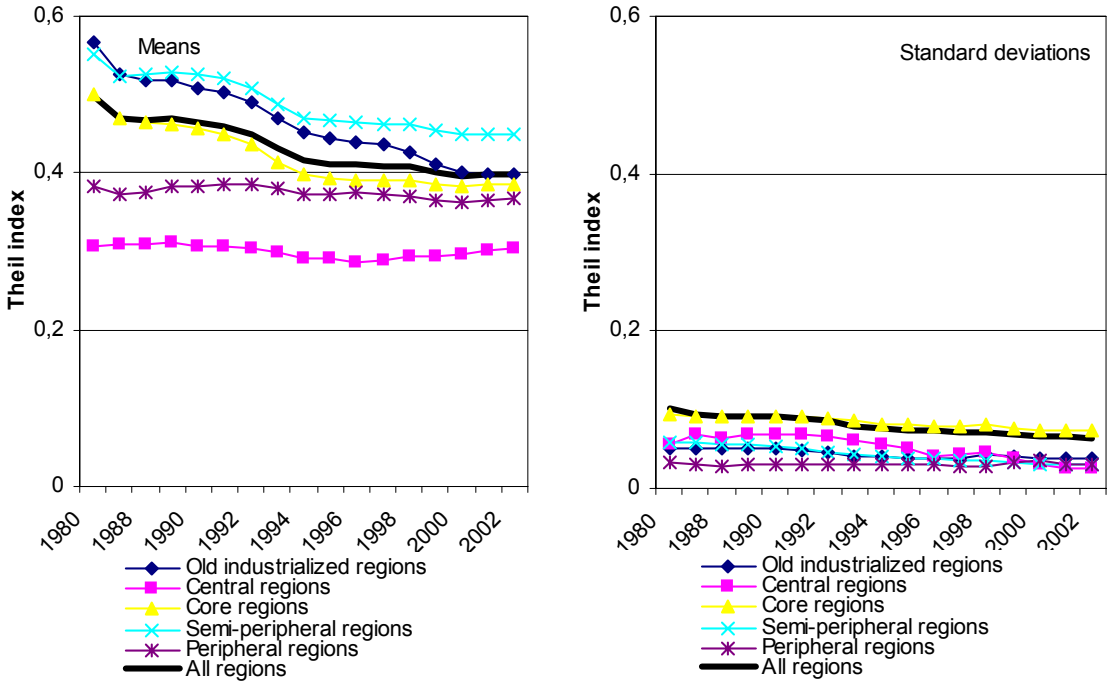
As trade theories hold that the initial structural mix of a region matters for its further economic development, the evolution of regional specialization within these classes of regions should reveal similar characteristics. Questions are, what region classes get more specialized, what more diversified, 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?

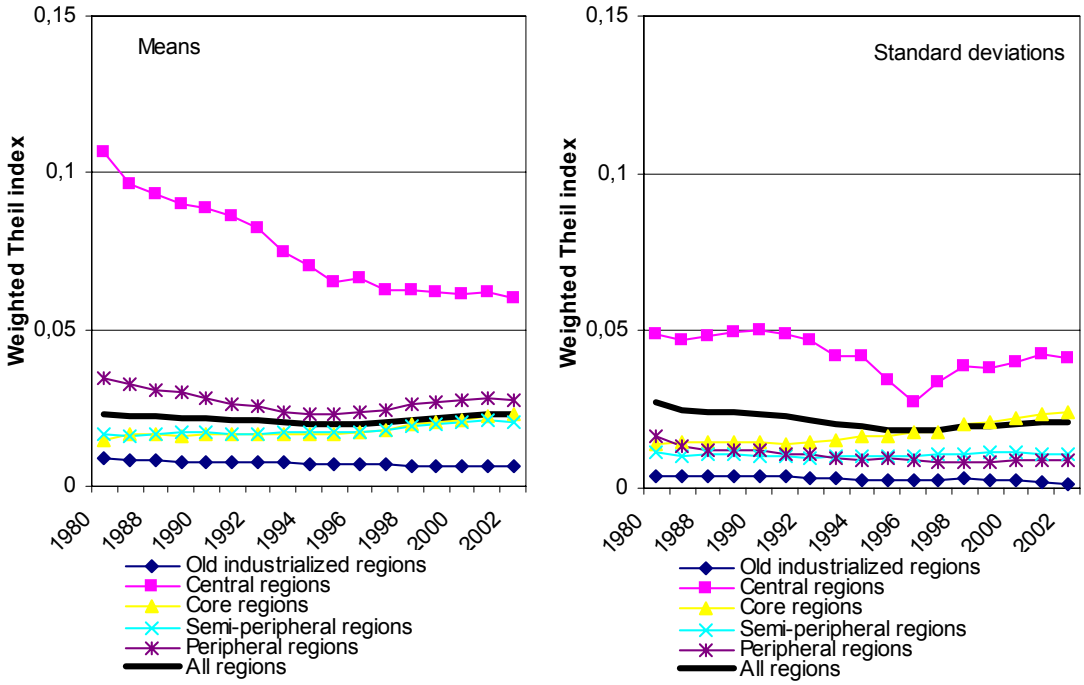
Regional specialization is once again analyzed by means of the Theil and weighted Theil index. On the basis of these indicators, means and standard deviations for region classes are calculated over time.

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

- the old industrialized regions and the semi-peripheral regions exhibit the highest specialization degrees in absolute terms, yet drawing on relative specialization measures the ranking of region classes almost gets inverted, with the central regions being most specialized, due to the localization of some small services sectors in these regions (recovery, trade and lodging services, other market services);
- 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 German regions, sectors



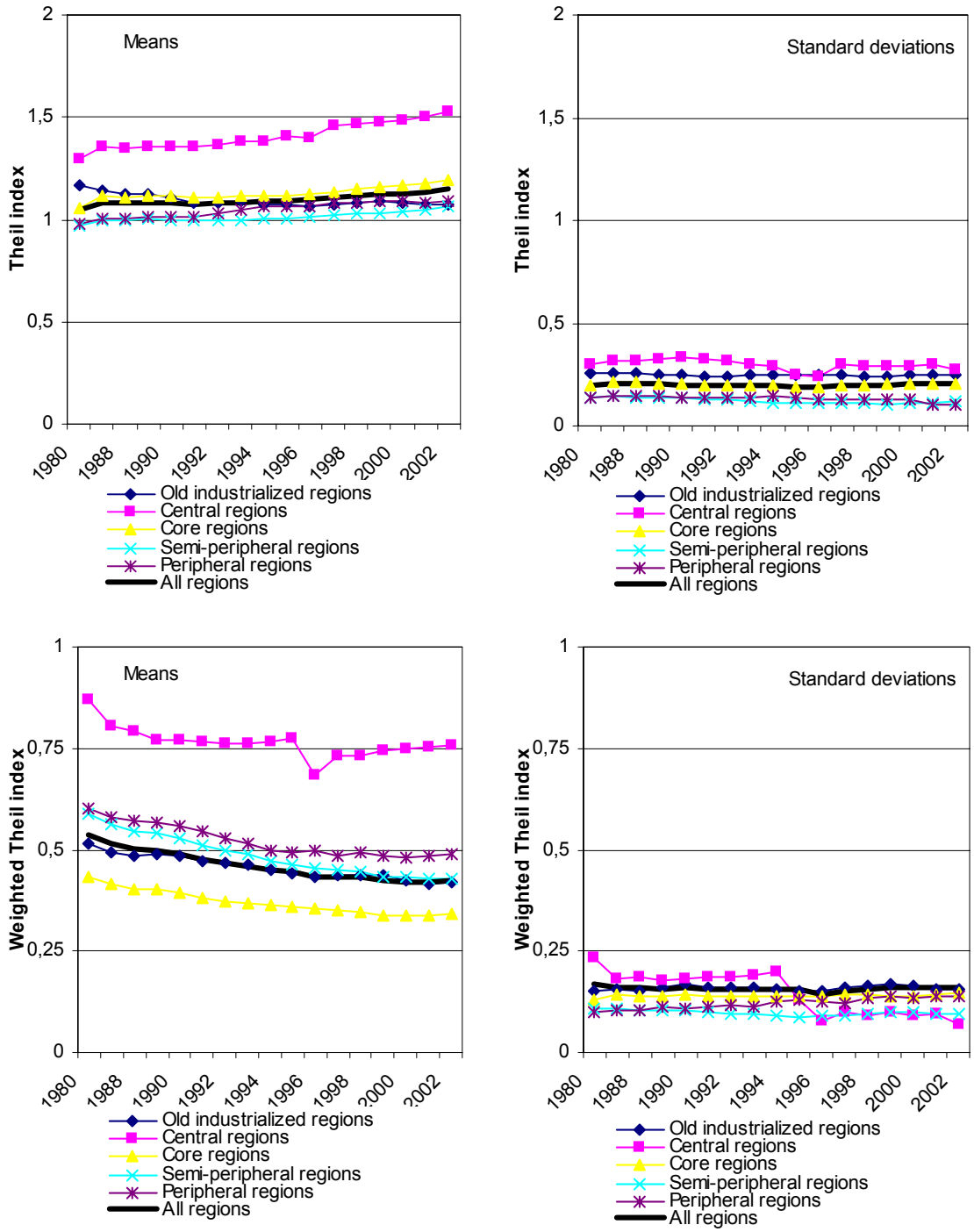


Source: BAA, Sozialversicherungspflichtig Beschäftigte.

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:

- Again, the central 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 increases slightly in absolute terms, yet decreases markedly in relative terms. The region classes evolve more or less in parallel to the average evolution. For all indicators, the standard deviations of the region classes do not change much.

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

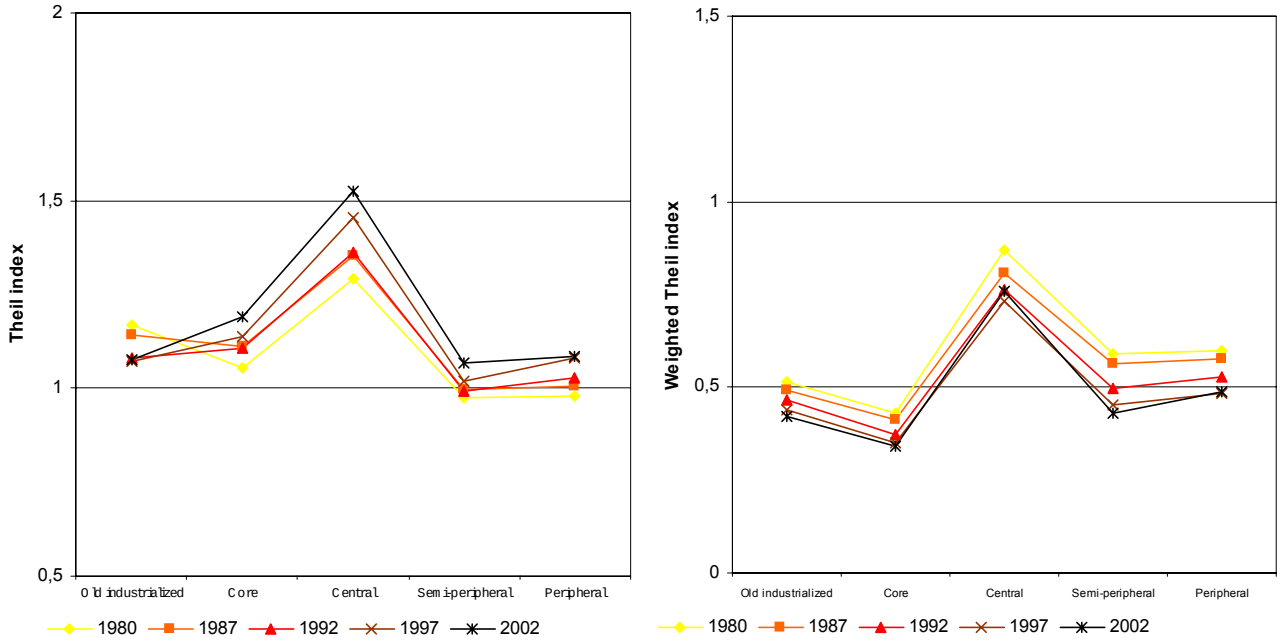


Source: BAA, Sozialversicherungspflichtig Beschäftigte.

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 in analogy to the case studies on Spain and France, where a systematic spatial pattern of such region classes can be detected: old industrialized regions, core regions, center region, semi-peripheral

regions and peripheral regions are situated at an approximate axis stretching from the north east to the south west of these countries. In Germany, this pattern is not similarly conclusive, due to the polycentric structure yet for the sake of comparison, this arrangement is adopted here. If only focusing on the absolute measures, this figure seems to tell an appealing story: regional specialization is high at the centers of the country, and it is elevated at the peripheries, whereas it is relatively low for regions between center and periphery. Over time, specialization of all regions apart from the old industrialized increases. This story would comply to some NEG models that suggest a high specialization of the center (on IRS industries) and a high specialization of the periphery (on non-IRS industries).[27] Yet however appealing the story, differences between center region and neighboring regions are small and most certainly not significant, as is the movement over time. When considering the relative measures the argument is converted with respect to the evolution over time.

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



Source: BAA, Sozialversicherungspflichtig Beschäftigte.

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 German 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?

[27] Similar pattern can also be detected for French and Spanish regions.

The first view is on sectoral specialization of German regions and their subsequent performance (table 3.4-1). During the observation period, the peripheral regions and the semi-peripheral regions seem to grow the most quickly in terms of employment. By contrast, the the old industrialized and the central 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 1980	Shares in 1980	1980-1987	1987-1992	1992-1997	1987-2002	1980-2002
Old industrialized regions	0.57	19.74	-0.51	1.82	-1.56	0.31	0.18
Central regions	0.31	5.12	0.38	2.68	-0.88	0.59	0.79
Core regions	0.52	44.36	0.31	2.21	-1.37	0.94	0.58
Semi-peripheral regions	0.43	22.12	-0.07	2.84	-0.41	0.65	1.02
Peripheral regions	0.58	8.66	-0.94	1.96	-1.70	0.75	0.32
Total	.	100.00	0.07	2.26	-1.25	0.73	0.57

Correlation between initial specialization (1980) and subsequent employment change (1980-2002)		
Specialization measures	Pearson correlation coefficients	Error probabilities
Theil index	0.05002	0.7893
Weighted Theil index	-0.24754	0.1794
Herfindahl index	0.05840	0.7550
Krugman index	-0.17685	0.3412

Source: BAA Sozialversicherungspflichtig Beschäftigte.

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

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. The central regions, the cities of Hamburg and Bremen, differ most remarkably from all other region classes. Over time, German regions become more similar with respect to their sectoral specialization, yet less so with respect to industrial specialization. The initial specialization of regions does not seem to influence their subsequent performance regarding job gains or losses.

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

Region types	Abso-lute speciali zation in 1980	Shares in 1980	1980-1987	1987-1992	1992-1997	1987-2002	1980-2002
Old industrialized regions	1.17	21.59	-1.45	0.27	-4.34	-2.29	-2.14
Central regions	1.29	3.11	-0.20	1.85	-3.01	-0.48	-0.56
Core regions	1.08	43.70	-0.52	0.62	-4.08	-0.56	-1.36
Semi-peripheral regions	0.97	24.64	-1.01	2.54	-2.72	-0.67	-0.31
Peripheral regions	0.98	6.96	-1.79	0.67	-3.48	-1.21	-1.36
Total	.	100.00	-0.73	0.92	-3.80	-0.89	-1.28

Correlation between initial specialization (1980) and subsequent employment change (1980-2002)

Specialization measures	Pearson correlation coefficients	Error probabilities
Theil index	-0.24189	0.1899
Weighted Theil index	0.11440	0.5400
Herfindahl index	-0.21977	0.2349
Krugman index	0.14292	0.4431

Source: BAA Sozialversicherungspflichtig Beschäftigte.

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. It appears that the localization of specific industry groups influences markedly the subsequent evolution of regional specialization and of regional employment performance (table 4-2). This applies particularly to the localization of resource intensive and high IRS industries. A high *localization of resource intensive industries* in a specific region tends to coincide with a decrease of the specialization of this very region (in absolute terms; columns 2 and 4 of table 4-2). Also, it tends to coincide with a drawback of resource intensive industries from this region (column 6 of table 4-2), and an overall bad employment performance of this region's manufacturing sector (column 7 of table 4-2). Within the sub-group of old industrialized regions that are characterized by a high localization of resource intensive industries these influences are less obvious. At any rate, a negative correlation to the subsequent employment performance of this sector in these regions is detected. A high *localization of IRS industries* in a specific region tends to coincide with an increase of the specialization of this very region, and with a drawback of IRS industries from this region. A high *localization of concentrated footloose industries* tends to coincide with an increase of the region's absolute specialization (in terms of the Herfindahl measure) and a decrease of this industry group's employment in the specific region. A high *localization of dispersed footloose industries* tends to coincide with an decrease of the

region's relative specialization (in terms of the Krugman measure) and an increase of the region's manufacturing employment.

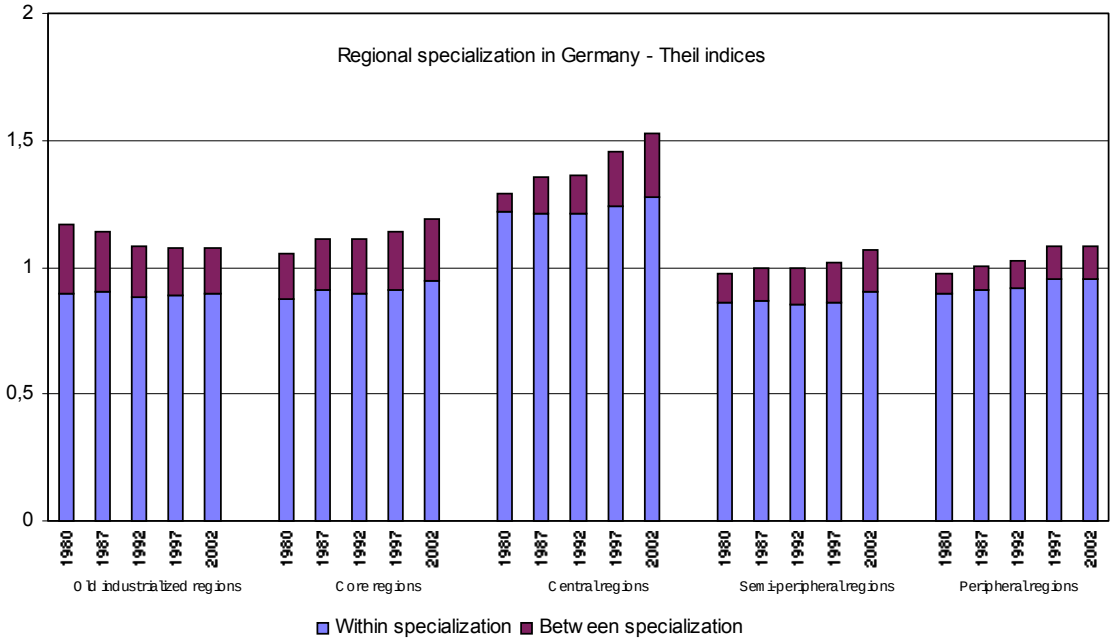
Table 4-2: Impact of highly localized industry groups on the respective regions – Pearson correlation coefficients (error probabilities in parentheses)

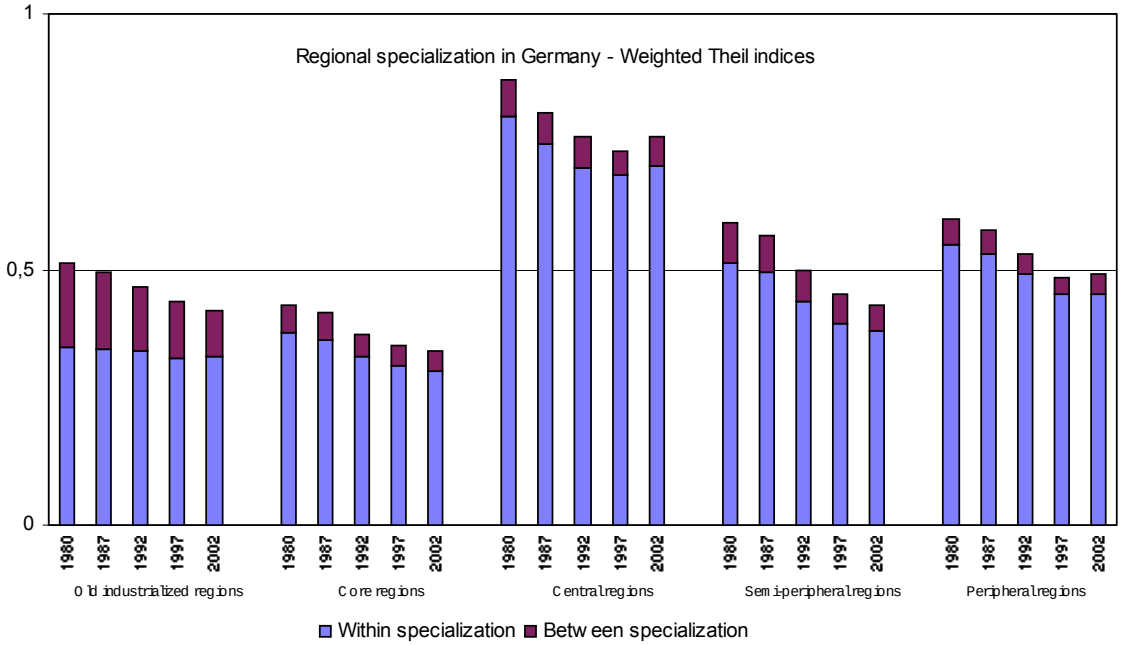
Localization coefficients	Correlation to change of regional specialization				Correlation to regional employment change	
	Theil index	Weighted Theil index	Herfindahl index	Krugman index	of resp. ind. group	of all manufact. industries
Resource intensive industries						
Old industrialized regions	0.24280 (0.7572)	0.55624 (0.4438)	0.27983 (0.7202)	-0.08518 (0.9148)	**-0.99095 (0.0090)**	0.25015 (0.7498)
All regions	**-0.54056 (0.0017)**	0.14928 (0.4229)	**-0.46520 (0.0084)**	-0.01355 (0.9423)	**-0.97854 (<.0001)**	**-0.37914 (0.0354)**
Industries with high IRS						
Core regions	0.42420 (0.1693)	**0.62016 (0.0315)**	**0.67018 (0.0171)**	**0.60726 (0.0362)**	-0.20153 (0.5299)	-0.27446 (0.3880)
All regions	**0.53575 (0.0019)**	0.18593 (0.3166)	**0.52456 (0.0025)**	0.30828 (0.0915)	**-0.44542 (0.0120)**	-0.21494 (0.2456)
Concentrated footloose industries						
Semi-peripheral regions	0.27211 (0.4787)	0.15654 (0.6875)	0.35450 (0.3492)	-0.00349 (0.9929)	**-0.81296 (0.0077)**	-0.48451 (0.1862)
Peripheral regions	0.71346 (0.2865)	-0.86307 (0.1369)	0.55472 (0.4453)	-0.58659 (0.4134)	-0.94368 (0.0563)	-0.73034 (0.2697)
All regions	0.28470 (0.1206)	-0.21286 (0.2503)	**0.36257 (0.0450)**	0.17620 (0.3430)	**-0.86139 (<.0001)**	0.05778 (0.7575)
Dispersed footloose industries						
Semi-peripheral regions	-0.66390 (0.0512)	0.02743 (0.9442)	-0.59838 (0.0887)	0.24982 (0.5184)	-0.47055 (0.2011)	-0.13074 (0.7374)
Peripheral regions	-0.81515 (0.1849)	0.91808 (0.0819)	-0.77622 (0.2238)	0.30211 (0.6979)	-0.20897 (0.7910)	-0.52764 (0.4724)
All regions	-0.18184 (0.3276)	-0.17776 (0.3387)	-0.28202 (0.1243)	**-0.37108 (0.0399)**	0.20208 (0.2756)	**0.49371 (0.0048)**

Source: BAA, Sozialversicherungspflichtig Beschäftigte.

Finally, in order to detect whether the specialization of the German regions is driven at all by the groups of industries with similar trade related characteristics or rather by the specialization on industries within these groups, the decomposition property of the Theil index is once again exploited (figure 4-1): The total regional specialization is decomposed in a component describing the specialization degree on the four groups of industries (between index), and a component describing the specialization degree within these type classes of industries (within index). The results for the different region classes is 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 – with the exception of the old industrialized regions (and this result holds whether applying the absolute or the relative measure) and the core regions.

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





Source: BAA, Sozialversicherungspflichtig Beschäftigte

Part D. Conclusion: Results for the German case

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

- Germany is found to be among the EU countries exhibiting the lowest concentration of sectors, particularly so in terms of topographic concentration. In particular, the agricultural and the manufacturing sector are much more dispersed than in most other EU countries. Yet, the German sectors and manufacturing industries reveal a considerable variation as to their concentration degrees in the initial year. Thus, resource dependent industries and some though not all IRS industries are highly concentrated. 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. The central regions, the cities of Hamburg and Bremen differ most remarkably from all other region classes. Moreover, the more peripheral regions tend to be higher specialized than the regions in-between.
- Integration, which can be said to be continuously growing during the observation period of more than 20 years, clearly changes concentration and specialization pattern in Germany. In contrast to other European countries, the concentration of German sectors decreases remarkably. At the same time, their concentration pattern seems to become more alike whereas the concentration pattern of manufacturing industries remains more or less unchanged. Also, German regions seem to become more similar with respect to their sectoral specialization, yet less so with respect to industrial specialization.
- Initial concentration degrees seem to exert little influence on the subsequent evolution of concentration of industries. Initial specialization degrees concerning sectors, however seem to exert an influence on the subsequent specialization of regions: the higher the specialization the more pronounced its subsequent decrease. There is no clear distinction of trends for peripheral versus central regions.
- Initial concentration seems to influence the performance of sectors and industries: (Spatially) concentrated sectors perform better than (spatially) dispersed ones whereas, within manufacturing, concentrated industries perform worse than 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 a specific industry group in a specific region seems to influence markedly the subsequent evolution of specialization and of employment performance in this very region. This applies particularly to the localization of resource intensive and high IRS industries. 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, and in the case of resource intensive industries, there seems even to be an influence on the overall manufacturing performance of the respective 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 Germany and the UK. The sectors are agriculture, construction, 9 manufacturing and energy industries, and 6 services industries.

The second database is provided by the Bundesanstalt für Arbeit (today: Bundesagentur für Arbeit) that offers data on persons employed that are subject to social insurance contributions. 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, 165 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.[28] 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

[28] 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:[29] 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.[30] 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.[31] As a consequence, the measure would be biased. The bias would be

[29] 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.

[30] 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).

[31] 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.[32] 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.[33] 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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[32] 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.

[33] 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.[34] 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.[35] 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

[34] 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.

[35] 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.[36] 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.

[36] 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

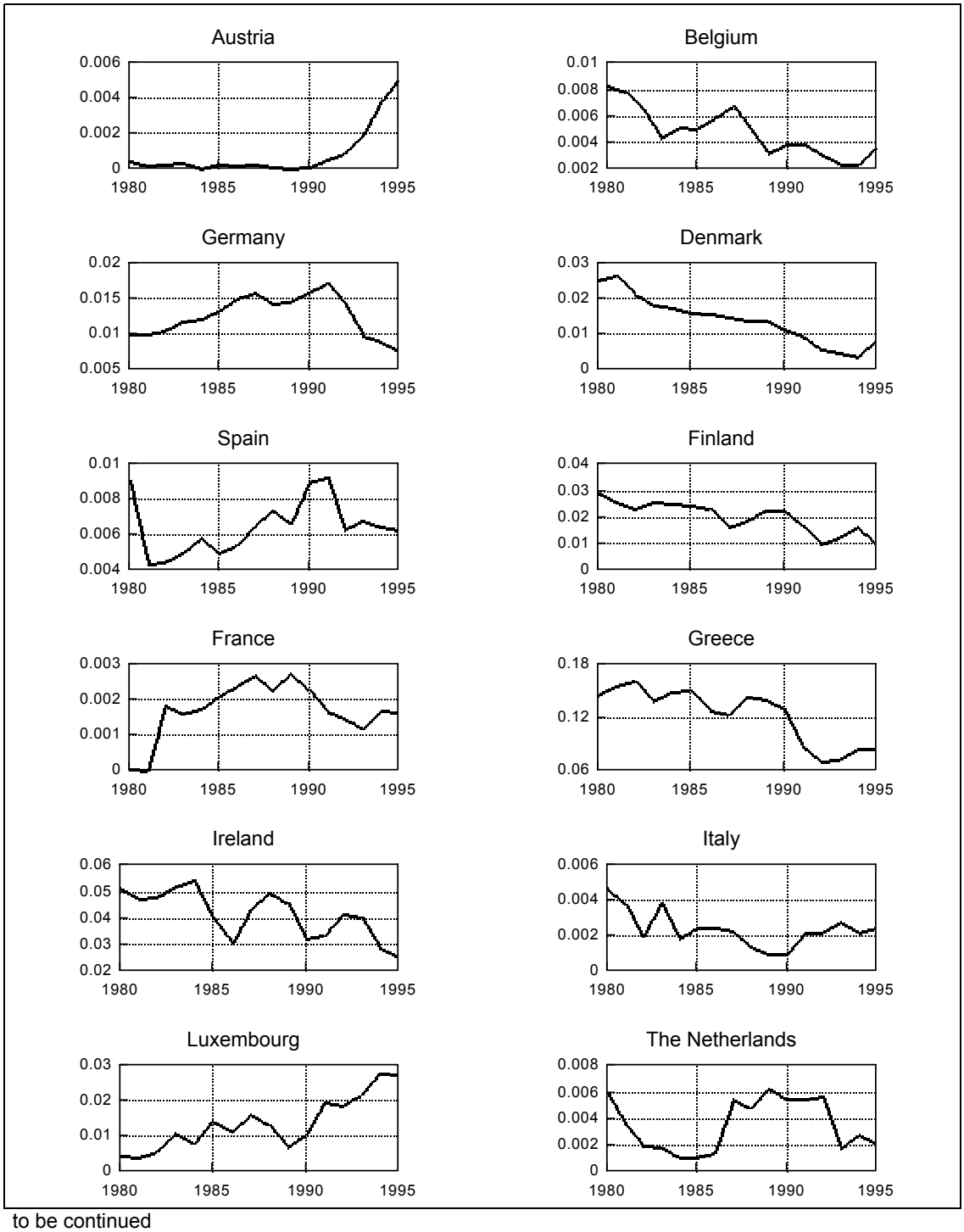
Table A3–1 — Geographic concentration of four sectors across 118 regions in EU15 countries: Absolute changes in total, between and within components of Brülhart/Träger Theil indices 1980-1995, reference: total area

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

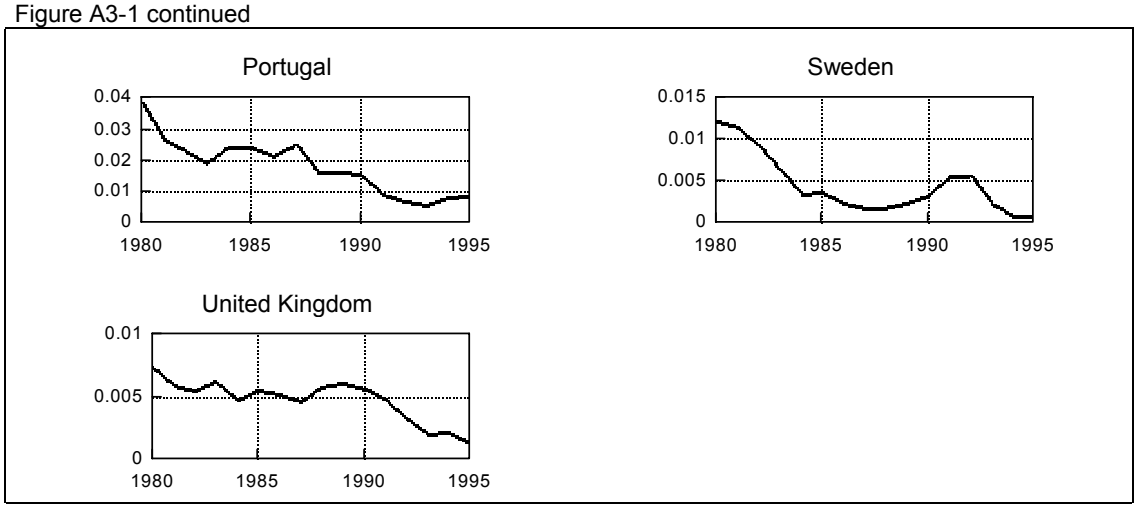
Index-component/ Country-specific within	All sectors	Agriculture	Manufac-turing	Construction	Services
Total	—	–0.004	–0.000	+0.004	–0.005
Between	—	–0.015	–0.001	+0.010	–0.002
Within	—	+0.011	+0.001	–0.006	–0.003
Austria	—	—	—	—	—
Belgium	—	–0.040	+0.028	+0.002	–0.000
West-Germany	—	–0.009	–0.000	+0.001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