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**Abstract— Food production and food processing, nowadays, are economic activities in which local and global strategies are interconnected. Moreover the importance of the food industry in total manufacturing is growing; local production systems are competing on the global market by producing specific quality goods or products. Many local regions have attempted to improve their economic situation by encouraging the growth of manufacturing activities. The basic objective of this study to determine and analyze the patterns of food manufacturing and the spatial changes between 2007 and 2001 in the 439 regions in Germany.**

*Keywords—* Spatial analysis, Food, Germany.

## I. INTRODUCTION

Germany is the Europe's largest market of food and beverage retail market with more than 82 million consumers. Food and beverage industry is the fourth largest industry sector in Germany and generating the transaction value of EUR 138.3 billion in 2008.

Table 1. Overview of Food Industry in Germany (2008)

		2008	% change 2007
Total sales	Mill. EUR	138.341.749	5,98
Domestic sales	Mill. EUR	113.219.948	5,02
Foreign sales	Mill. EUR	25.121.801	10,51
% of foreign sales	%	18	
Firm	Number	2.580	0,16
Employment	Number	430.976	0,60

Source: destatis 2010, own calculation.

## II. OBJECTIVE

Against this background, the paper reviews, describes, and evaluates the current situation of the

food industry in Germany with respect to its spatial structure on regional level. The spatial analysis provides the tools and methods to represent and analyze these important activities and the competitive dynamic of the food industry within Germany's regions. The overall objective of this study is identifying and explaining the growth pattern of food industry for regional/counties level.

This paper has four key questions to investigate:

1. What are the current food industry market trends that are occurring in Germany?
2. Benchmark food processing in the region in terms of how important is the industry. In particular, how many jobs are created, where are the growth and decline patterns from this sector within the region?
3. How is the role of rural areas that operating in the food processing industry in Germany's region?
4. Outline food industry opportunities specific to the identified study area. Provide suggestions and ideas on how the region might work with and support the existing food industry.

## III. METHODOLOGY & DATA

This research conducts a shift-share analysis and location quotient analysis using employment statistics data across a period of six years - 2001 and 2007. Analyses complimented by a GIS analysis. We use spatial analytical tools to examine geographic analysis across counties and states. GIS procedures help to differentiate concentrations in regions and also to mapping county-level employment by food industry as well as changes between these years. Data categories are based on the standard industrial classification (SIC) codes that are food related (two-digit SIC) considered for analysis. The food manufacturing sector data includes 24 different SIC sub-codes and in

439 regions in Germany. The main data sources for this paper were Statistics Germany.

The shift-share model being used in this study may be presented as follows:

*Calculating the national growth component:*

Growth rate of total employment:

$$R = (E_t - E_i) / E_i$$

Where:

$E_t$  = Value of total employment in Germany in the terminal year (2007)

$E_i$  = Value of total employment in Germany in the initial year (2001)

*Calculating the industrial mix component:*

Growth rate of industry's employment:

$$R^i = (E_t^i - E_i^i) / E_i^i$$

Industry mix:

$$(R^i - R)$$

Where:

$E_t^i$  = Value of total employment in the food industry in Germany in the terminal year (2007)

$E_i^i$  = Value of total employment in the food industry in Germany in the initial year (2001)

*Calculating the competitive local share component:*

Growth rate of county's i in food employment:

$$r^i = (e_t^i - e_i^i) / e_i^i$$

The regional shift in the industry:

$$S^i = r^i - R^i$$

Where:

$e_t^i$  = Value of total employment of the food industry in region/county i in the terminal year (2007)

$e_i^i$  = Value of total employment of the food industry in region/county i in the terminal year (2007)

The formula for computing location quotients used in this study presented as follows:

$$LQ = \frac{e_i/e}{E_i/E}$$

Where:

$e_i$  = local employment in food industry

$e$  = total local employment

$E_i$  = national employment in food industry

$E$  = total national employment

## IV. RESULTS

We present the results of our study in the same order as the sequence of analytical tools listed above. A key purpose of our work is to show that different analytical tools identify different combinations and sets of food industry analysis. Thus, caution is needed when comparing the results obtained from different methods. Table 2 shows the 2-digit food industries from the 2007 industrial classification.

Table 2. General Industrial Classification of Economic Activities in the Food Industry, Germany (2-3 digit, version 2003)

SICCode	Industry Titel
WZ-15	Food Manufacturing
WZ-151	Slaughtering and Meat Manufacturing
WZ-152	Fish Manufacturing
WZ-153	Fruit & Vegetable Manufacturing
WZ-154	Plant & Animal Fats and Oils Manufacturing
WZ-155	Milk & Ice Manufacturing
WZ-156	Flour Milling & Malt and Spice & Extract
WZ-157	Animal Food Manufacturing
WZ-158	All Other Miscellaneous Food Manufacturing
WZ-159	Soft Drink Manufacturing

Source: Destatis, 2010

### *Shift Share Analysis*

With shift share analysis we can decompose total employment change in food industry in any given regions into three components of change: one due to national growth, one due to industrial mix of existing jobs, and one due to the fact that the state's economy is more or less competitive than other regions/counties in Germany. Adding up these three components yields the total change in the number of jobs over time. Region with growth due to positive competitive advantage has ability to draw jobs away from other

region because of favourable local conditions. These are listed in Table 3. The regions/counties are sorted according to declining competitive advantage for each region, as measured by the total number of jobs generated because the region was more competitive in that industry than the nation or other region. The national and industry component are negative in most places because not much growth/decline occurred in this industry nationally over the period studied, reflecting a general slump in overall region.

Table 3. Top 30 regions gain local competitive share in food employment in 2007

Rank	Region name	Industry	Competitive
1	Ludwigslust	- 145	1179
2	Steinfurt	- 266	1039
3	Eifelkreis Bitburg-Prüm	- 106	912
4	Spree-Neiße	- 30	883
5	Marburg-Biedenkopf	- 207	844
6	Emsland	- 189	769
7	Vechta	- 229	708
8	Osnabrück	- 438	669
9	Stendal	- 77	645
10	Unna	- 76	608
11	Gütersloh	- 459	607
12	Weißenfels	- 76	604
13	Harburg	- 67	548
14	Ludwigsburg	- 217	539
15	Cloppenburg	- 299	512
16	Heilbronn	- 169	492
17	Fulda	- 139	482
18	Ravensburg	- 133	477
19	Bernkastel-Wittlich	- 110	455
20	Ammerland	- 90	453
21	Burgenlandkreis	- 80	446
22	Donau-Ries	- 141	431
23	Darmstadt	- 54	424
24	Gotha	- 93	407
25	Teltow-Fläming	- 81	401
26	Straubing-Bogen	- 60	400
27	Rhein-Sieg-Kreis	- 140	395
28	Alzey-Worms	- 53	375
29	Viersen	- 188	367
30	St. Wendel	- 75	342

The results of the shift share analysis suggest that regions: Ludwigslust (13054), Steinfurt (05566), Eifelkreis Bitburg-Prüm (07232), Spree-Neiße (12071), Marburg-Biedenkopf (06534), Emsland (03454), Vechta (03460), Osnabrück (03459), and Stendal (15363) are most competitive regions in the food industry in term of employment analysis in Germany.

The shift share analysis itself does not indicate why a region has productive advantage or disadvantage. This shows that these results have to be interpreted carefully. We have to use industry knowledge, local firms and market conditions for in-depth analysis.

### *Location Quotient*

We calculate two-digit food industry location quotients (LQ) for each region using imputed employment data for 2001 and 2007, and list the top 30 regions with a 2007 location quotient of greater than 2.00 in Table 4, along with the 2001 LQ.

The industry clusters are sorted in descending order by 2007 LQ for each state. The interpretation of the results is that a larger LQ points to a potential industry concentration in the regions. Of course, the LQ is calculated here using employment numbers, to determine if the industry is also potentially competitive, it would be important to see and compare how the local competitive share are in fact located in that region.

It is interesting to note how the location quotient changes over time, sometimes increasing noticeably and in other cases declining, in response to dynamically changing competitive positions of the industries in the different regions.

Weißenfels increased its employment concentration in food sector (with the LQ rising from 2.84 to 4.71). In Cloppenburg, the LQ for food sector slipped slightly, from 5.79 to 5.60.

Table 4. Industry Concentration by 2007 and 2001 Location Quotients

Rank	Region	Region Name	LQ	LQ
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	code		2007	2001
1	03453	Cloppenburg	5,60	5,79
2	07232	Eifelkreis Bitburg-Prüm	4,94	3,59
3	15268	Weißenfels	4,71	2,84
4	13054	Ludwigslust	4,64	3,16
5	09477	Kulmbach	4,36	4,03
6	03460	Vechta	4,24	4,17
7	03459	Osnabrück	3,92	3,77
8	07233	Vulkaneifel	3,92	4,01
9	13052	Demmin	3,77	2,83
10	03361	Verden	3,43	4,01
11	09278	Straubing-Bogen	3,41	2,66
12	03360	Uelzen	3,35	3,26
13	15355	Bördekreis	3,34	3,01
14	10046	St. Wendel	3,33	2,74
15	03154	Helmstedt	3,29	2,85
16	07231	Bernkastel-Wittlich	3,16	2,71
17	14292	Kamenz	3,13	2,62
18	09377	Tirschenreuth	3,04	2,81
19	09776	Lindau (Bodensee)	2,99	3,59
20	09678	Schweinfurt	2,95	3,18
21	15151	Anhalt-Zerbst	2,86	2,08
22	05754	Gütersloh	2,85	2,76
23	03354	Lüchow-Dannenberg	2,84	1,78
24	09183	Mühdorf a.Inn	2,78	2,89
25	03451	Ammerland	2,76	2,29
26	09779	Donau-Ries	2,69	2,50
27	09771	Aichach-Friedberg	2,66	2,54
28	03355	Lüneburg	2,66	2,67
29	09277	Rottal-Inn	2,65	2,50
30	09777	Ostallgäu	2,58	2,54

Table 4 reveals that Cloppenburg (03453), Eifelkreis Bitburg-Prüm (07232), Weißenfels (15268), Ludwigslust (13054), Kulmbach (09477), Vechta (03460), Osnabrück (03459), and Vulkaneifel (07233) are the top industry clusters, based on 2007 location quotients in Germany.

Using the Location Quotient Method in which we compare regional food industry concentration to the entire Germany, we can determine the following information:

Most regions in Industry Code 15 (Food Manufacturing) as mention above have a Location Quotient of above 2.10 which is far greater than 1.0.

Therefore, under the assumptions of this method, we have determined that this region exports many of its goods to non-local markets and many of its jobs should be considered as Basic sector employment.

Basic Sector employment means that this sector is made up of local businesses (firms) that are entirely dependent upon external factors. They build and sell large products to companies and countries located throughout the world. Their business is dependent almost entirely upon non-local firms. Mostly, they do not sell product to families or households locally, so their business is very much dependent upon exporting their goods. Manufacturing and local resource-oriented firms are usually considered to be basic sector firms because their fortunes depend largely upon non-local factors, they usually export their goods.

Of the 6,133 Food Manufacturing jobs in Cloppenburg approximately 5,038 have been determined to be Basic Sector jobs. See table 5.

The means of strengthening and growing the local economy is to develop and enhance the basic sector. The basic sector is therefore identified as the "engine" of the local economy. Klosterman (1990) *assumes that the basic sector is the prime cause of local economic growth, that it is the economic base of the local economy.*

This theory also posits that the local economy is strongest when it develops those economic sectors that are not closely tied to the local economy. By developing firms that rely primarily on external markets, the local economy can better insulate itself from economic downturns because, it is hoped, these external markets will remain strong even if the local economy experiences problems. In contrast, a local economy wholly dependent upon local factors will have great trouble responding to economic slumps.

Table 5. The number of Basic sector jobs

Rank	Region Name	Regional Employment	Basic Sector
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		in Food	
1	Cloppenburg	6.133	5038
2	Eifelkreis Bitburg-Prüm	2.900	2313
3	Weißenfels	2.036	1604
4	Ludwigslust	3.914	3071
5	Kulmbach	2.547	1963
6	Vechta	5.028	3843
7	Osnabrück	8.926	6649
8	Vulkaneifel	1.477	1100
9	Demmin	1.752	1287
10	Verden	3.194	2262
11	Straubing-Bogen	1.521	1075
12	Uelzen	1.928	1352
13	Bördekreis	1.551	1087
14	St. Wendel	1.753	1227
15	Helmstedt	1.441	1003
16	Bernkastel-Wittlich	2.521	1723
17	Kamenz	3.203	2178
18	Tirschenreuth	1.434	962
19	Lindau (Bodensee)	1.807	1203
20	Schweinfurt	1.376	909
21	Anhalt-Zerbst	1.182	769
22	Gütersloh	9.247	6005
23	Lüchow-Dannenberg	791	513
24	Mühldorf a.Inn	1.994	1277
25	Ammerland	2.143	1367
26	Donau-Ries	3.095	1943
27	Aichach-Friedberg	1.827	1140
28	Lüneburg	2.912	1817
29	Rottal-Inn	1.982	1235
30	Ostallgäu	2.297	1406

### *Trends of individual regions*

The aggregated county data on total food manufacturing employment do not reveal the dynamic of potential growth or decline of the individual counties/regions. Employment changes from 2001 to 2007 for the 2-digit standard industrial classification industries may be reclassified according to relative growth or decline.

#### *Stable regions*

For a region to be classified as stable, employment could not deviate more than 15 percent in either growth or decline in 2007 from its 2001 employment.

256 regions are found in this group (Appendix 1). Employment in food sector in Erlangen city increased from 1.390 to 1.598, an increase of 14.96 percent between 2001 and 2007, and food employment in Köln decreased from 6.504 to 5.777, a decline of 11.18 percent.

#### *Growth regions*

When employment in a region increased by more than 15 percent between 2001 and 2007, it is classified as growing. 31 regions are in this category (Appendix 2). Employment in the food industry in Spree-Neiße increased from 613 to 1.445, an increase of 135.73 percent; Eifelkreis Bitburg-Prüm, 2.169 to 2.900, 33.70 percent; Ludwigslust, 2.983 to 3.914, 31.21 percent; Weißenfels, 1.562 to 2.036, 30.35 percent; Ammerland, 1.844 to 2.143, 16.21 percent.

#### *Declining regions*

When employment in a regions declined by 15 percent or more it is classified as declining. 146 regions were in this group (Appendix 3). Employment in food industry in region Hagen city 1.547 in 2001 to 501 in 2007, a decline of 67.61 percent; Magdeburg Landeshauptstadt, 1.445 to 763, 47.20 percent; Karlsruhe city, 2.235 to 1.284, 42.55 percent; Cuxhaven, 3.596 to 2.123, 40.96 percent; Wuppertal city, 1.421 to 872, 38.63 percent.

#### *Spatial Distribution*

Following *Location Quotient* county-level establishment data, we identified groups of counties: central cluster counties and counties peripheral to the clusters. Figure 1 presents summary of spatial analysis for these food industry concentration. The detailed distributions of the industry concentration are shown in the following Maps.

From Figure 1 it is clear that some industry clusters are more concentrated than others in counties in particular states, such as in Cloppenburg, Vechta, and

Osnabrück in Niedersachsen; Ludwigslust, Nordwest Mecklenburg, Demmin in Mecklenburg Vorpommern and counties border between Niedersachsen; Börde and Stendal in Sachsen-Anhalt; counties around Kulmbach and Straubing-Bogen in Bayern; counties around Vulkaneifel and Eifelkreis Bitburg-Prüm in Rheinland-Pfalz.

The mapping of industry clusters in the entire study area helps us better understand the geographic distribution of food industry concentrations in Germany. It also shows where the potential exists for agglomeration economies among firms, and where it does not.

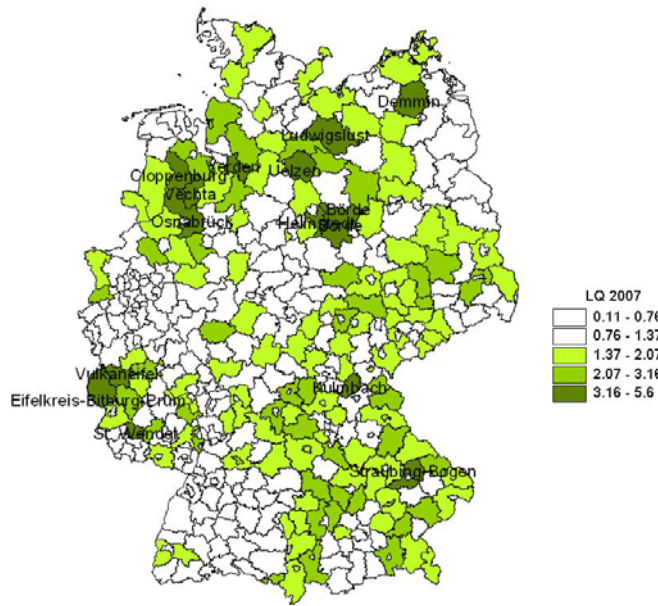


Figure 1. Food Industry Concentrations in Germany

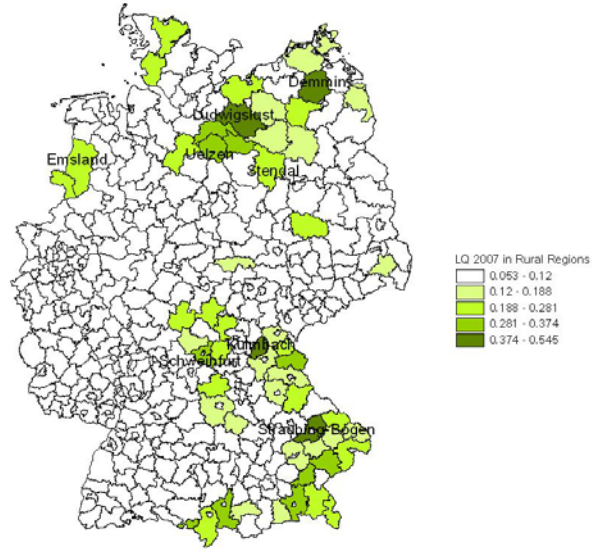


Figure 2. Food Industry Concentrations in Rural Regions

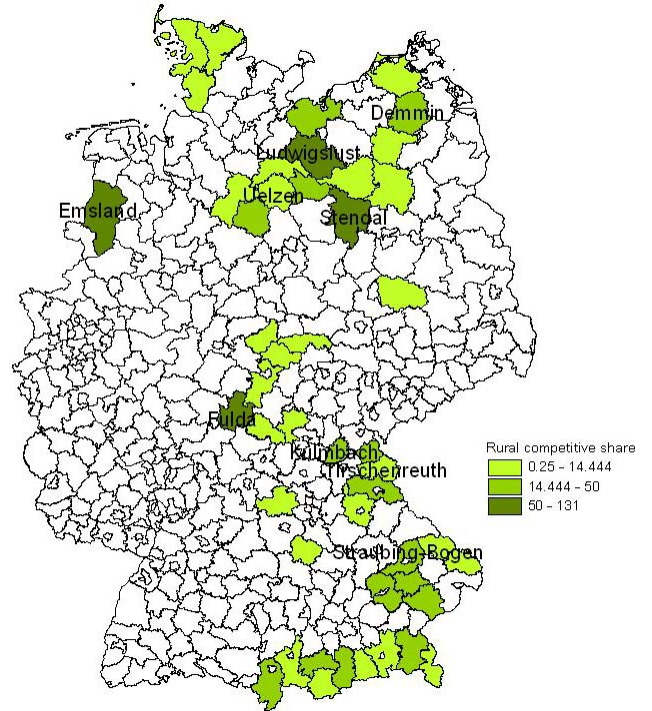


Figure 3. Rural Competitive Share in Food Industry.

## V. CONCLUSIONS

The spatial patterns reflect the declined of the food employment in national as well as in industry level between 2001 and 2007 in Germany. Although the



industry was slump, analysis reveals that many of the counties are experiencing considerable shifts in employment potential. Thus, some are growing more rapidly and others less rapidly. Therefore, the potential for growth varies greatly in industry from county to county.

Using shift share analysis, we find that Ludwigslust, Steinfurt, Eifelkreis Bitburg-Prüm, Spree-Neiße, Marburg-Biedenkopf, Emsland, Vechta, Osnabrück, Stendal, Gütersloh, and Weißenfels are on the top of competitive advantage regions in Germany.

Location quotient analysis showed that Cloppenburg, Eifelkreis Bitburg-Prüm, Weißenfels, Ludwigslust, Kulmbach, Vechta, Osnabrück, Vulkaneifel, Demmin, and Verden are the most heavily concentrated or localized regions in food industry in Germany.

Using ArcGIS, we mapped the distribution of industry concentration across counties in the Germany. Many industry concentrate stretch across several counties and even across state borders. For example, regional food industry is concentrated across Niedersachsen, Mecklenburg-Vorpommern and Sachsen-Anhalt border. This suggests that practitioners and analysts should be careful not to limit their spatial analysis only to single counties or event states, depending on where they are located.

The results also allow us to classify regions into one of two types, as outlined below:

*Type I - Local regions underperforming in a low growth industry*

These industries are showing a slower employment growth than the average recorded across Germany in food sector. This type of regions may be mature or declining industries and there may be few opportunities for growth. For example: Cuxhaven Hagen, Stadt Karlsruhe, Stadt Stuttgart, Landeshauptstadt Magdeburg, Landeshauptstadt, etc. Organisations of regional management should focus on the development of new growth opportunities such

as development of new products or accessing new markets.

*Type II - Local regions outperforming in a low growth industry*

These regions are recording higher employment growth in the local area, despite lower than average employment growth in the industry across the rest of the state. These types of regions are likely to be mature or declining industry; however there may be relatively better opportunities in Ludwigslust, Steinfurt, Eifelkreis Bitburg-Prüm, Spree-Neiße, Marburg-Biedenkopf, Emsland, Stendal, etc. Efforts should be made to attract more investment in this industry in the local area.

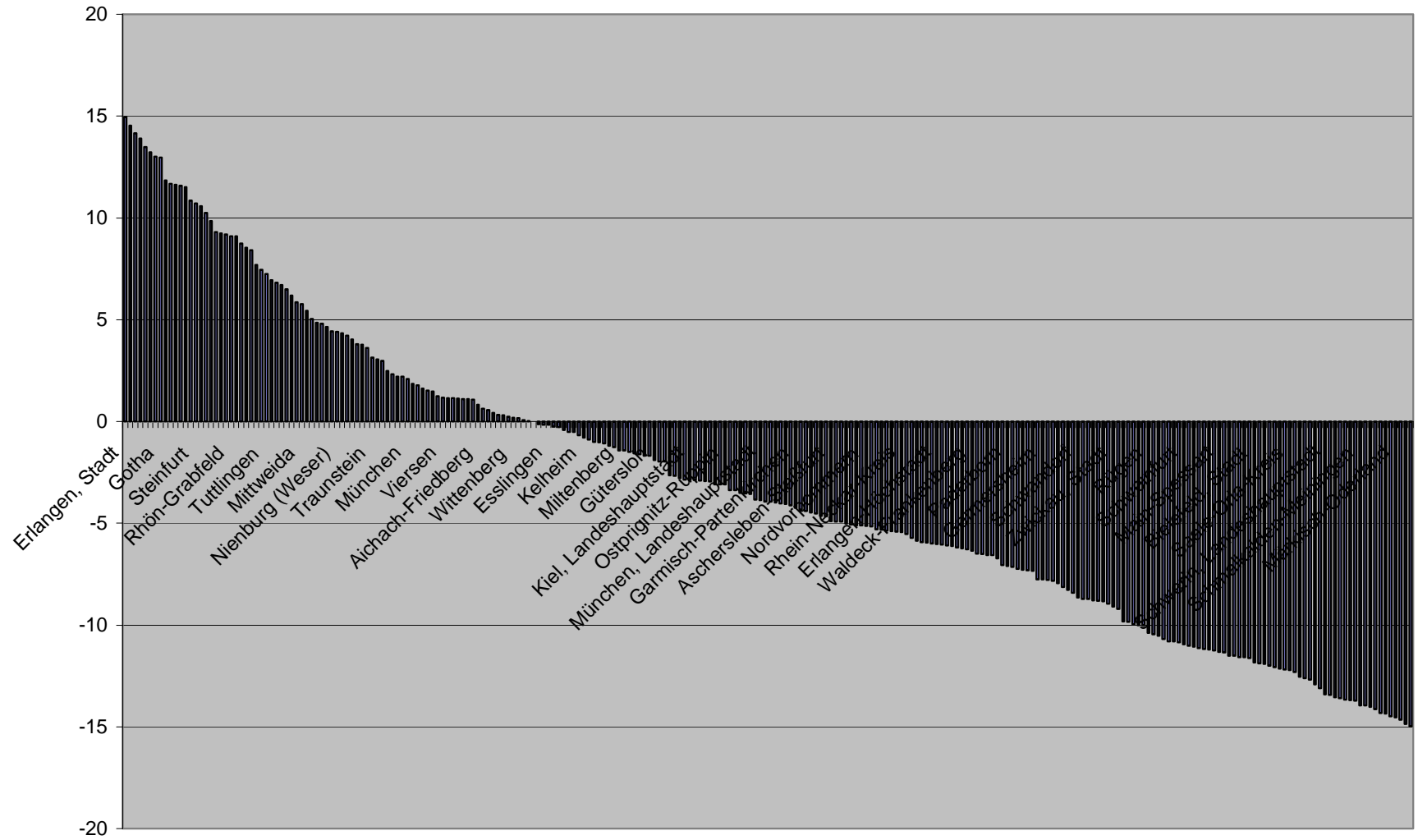
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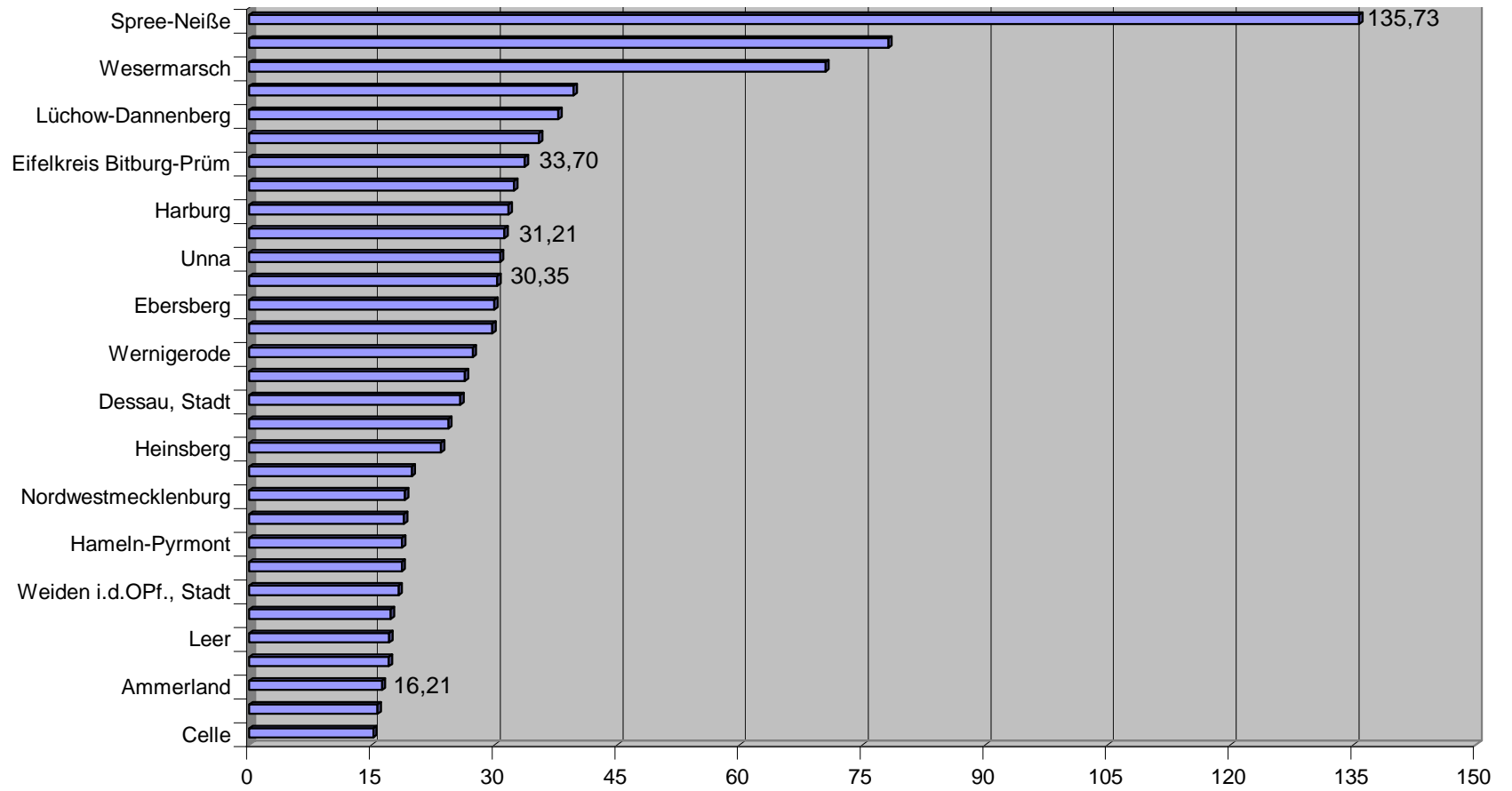


## APPENDICES

## Appendix 1. Stable Regions



## Appendix 2. Growths Regions



## Appendix 3. Declining Regions

