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Industrial Clusters as Source of Prospering Regions? Economic Structure and Regional Performance 1996-2005

Alexander Kubis¹, Matthias Brachert, Mirko Titze

Abstract: This paper explores the impact of industrial clusters on regional growth at level of German labour market regions within a regional convergence model. It focuses on vertically connected industrial sectors, which can emerge parallel to horizontal interconnections. Based on works of Schnabl (2000) it is possible to identify three different effects of industrial clusters on regional economic performance. Beside the effects of regionally concentrated economic sectors (horizontal clusters) and value-added production chains (vertical clusters) on the region itself, the paper segregates regional spillover effects of industrial clusters. Furthermore, the study allows the isolated examination of the impact of industrial clusters while taking regional convergence into consideration.

In addition to the all-German process of convergence and the specific East German process, positive growth effects of industrial clusters are detected. Therefore industrial clusters present an opportunity to explain deficits within the process of East-West convergence. The relative absence of industrial clusters in East Germany influences the growth potential in a negative way.

Keywords: Convergence, Industrial Cluster

JEL: R11, L14

1. Introduction

Since the mid-1990's, regions within Germany have developed very heterogeneous. There exist regions, which observe an increase in their real gross value added (GVA) as well as an increase in labour force next to regions, whose economic growth and workplace situation developed a lot more unfavourable. Economic literature presents different theoretical concepts, which offer an explanation for this development. They underline amongst others the role of regional factor endowments with the production factors of labour and capital (Solow 1956), the importance of circularly caused cumulative growth processes (Myrdal 1957), the influence of knowledge spillover and innovations (Romer 1986, 1990), of transportation costs and mobility (Krugman 1991) as well as the role of structural composition of regional economy for the growth of a region (Porter 1990, 1998).

Considering the development of successfully growing regions, the cluster concept gained appreciation for the explanation of regional growth (Maskell and Kebir 2005). Continuative analysis, predominantly based on regional case studies, point out the positive effects of industrial clusters as well. However, universal empirical examinations, which identify positive effects of industrial clusters on regional performance, are missing so far. Albeit, the concept enjoys an increasing popularity in practical apply, especially amongst actors of regional economic aid (Kiese and Schätzl 2008). The following article examines regional industrial clusters within the scope of a regional growth model. Based on the works of Roelandt and den Hertog (1999) as well as Schnabl (2000) it permits a

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systematic effect determination of different cluster structures on regional growth. Horizontal and vertical clusters generate external effects.

The contribution applies a neoclassical background for the identification of these effects and explains the real growth of GVA per capita between 1996 and 2005. The results are based on regional data of the Working Party on National Accounts, the employee data of the Federal Employment Office as well as the German input-output table 2003. They allow a consideration of positive external effects of industrial clusters as well as the regional convergence process of the 270 German functional labour market regions. Statements about the contribution of industrial clusters to regional growth as well as about the effect of convergence are enabled.

2. Industrial Clusters as Determinants of Regional Growth

First considerations about industrial clusters harken back to Alfred Marshall (1920: 270pp.). With the help of the term of *industrial districts*, he describes the advantages of spatial concentration for small and medium-sized enterprises. Referring to his work, local industrial concentrations exist because of advantages as a cause of the agglomeration of specialized employees and suppliers as well as technological spillover effects.

Porter (1990) adopts these ideas for the explanation of international competitiveness of economies. He enhances them on the spatial concentration of economic branches (Porter 1998). He discusses industrial clusters as determinants of regional performance and follows the thesis, that competitiveness is mainly dependant on their regional economic environment. Porter (2000: 16) defines cluster as „a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities“.

Actors within industrial clusters normally feature complementary characteristics. In order to characterize the interdependence, Porter developed the so-called *diamond model*. In this model, he raises the thesis that an increased competitiveness results from the interaction of four factors. The keyword *factor conditions* comprehends quantity and costs of production factors as well as the material, administrative and scientific-technological infrastructure.

A specialized endowment with production factors, adapted to the respective branch (e.g. specialized labour force pool) forms the basis of competitive strength. He points out the importance of local *demand conditions* (proximity to customers and rivalling companies). By this regional interaction on horizontal level, companies are pushed to a higher product quality, permanent improvements and innovations. The context of *firm strategy, structure and rivalry* stimulates all further factors sustainably (Porter 1999). The local competitors do not only motivate each other to reduce costs, but simultaneously to improve the quality of their products.

The vertical level of industrial clusters is described by the interactions of *related and supporting branches*. Nearby located suppliers and end users benefit from short ways of communications, a fast and increasing information flow and from the continuous exchange of ideas and innovations (Porter 1999: 187). By spatial proximity, companies can furthermore get influence on technical activities of their suppliers and the creation of their pre-products. This integration of vertically connected econo-

mic branches results in positive external effects, emerging from the utilization of common technologies and a common basis of knowledge.

The cluster concept of Porter does not contain a precise definition of the term of *spatial proximity* (Martin und Sunley 2003: 11). Industrial clusters are often not bound to an administrative district. Depending on the examined regional level, clusters might even be a component of several regions. Accordingly, the positive effects of industrial clusters are not limited to one region but can spill over on neighbouring regions by interdependence of production. Summarizing these statements, three forms of transmission mechanisms can be deduced from the cluster concept (Delgado et al. 2007: 3). They are classified by positive external effects

- within an economic branch (horizontal clusters),
- between connected economic branches (vertical clusters),
- as well as their spatial effect (spillover effects of horizontal and vertical clusters).

The identification of regional cluster effects is however often complicated by the influence of convergence (Henderson 1995: 1069). While industrial clusters can contribute to the increase of the growth potential and thereby to the divergent development of the region itself, convergence shows as a result of decreasing marginal profits of the input factors capital and labour in the regions. The general growth potential decreases with increasing economic level (Delgado et al. 2007: 2).

From the empirical perspective, the identification of industrial cluster effects within the scope of convergence processes turns out to be demanding. If convergence occurs together with external effects, simple growth regressions show coefficients, which represent both effects. The aim of this article is to consider the effects isolated, in order to draw conclusions to the effects of different industrial clusters. It therefore considers two potentially competing forces of economic development. The following three hypothesis are to be analysed in the contribution:

- hypothesis 1: Regional convergence and agglomeration effects of industrial clusters coexist.
- hypothesis 2: Both horizontal and vertical industrial clusters positively effect the growth of the region.
- hypothesis 3: Both horizontal and vertical industrial clusters have spatial effects.

3. The Operationalization of Clusters

Different approaches of operationalization have been made for the cluster definition of Porter. The methodological diversity (e.g. specific case studies, cluster mapping, spatial concentration measures) as well as the differentiating establishment of priorities caused a rising criticism on the cluster concept, since they revealed a conceptional weakness, implementation problems and a limited comparability (Martin und Sunley 2003).

Due to these operationalizational difficulties, the article is based upon another cluster definition as the one proposed by Porter. Clusters are specified as „networks of production of strongly interdependent firms (including specialised suppliers) linked to each other in a value-added production chain“ (Roelandt and den Hertog 1999: 9) on the level of functional labour market regions. This form of definition integrates the cluster transmission mechanisms in an input-output-framework and allows thereby the use of the respective methods.

The qualitative input-output analysis allows, by inclusion of spatial concentration measures, the identification of horizontal clusters (concentration of one or several unconnected economic branches) and vertical clusters (concentration of several connected economic branches). The developed method will be described in brief in the following. Detailed demonstrations can be found at Kubis et al. (2008: 79pp) or at Titze et al. (2009). The analysis basically intends to evaluate quantitative streams between different economic branches of the input-output table.

The procedure identifies, if a stream between two economic branches is relevant or not for the structural integration of an economy (Schnabl 2000). It targets at a complexity reduction for the integration structure of input-output table and at the identification of industrial value-added chains. Applying regional input-output tables, regional value-added chains could be identified, but these tables are not provided by official statistics. The method regionalizes therefore the German input-output table with the help of three assumptions:

- The employment structure according to economic branches (German economic branch classification 2003) is displayable by the production branch within input-output table (CPA-classification).
- There exist no elementary differences between regional and all-German input-output table.
- The productivity within an economic branch is comparable amongst the regions, i.e. the received input of a production branch can be distributed according to regional employment shares of an economic branch over the regions.

The transmission of the relevant inter-industrial supply structures on regional level is effected by application of spatial concentration measures. Thereto, initially, input received by an economic branch according to regional employee shares within this branch is distributed to the individual regions. Regional input can then be included in the calculation of concentration measures. The determination of important production sites by application of concentration measures (GINI-coefficient as well as concentration rate) provides the starting point for the identification of clusters on regional level. Two or more regionally concentrated economic branches form a vertical cluster if important supply integrations exist between them.

From the input-output tables can be deduced that a very high share of input within production branches is intrasectoral trade. For regional concentrated economic branches, the number of companies in a branch indicates a horizontal cluster. In this form of application, quantitative input-output-analysis offers the opportunity to identify industrial clusters on given examination levels according to standardized criteria. Particularly, the methodology allows the linkage of an identified critical mass of companies with the necessity of the interaction by input-output relations, even on different regional examination levels. Methodology can therefore make a contribution to universally valid statements on the effects of industrial clusters.

4. Empirical Results

Applying the methodology illustrated in section 3 for labour market regions of Germany, the following picture of spatial distribution of industrial clusters results. 103 of 270 labour market regions feature concentrated but unconnected economic branches. The concentrated economic branches of 28 regions form the basis for concentrated value-added chains in these regions. In order to characterize

these concentrations of economic activity and classify them in corresponding cluster types, five types have been developed that are visualized in table 1 (Kubis et al. 2008: 87pp.). The differentiation of types conforms with the number of regionally concentrated economic branches as well as the number of connections between the economic branches, according to German input-output table.

Table 1: Scheme for concentration of economic activity

	concentrated economic branches		
connections	0	1-10	more than 10
0	class 1	class 2	class 3
1-9	-	class 4	class 5
more than 9	-	class 6	class 7

Source: own presentation.

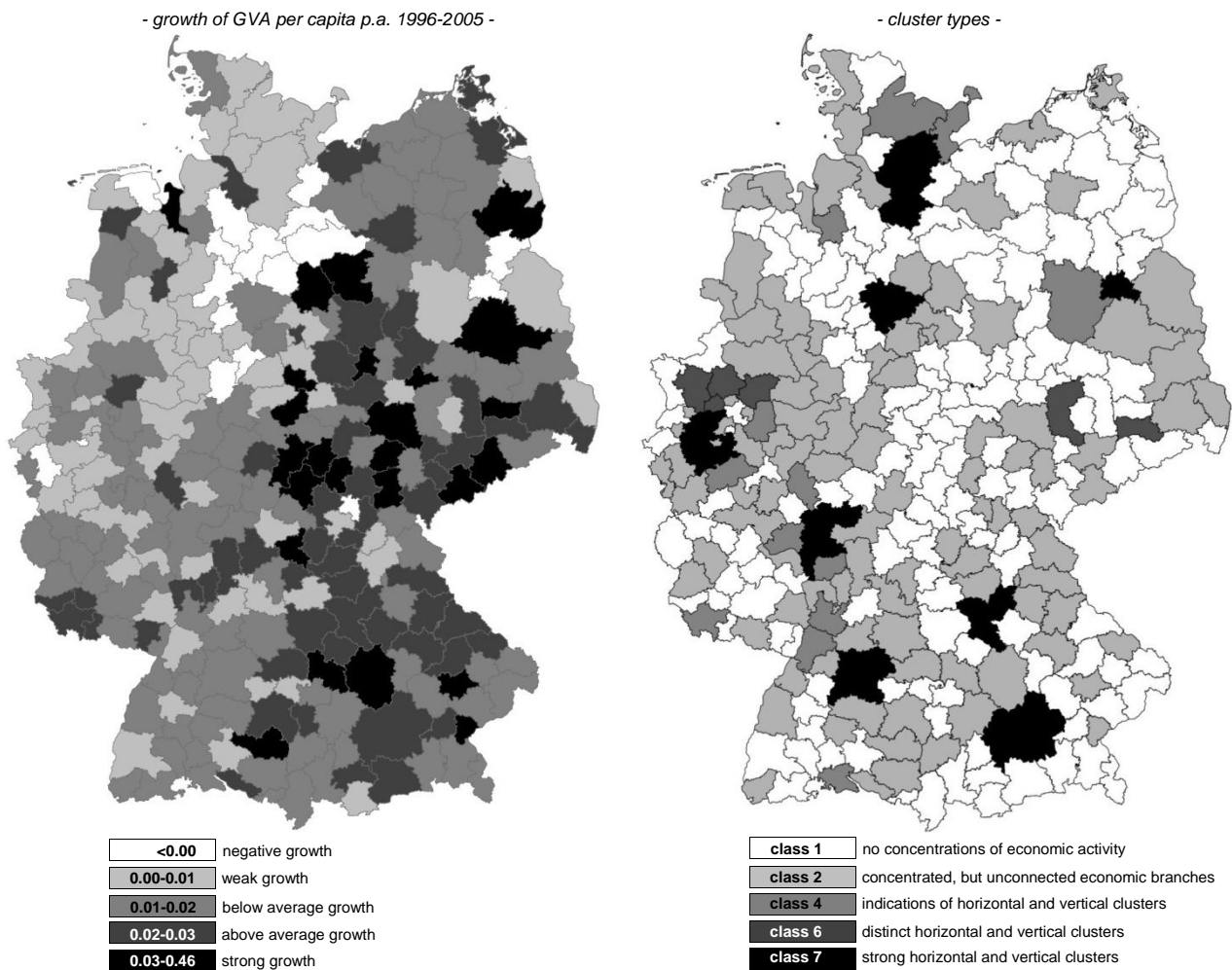
Regions of class 1 do not show concentrations of economic activity. Class 2 contains regions with one or more concentrated, but unconnected economic branches. Regions of this type are designated as indications of horizontal clusters. Class 3 stays unoccupied in our case. Regions with concentrated connected economic branches are divided in four classes (class 4-7). By existence of some vertical connections, class 4 shows indications of horizontal and vertical clusters. Class 5 stays unoccupied in our case. If strong integration (more than 9 connections) exists between the regional concentrated economic branches, distinct or even strong horizontal and vertical clusters can be identified. Distinct horizontal and vertical clusters (class 6) apply, if these connections exist between 1 and 10 concentrated economic branches. Regions with more than 10 regional concentrated connected economic branches are designated as strong horizontal and vertical clusters (class 7).

Regarding the regional classification of these cluster types, in about 51 percent of German labour market regions neither horizontal nor vertical clusters could be identified (class 1). In 103 regions, indications of horizontal clusters could be determined, which however do not show relevant connections according to German input-output table (class 2). In 13 regions, indications of horizontal and vertical clusters exist (class 4), in 6 regions, distinct horizontal and vertical clusters could be identified (class 6). Within the classification, 9 German labour market regions reach class 7.

The regional distribution of industrial cluster types overlaps with important German agglomeration areas. The distinct and strong horizontal and vertical clusters (class 6 and 7) can e.g. be found in the labour market regions Munich, Stuttgart, Hamburg, Düsseldorf and Cologne. It is apparent that cluster types are located in only 3 East German labour market regions (Dresden, Leipzig and Berlin, see fig. 1). Class 2 is distributed in all Germany, whereas it has to be considered that the according concentrated economic branches show differentiated macroeconomic importances (Kubis et al. 2008: 92).

Moreover, examining the regional effect of industrial clusters, the consideration of the target parameter GVA per capita is necessary. The majority of German labour market regions increased the real GVA per capita in the examined period from 1996 to 2005 (annual growth rate of about 1.3 percent). Though there can be observed strong differences between the regions. The growth of GVA per capita in German labour market regions is marked by strong increases in the East German federal states Saxony, Saxony-Anhalt, Thuringia as well as in Hamburg and the regions of Bavaria and Saarland (see fig. 1). Negative developments become apparent in the north-east of Lower Saxony.

Fig. 1: Regional distribution of growth of GVA per capita and of cluster types

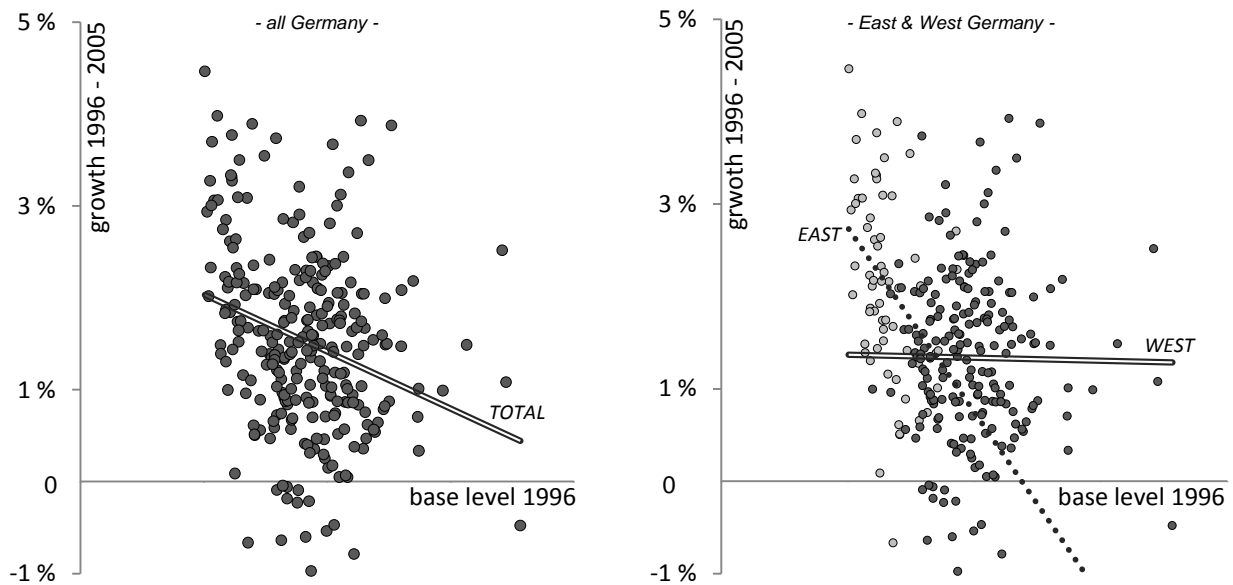


Source: own presentation.

In order to visualize the correlation between the growth of GVA per capita and the occurrence of industrial clusters, fig. 1 opposes the changes of target parameter to the different cluster types. It is remarkable that especially East German regions show high growth rates for GVA per capita despite structural deficits due to low spread of industrial clusters. A major part of observed growth seems to result only to a lesser extent from vertical and horizontal clusters. Industrial clusters are mainly positioned in West German agglomeration areas. They consequently are to develop their regional effects rather in these regions. In contrast to East Germany, the growth of single regions seems to involve the identified spatial allocation of industrial clusters.

Figuring the regional base level of GVA per capita and thereby regional processes of convergence, the connection between a low regional base level in 1996 and a high growth of GVA per capita becomes apparent, especially for East German regions. While the left side of fig. 2 still confirms a general convergence process in Germany, the separate analysis for East resp. West German labour market regions (right side of fig. 2) demonstrates on the other hand, that this convergence process is mainly driven by the East German growth.

Fig. 2: Real growth p.a. and base level of GVA per capita of German labour market regions; 1996 – 2005



Source: own presentation.

At first view, in West German labour market regions, an absolute convergence growth does not seem to be clearly detectable. The connection between base level and the observed growth of regions is not very distinctive. The examined medium term analysis period allows an evaluation of the longterm East German convergence process only to a limited extent. As long as growth rates of East German regions are above West German average, these regions converge along their convergence path towards West German labour productivity.

5. Regional Growth Model

A regional growth model provides the possibility to test, how the endowment with different structures of horizontal and vertical clusters influences regional growth of GVA per capita. Following the assumptions of section 2, a regional convergence model is set up. The empirical convergence approach is mainly based on the works of Baumol (1986) and DeLong (1988) as well as Mankiw et al. (1992) and Barro and Sala-i-Martin (1992).

In their work, they refer to the neoclassical approach of Solow (1956) and Swan (1956), which describes the theoretical principles of convergence of regional GVA per capita. While, in the *Solow Swan model*, differences in GVA per capita on international level have been subject of examination, later works extended the analysis to regional level (Arbia 2006: 8). Within the scope of the neoclassical approach, regional convergence towards a mutual balanced condition is reached, if regions dispose of equal structural conditions (e.g. factor endowment and technology).²

² This case is designated as absolute convergence. The corresponding regions converge to the same *steady state* (Hemmer und Lorenz 2004: 143). Barro and Sala-i-Martin (1995: 328) as well refer to the importance of absolute

This assumption proves to be questionable for different economies, but within one economy, the probability increases that the regional differences of these parameters are less important (Barro and Sala-i-Martin 1995: 382). For the analysis of growth of German labour market regions, this contribution refers to the works about absolute β -convergence $\beta = (1 - e^{-\lambda t})$.³

In this case, growth rate is solely explained by the base level of GVA per capita as well as a constant c (Barro and Sala-i-Martin 1992 or Mankiw et al. 1992).⁴ The contribution examines the growth of labour productivity of a region i , measured as its growth of GVA per capita, whereby $0 < \beta < 1$ and ε_{it} has the average value of zero. The left term of the first equation corresponds to the growth of GVA per capita y which depends on the base level y_{i0} and the convergence rate β . Thereby, a negative correlation between growth and logarithmized base GVA per capita is assumed.

$$(1) \quad \ln y_{it} - \ln y_{i0} = c - \beta \ln y_{i0} + \varepsilon_{it} .$$

The main attention of this work is turned to the examination of effects of regional endowment with horizontal and vertical clusters on regional growth. The integration of horizontal clusters in the model equation is effected by the number of concentrated economic branches within a region. It represents a measure for intrasectoral interdependence structure.⁵ Vertical clusters result from regionally concentrated value-added chains (regionally concentrated connected economic branches) according to German input-output table.⁶ A variable for the measurement of vertical clusters is the number of connections between the concentrated economic branches. This vertical interdependence structure of a labour market region is calculated on the basis of the input-output structure of the year 2003.⁷

The work uses both indicators for the verification of the influence of regional endowment with horizontal and vertical clusters on medium-term growth. The fact that the determination of vertical clusters basically depends on the identified concentrated economic branches of a region, shows that

convergence between regions: „Absolute convergence is more likely to apply across regions than across countries“. Conditional convergence models extend the model by region-specific model parameters and allow different longterm equilibria. Regionspecific steady states result, according to their parameters on different levels, but with similar growth rates of GVA per capita.

³ The estimation of a conditional convergence model on basis of the 270 German labour market regions is not feasible for the examined medium-term period, as some small-area regions have to cope with strong depreciation of capital stock resp. of employee or inhabitant numbers. In this case, the conditional neoclassical convergence model is not applicable, as no long-term steady state exists.

⁴ $c = (1 - e^{-\lambda t}) \frac{\alpha}{1-\alpha-\beta} \ln s_k + (1 - e^{-\lambda t}) \frac{\beta}{1-\alpha-\beta} \ln s_h - (1 - e^{-\lambda t}) \frac{\alpha+\beta}{1-\alpha-\beta} \ln(n + g + \delta)$

⁵ The estimation of the labour market region of Berlin does not correspond to its spatial effects to surrounding regions because of the delimitation on NUTS 1 level and requires therefore a *dummy Berlin*, which controls these functional relations. The dummy is 1, if the labour market regions are subareas of the functional area of Berlin, otherwise zero.

⁶ The number of companies in a region represents a similar indicator.

⁷ A possible problem of causality may limit the consistency of the statements. The calculation of the connections is not feasible for 1996 for the reason of lacking data. Calculations of cluster structure from 2003 to 2005 display however in medium-term a high steadiness of the results. Therefore, the applied cluster structure turns out to be an appropriate proxy for the structure of the year 1996.

both parameters are correlated. A two-stage estimation is applied, to face this problem of multicollinearity adequately.

In a first step, the variable *concentrated economic branches* are regressed on the *number of connections*. This step allows in a second estimation, to integrate the residuum of the first equation instead of the number of concentrated economic branches. The parameter *residuum concentrated economic branches* contains information about the variable *concentrated economic branches* that go beyond the number of connections.

Assuming that structural differences in the base level exist between East and West Germany, it seems to be useful to control this specific East German post transformation aspect in a second estimation. On the one hand the *Dummy East Germany* considers a *constant c*, deviating from West German average.⁸ On the other hand, the variable *convergence process East Germany* represents the post transformation growth of the regions which goes beyond the general regional convergence.⁹ An additional East German growth can be explained by the structurally lower East German base level.

Possible spillover effects can be integrated in the estimation approach with the help of exogenous explanatory variables x , weighed by a standardized matrix W . Matrix W models the average value of the explanatory parameters x of all neighbouring regions on the basis of the reciprocal distance. Therefore, the model explains the annual growth of a region with the help of the endowment of the region itself and with the help of the average endowment of the neighbouring regions. On the basis of 270 German labour market regions ($i = 1, \dots, 270$), a first estimation approach results.

$$(2) \quad \ln y_{it} - \ln y_{i0} = \beta_0 + \sum_{n=1}^N \beta_n \ln x_{i,n,t=0} + \sum_{n=1}^N \gamma_n \ln Wx_{i,n,t=0} + u_{it} .$$

Due to the exogeneity of spatial interaction parameter, the test on spatial connections is effected by the t-tests of the estimation.

6. Empirical Findings to the Growth Effects of Clusters

As a result of the theoretical preliminary considerations, four model variations are presented as an explanation of medium-term growth of GVA per capita in the time period between 1996 and 2005. While model 1 assumes an all-German convergence process, the second model allows different growth rates and different base conditions between East and West Germany. Model 3 and 4 differ from the other models by consideration of spatial effects. Cluster structures are not yet considered in these models. Table 2 confirms that the convergence process in Germany is primarily driven by the strong growth of East German regions. The functional area of Berlin grows below average.

⁸ The intercept-dummy is 1 for a region within East Germany, otherwise zero. Berlin is attributed to West Germany.

⁹ The slope-dummy results from the interaction between the GVA per capita in 1996 and *dummy East Germany*.

Table 2: Estimation of growth without cluster structure

endogeneous variable: growth of GVA per capita 1996-2005				
exogeneous variables:	model 1	model 2	model 3	model 4
Growth by own endowment				
constant c	-0.0390 ***	0.0120	-0.1210	0.7680 ***
GVA per capita 1996	-0.0135 ***	-0.0003	-0.0145 ***	-0.0034
dummy East Germany		-0.1058 ***		-0.0903 **
convergence process East Germany		-0.0263 ***		-0.0233 **
dummy Berlin	-0.0078 **	-0.0089 **	-0.0029	-0.0001
Growth by endowment of surrounding regions				
W*GVA per capita 1996			-0.0199 *	0.1948 ***
W*dummy East Germany				-1.0708
W* convergence process East Germany				-0.2667
W*dummy Berlin			-0.1386	-0.2469 **
adjusted R-squared	0.1055	0.1620	0.1073	0.2410
F-statistic (p-value)	0.0000	0.0000	0.0000	0.0000
LM(Lag)-test	0.0000	0.0000		

signif. codes: ***=0.01; **=0.05; *=0.1.

Source: own calculation.

Table 3 describes important indicators of the applied variables. The annual real growth rate of GVA per capita between 1996 and 2005 varies between 4.6 percent p.a. in the region Sonneberg and a decrease of 1.0 percent p.a. in the region Wilhelmshaven. Beyond that, the analysis shows very different basic conditions in the examined labour market regions in the year 1996. The GVA per capita reaches values between 10,073 and 35,638 Euro per inhabitant. The best basic condition in East Germany reaches the labour market region of Erfurt with a GVA per capita of 18,625 Euro in the year 1996.

The distribution of horizontal and vertical clusters has already been characterized more closely in section 4. 139 labour market regions do not possess signs of clusters. The average number of concentrated economic branches is 1.5 per region, whereas the region Munich shows the strongest concentration of industry in Germany with 23 concentrated economic branches. This concentration shows a strong integration, whereby Munich reaches the highest number of regional connected economic branches with 81 connections. In comparison to these results, the average number of regional connections is about 2.25.

Table 3:
Characterization of model parameters

determinant	indicator	Min.	mean	Max.
growth of prosperity 1996-2005	growth of GVA per capita 1996-2005	-1.025	1.411	4.567
level of prosperity 1996	GVA per capita 1996	10,073	18,160	35,638
East Germany	dummy East Germany	0	-	1
East German level of prosperity	convergence process East Germany	10,073	-	18,625
functional area Berlin	dummy Berlin	0	-	1
horizontal cluster	residual concentrated economic branches	0	1.481	23
vertical cluster	number of connections	0	2.248	81

Source: own calculation.

If clusters mainly occur in more wealthy agglomeration areas and promote their regional growth, the estimated convergence rate should be enhanced by negligence of these effects. This coexistence of growth and cluster structures, formulated in hypothesis 1, is confirmed in table 4 which describes the results of model variation 1 to 4 for the explanation of growth of GVA per capita considering cluster structures (models 5 to 8).

Table 4: Estimation of growth and cluster structure

endogeneous variable: growth of GVA per capita 1996-2005

exogeneous variables:

	model 1	model 2	model 3	model 4
Growth by own endowment				
constant c	-0.0486 ***	0.0077	0.1640	0.4704 **
GVA per capita 1996	-0.0157 ***	-0.0013	-0.0207 ***	-0.0075 *
dummy East Germany		-0.1090 ***		-0.0628
convergence process East Germany		-0.0270 ***		-0.0174 *
dummy Berlin	-0.0088 **	-0.0090 **	-0.0028	-0.0005
residual concentrated econ. branches	0.0006	0.0005	0.0017 ***	0.0016 ***
number of connections	0.0001	0.0001	0.0001 **	-0.0001
Growth by endowment of surrounding regions				
W*GVA per capita 1996			0.0482 *	0.1122 *
W*dummy East Germany				0.9658
W* convergence process East Germany				0.2215
W*dummy Berlin			-0.1350	-0.1679 *
W*residual concentrated econ. branches			-0.0360 ***	-0.0271 ***
W*number of connections			-0.0043 *	-0.0062 ***
adjusted R-squared	0.1083	0.1620	0.2777	0.3478
F-statistic (p-value)	0.0000	0.0000	0.0000	0.0000
LM(Lag)-test	0.0000	0.0000		

signif. codes: ***=0.01; **=0.05; *=0.1.

Source: own calculation.

As can be seen at the variable *residuum of concentrated economic branches* after the control of spatial effects, the existence of horizontal clusters leads to positive growth effects in a region. Furthermore, in models with assumed all-German convergence it shows that vertical clusters, measured by the variable *number of connections*, exert a positive influence on regional growth as well.

An important role plays the question, what drives East German growth process. In East Germany, horizontal and vertical clusters are represented only to a lower extent due to the unfavourable base conditions in the beginning of the 90s. The transformation induced East German growth differs therefore distinctively from the growth of West German regions. While models 5 and 7 prove an all-German convergence process by the variable *GVA per capita 1996*, models 6 and 8 clearly show that this process is mainly driven by East German growth. For West German regions, an independent convergence behaviour is observed, which is only weakly significant. By controlling regional cluster structure, East German regions seem to converge to a lower convergence target, based on their unfavourable starting conditions in the year 1996.

By non-consideration of important spatial relations, distortions may occur. However, the highly significant F-test shows for all presented models, that the based model frame bears a good explanatory power. The inclusion of horizontal and vertical cluster structures as well as spatial interactions lead to a distinct improvement of model quality (\bar{R}^2). The estimation of interregional growth effects of horizontal and vertical clusters on neighbouring regions is effected by the implementation of the

parameter *number of connections* and *residuum of concentrated economic branches*, weighed by a matrix W .

After control of the spatial, positive effects of horizontal (and vertical) clusters on the growth of a region are confirmed (hypothesis 2). Contrary to the assumption of hypothesis 3, the existence of horizontal and vertical clusters negatively affects the regional development of neighbouring labour market regions. Additional calculations reveal that, if the spatial effect of clusters exceeds the functional area, the positive spatial influence changes to a negative effect. Regions with horizontal and vertical clusters therefore handicap the development of the surrounding regions. The spatial growth effects of other explanatory parameters, as the starting conditions of neighbouring regions are not significant.

As a result of the analysis it can be noted that, with increasing wealth level, the observed growth process turns out to be lower. The regional endowment with horizontal and vertical clusters fortifies growth. Due to the concentration process of economic activities, neighbouring functional areas have to consider growth deductions. Furthermore, an ordinary growth process of East German regions exists, which also leads to a convergence process to the West level in the examined time period.

7. Summary and Outlook

Considering the assumptions set up in section 2, the coexistence of regional convergence and positive external effects of industrial clusters as well as the positive effects of horizontal and vertical clusters on growth in the according region, can be confirmed. Positive effects of clusters on the surrounding labour market regions could not be detected. In contrast, effects on these regions prove to be significantly negative and therefore represent a disadvantage for neighbouring regions. The results confirm the high degree of heterogeneity for the examined labour market regions due to regional particularities. The strong negative growth of population, especially in East Germany, means a specific challenge for the applied theoretical framework.

The spatial allocation of the identified horizontal and vertical cluster structures shows an affinity to agglomerations. The associated positive effects on regional development therefore mainly occur in these areas. West Germany shows structural advantages in comparison to East German regions. On the other hand, the economic growth in East German regions is partly driven by capital inflows, but often the necessary critical mass of companies is lacking. The relative deficit of large enterprises and headquarters detains an integration of the regions in nationally important sites. Moreover, the integration of existing structures in horizontal and vertical cluster structures is still at the beginning of its development. For improved data availability, the key sectors of the examined industrial clusters should be considered and set in a dynamic context. Growth and consolidation processes of branches can thereby be controlled in the approach.

Literature

- Arbia G (2006) *Spatial Econometrics: Statistical Foundations and Applications to Regional Growth Convergence*. Springer, New York
- Barro RJ, Sala-i-Martin X (1992) Convergence. *Journal of Political Economy* 100(2): 223-251

- Barro RJ, Sala-i-Martin X (1995) *Economic Growth*. McGraw Hill, New York
- Baumol WJ (1986) Productivity Growth, Convergence, and Welfare: What the Long Run Data Show. *American Economic Review* 76(5): 1072-1085
- Delgado M, Porter ME, Stern S (2007) *Convergence, Clusters and Economic Performance*. Working Paper draft Juli 20
- DeLong JB (1988) Productivity Growth, Convergence and Welfare: Comment. *American Economic Review* 78(5): 1138-1154
- Hemmer H-R, Lorenz A (2004) *Grundlagen der Wachstumsempirie*. Vahlen, München (in german)
- Kiese M [ed.], Schätzl L [ed.] (2008) *Cluster und Regionalentwicklung. Theorie, Beratung und praktische Umsetzung*. Rohn-Klewe, Dortmund (in german)
- Krugman P (1991) Increasing Returns and Economic Geography. *Journal of Political Economy* 99(3): 483-499
- Kubis A, Brachert M, Titze M, Lehmann H, Bergner U (2008) *Regionale Entwicklungsmuster und ihre Konsequenzen für die Raumordnungspolitik. Gutachten im Auftrag des Bundesamtes für Bauwesen und Raumordnung*, Bonn (in german)
- Mankiw NG, Romer D, Weil D (1992) A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics* 107(2): 407-438
- Marshall A (1920) *Principles of Economics*. Macmillan, London
- Martin R, Sunley P (2003) Deconstructing Clusters: Chaotic Concept or Policy Panacea? *Journal of Economic Geography* 3(1): 5-35
- Myrdal G (1957) *Economic Theory and underdeveloped regions*, London
- Porter ME (1990) *The Competitive Advantage of Nations*. Free Press, New York
- Porter ME (1998) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. Free Press, New York
- Porter ME (1999) Cluster und Wettbewerb: Neue Aufgaben für Unternehmen, Politik und Institutionen. In: Ders. [ed.] *Wettbewerb und Strategie*. München: 207-302 (in german)
- Porter ME (2000) Location, Competition and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly* 14(1): 15-34
- Rolandt TJA, den Hertog P (1999) Cluster Analysis and Cluster-Based Policy Making in OECD Countries: An Introduction to the Theme. In: *OECD Proceedings, Boosting Innovation: The Cluster Approach*. Organisation for Economic Co-operation and Development, Paris
- Romer PM (1986) Increasing Returns and Long-Run Growth. *Journal of Political Economy* 94(5): 1002-1037
- Romer PM (1990) Endogenous Technological Change. *Journal of Political Economy* 98(5): 71-102
- Schnabl H (2000) *Struktur-Evolution. Innovation, Technologieverflechtung und sektoraler Strukturwandel*. Oldenbourg (in german)
- Solow RM (1956) A Contribution to the Theory of Economic Growth, *The Quarterly Journal of Economics* 70(1): 65-94
- Storper M, Walker R (1989) *The Capitalist Imperative. Territory, technology and industrial growth*. New York
- Swan TW (1956) Economic growth and capital accumulation. *The Economic Record* 32(2): 334-361
- Titze M, Brachert M, Kubis A (2009) Die Qualitative Input-Output-Analyse als Instrument der Clusterforschung. in: *Beiträge zum Halleschen Input-Output-Workshop 2008, IWH-Sonderheft* (in german)