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Inter-industrial relations and sectoral employment development in German regions*

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Key words: input-output; shift-share; regional cluster; employment development

Abstract

This paper aims to find evidence for the positive impact of cluster structures on employment development in Germany. It develops a new way of measuring the co-location of suppliers and buyers of intermediate goods in a region as well as the importance for the employment development in individual industries. The findings indicate that co-location of inter-connected industries did have a positive effect on employment growth in 16 out of 56 industries between 1998 and 2007 supporting the assumption that agglomeration advantages tend to occur within regional clusters rather than within single industries. However, for the majority of industries such advantages cannot be identified.

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1. Introduction

Large disparities in employment growth rates across regions within the same country have stimulated a variety of studies trying to find the factors behind economic and employment growth at the regional level. In addition to location specifics, such as infrastructure, the general qualification structure of the workforce, or the disadvantages of boundary regions, the industrial structure was found to be highly relevant. Thereby, the theoretical and empirical literature attaches great importance to the economic environment in which an industry or a firm is located. Alfred Marshall (1890) was the first to introduce the idea that not only internal economies of scale but also external agglomeration advantages contribute to economic growth and encourage the spatial concentration of an industry. In addition to the availability of natural resources or public infrastructure he identified three reasons for the concentration of congenerous economic activities, namely localization advantages. These are the local availability of specialized intermediate goods and services, the advantage of a specialized labour supply, and the advantage from knowledge spillovers. Thus, localization advantages are mainly ascribed to cost minimization due to proximity to markets and inputs. Building on this idea, Porter developed the concept of clusters defined as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in a particular field that compete but also cooperate" (Porter 2000: 15). Thus, economies of agglomeration arise because of the co-location of interconnected industries and institutions rather than the concentration of a single industry. A regional cluster, in which firms are connected by supplier-buyer and buyer-supplier relationships, is likely to develop and become more effective when cooperation becomes more organized and based on norms and trust. Furthermore, local competition is important for productivity increases in individual firms, the innovative capacity of the cluster, and new business formations within the cluster (Porter 2000: 21). However, the concept of clusters is very vague in terms of its spatial dimension and the associated socio-economic interactions. Furthermore, measuring cooperation between proximate firms is very difficult when it goes beyond the trade of intermediate goods. Therefore, it is not surprising that a lot of different cluster identification techniques have been developed over time and empirical studies about their impact on regional economic development is rather scarce.

Although empirical evidence on the source of agglomeration advantage is ambiguous, the cluster concept has become a standard tool for policy-makers to promote regional competitiveness and growth (Martin/Sunley 2003; Alecke/Untied 2005). This paper aims to counter to this lack of evidence by supporting the creation of adequate instruments for regional development. It evaluates the reasons for differences in the employment growth of industries within Germany – and the regions they are located in – and the role of inter-industrial connections in this development. Thus, agglomeration advantages which result from regional clusters for constituent industries are analysed.

Previous studies on industry-specific agglomeration advantages tended to focus on localization advantages according to Marshall (1890), i.e. advantages arising from regional specialization in individual industries (Moeller/Tassinopoulos 2000; Blien/Wolf 2002; Kowalewski 2011). Thereby, industries were, in general, classified according to the official sector classification system. Only a few studies, for example by Spencer et al. (2010) or Peri/Cuñat (2001), analysed the regional economic impact of clustered industries or, more precisely, the co-location of customers and suppliers of intermediate goods. The present model approach builds on the previous studies. It identifies strong inter-industrial dependences in the regions considered and estimates their importance for regional employment growth. The functional definition of a regional cluster has the advantage that an input-output framework can be applied. However, additional cluster characteristics that go beyond supply and demand relationships cannot be identified with this approach. An indicator for the strength of the input-output linkages of each industry in each region will be developed and integrated into an econometric model. The indicator is based on the methodology of Peri/Cuñat (2001). They downscale national input-output linkages to the regional level by applying the location quotient, i.e. they account for the size of the selling sector and the size of the region. In addition, the present approach accounts for the size of the purchasing sectors, and so it captures the availability of potential customers and suppliers of intermediate goods more precisely. Furthermore, the advantage of the approach is that it is directly comparable to previous studies on localization advantages because of the similar model approach. Thus, it can be used to verify the hypothesis of Porter that, due to global developments, such as the globalization of markets, easier mobility, and lower transportation costs, the nature of agglomeration advantages has shifted from the narrower industries to the cluster level (Porter 2000: 21).

The paper is structured as follows. The second section outlines some important pieces of the theoretical background and of the relevant empirical literature. Section three describes the data set. The specification of the indicator for inter-industrial relationships and the econometric model follows in section four, and in section five the results are presented. Section 6 concludes.

2. Insight into the theory of agglomeration advantages

Early theories presented by Marshall (1890) suggested that firms expand in a particular place not only because of internal economies of scale but also because of external economies, referred to as agglomeration economies. Hence, the allowance for regional disparities and growth differences became an inherent part of the economic geography (Simmie 2005).

The section gives a short overview of the different theories that explain regional economic disparities, and summarizes the general empirical findings. Firstly, the observation of regional specialization in individual industries is explained by localization advantages. According to this, the spatial concentration of firms in the same industry leads to the advantage of a specialized labour market, specialized intermediate products and knowledge spillovers (Marshall 1980). Secondly, there is the observation of deconcentration tendencies in individual industries (e.g. Buenstorf/Geissler 2010). They are explained by urbanization advantages which result from the overall level of economic activity. Thus, growth rates of different industries are positively correlated leading to diversified economic structures (Glaeser et al. 1992). Both localization and urbanization advantages are static externalities explaining regional economic structures.

Building on each theory, dynamic concepts evolved explaining endogenous growth through knowledge spillovers, the intensity of which is assumed decrease as the distance increases (Jaffe et al. 1993). These are MAR (Marshall-Arrow-Romer) and Jacobs externalities. The theory of MAR externalities assumes that growth promoting knowledge spillovers occur mainly intra-sectoral and thus lead to the spatial concentration of industries and foster regional specialization (Marshall 1890, Arrow 1962, Romer 1986). Jacobs externalities also explain spatial industrial concentration. But in contrast to MAR externalities, growth is generated through knowledge spillovers between firms of different industries, i.e. within diversified economic structures explaining regional growth differences (Jacobs 1969).

A comparatively large portion of the empirical literature focuses on the impact of regional specialization in individual industries on employment development, looking for the existence of localization advantages or MAR externalities. Thereby, the location quotient has become a common measurement for the industrial specialization of regions. In summary, the findings for Germany show that inverse localization advantages were at play in the majority of industries leading to deconcentration processes and an adjustment of regional industry structures (Möller/Tassinopoulos 2000; Blien/Wolf 2002; Blien/Suedekum 2005;

Kowalewski 2011). Furthermore, it was found that, in general, diverse economic environments have been the growth engine for industries in the US (Glaeser et al. 1992), Germany (Blien et al. 2006) as well as Great Britain (Bishop/Gripaios 2010). However, empirical findings are somewhat ambiguous. While Henderson et al. (1995) found MAR externalities to be important for mature industries in the UK, Fotopoulos et al. (2010) showed that regional specialisation had a positive effect on employment growth in growing manufacturing industries in Greece. Thus, there seems to be evidence that different externalities accelerate growth depending on both the area and the period under investigation (Robson 2009).

Building on the research of Marshall (1890), Porter (1998) developed the theory of clusters. The problem here is that there is neither a definition nor an identification technique for clusters which can be regarded as universally valid. Porter (1998) defined clusters as "a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter 1998: 199). Thus, he provided a very vague concept without a clear definition of the spatial scale or the internal socio-economic dynamics characterizing a cluster. Inevitably, this has led to a lot of different interpretations and empirical applications in the following literature (Martin/Sunley 2003: 10). According to Porter (2000) and Sternberg/Litzenberger (2004) a cluster can be seen as a hierarchy of concepts. The first hierarchical degree is a spatial industrial cluster. It is characterized by a close proximity of the firms belonging to the cluster, whereas the member firms are related through buyer-supplier and supplier-buyer relationships, common technologies, common distribution channels or common labour pools. The spatial industrial or regional cluster can be upgraded to a regional innovation network or even a regional innovation system, in which the cooperation between firms or between firms and organisations becomes more organized and based on trust, norms and conventions. This increases the innovation activity of firms located in the cluster and helps to develop and diffuse knowledge leading to higher competitiveness (Sternberg/Litzenberger 2004: 768-769). The analysis of clusters in empirical studies, in general, ends in the identification of regional clusters. This is mainly due to data restrictions on sub-national levels and the difficult assessment of actual cooperation and the underlying mechanisms. To get a more feasible definition Brachert et al. (2011) and Titze et al. (2011), for example, concentrate on production networks, i.e. a cluster is defined by strongly interdependent firms linked to each other in a value-adding production chain. This has the advantage that the concept can be integrated into an input-output framework, in which input-output linkages, i.e. the flow of intermediate goods and services, are indicators for inter-firm interactions (Tietze et al. 2011: 91).

The attempt to verify the encouraging effect of input-output linkages on economic performance, and especially job creation has been undertaken for example by Peri/Cuñat (2001) and Spencer et al. (2010). Peri/Cuñat (2001) analysed the determinants for job creation in the Italian local labour market regions, more precisely on the level of Local Labour Systems (LLS), between 1981 and 1996. Without referring to the terminus cluster they analysed the impact of agglomeration economies on the local level, such as backward and forward linkages, externalities and technological spillovers, controlling for further regional specifics. They found backward and forward linkages to be the most important local mechanisms for the generation of agglomeration economies and employment growth. Peri/Cuñat (2001) see the rationale for this observation in the competitive advantage which can be seen as the main determinant for long-run growth in income and employment in a geographic unit (Peri/Cuñat 2001: 70).

Another approach is offered by Spencer et al. (2010). Their cluster identification concept is based on the application of the location quotient – a measure for regional specialization in a specific industry – and takes regional and national variations in economic structures, inter-sectoral relations and historical contexts into account. After identification of clusters in Canadian city regions (labour market regions), they evaluate whether there has been an observable effect of clusters on the economic performance (Spencer et al. 2010: 698-699). Their results show that clustering tended to have a positive impact on the economic performance of an industry. Overall, they found a positive impact from clusters on income and employment and a negative impact on unemployment rates and patents. However, higher employment growth was not found for all of the 18 industries. In five manufacturing industries (steel, rubber and plastics, textiles and apparel, biomedical, and ICT manufacturing) employment growth rates were lower in clusters. Their interpretation of this finding is that growth in these industries has been expressed more in output than in employment as a result of productivity gains (Spencer et al. 2010: 708).

3. Description of the data sets

The employment data used in the current study has been provided by the German Federal Employment Agency. It covers data for each year of the time period 1998 to 2007 (30th June) and distinguishes between 60 industries based on the sector classification WZ 2003 (German Federal Statistical Office 2003). The data contain all employees subject to social insurance contribution by workplace excluding fractionally employed, civil servants and self-employed. As a result, the analysis covers around 65 percent of the working population. The employment data are at the district level and are aggregated to 97 German planning regions (‘Raumordnungsregionen’) defined by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR 2008). Their spatial boundaries are based on commuting flows between municipalities (‘Kreise’). Thus, they can be interpreted as labour market regions. This seems preferable to the use of administrative area units because labour market regions represent relatively independent and self-containing labour markets and thus specific economic interactions, such as labour pooling and diffusion of knowledge, are likely to be particularly intense within their boundaries (Peri/Cuñat 2001: 46). Thus, especially for the analysis of clusters or inter-industrial relations, the use of labour market regions is a logical approach (Spencer 2010: 701-702).

In order to identify actual inter-industrial relations at the regional level, input-output data for each labour market region would be necessary. However, such data only exists for Germany as a whole. Thus, the national table, provided by the German Federal Statistical Office (2010), will be downscaled to the regional level (see section 4). Therefore the above described employment data are used to estimate the size of each selling and supplying sector as well as the regional size and, thus, the intra-regional trade of intermediate goods. The input-output table of Germany in the middle of the observation period, i.e. 2003, is taken for the estimations. Four industries are excluded from the analysis because no values are observed in the national input-output table. These are Mining of Uranium and Thorium ores, Mining Metal Ores, Private Household with Employed Persons, and Extra-Territorial Organizations and Bodies.

4. How to measure the impact of input-output linkages on employment growth

4.1 Estimation strategy

The aim of the current study is to analyse how industry specific employment growth is affected by the co-location of up- and downstream industries. The approach consists of two steps. Firstly, input-output indicators based on regionalized input-output tables are estimated. They reflect the estimated average of backward and forward linkages of each industry in each region. Secondly, the indicators are included as explanatory variables in a shift-share regression approach with employment growth being the dependent variable. Thus, evidence for agglomeration advantages resulting from the co-location of interconnected industries as defined by Porter (2000) can be identified.

Similar approaches have already been applied in several empirical studies, such as in Moeller/Tassinopoulos (2000), Blien/Wolf (2002), Blien et al. (2003), Suedekum et al. (2006), and Kowalewski (2011). In contrast to the current study, they analysed the existence of localization advantages resulting from specialization in individual industries according to Marshall (1890) by using the location quotient as a measure for regional specialization. The advantage of using a common approach is that the results will be directly comparable with the earlier findings.

A non-survey regionalization technique developed by Flegg/Webber (1997) is applied to downscale the national input-output table to the level of functional regions. Evidence about the advantage of the so-called FLQ (Flegg's Location Quotient) formula compared to other non-survey regionalization methods is provided by several empirical studies such as Flegg/Tohmo (2011) for 20 Finnish regions, Bonfiglio (2009) by using Monte-Carlo simulation, Tohmo (2004) for the Keski-Pohjanmaa region in Finland, or Kowalewski (2012) for the German Federal State of Baden-Wuerttemberg.

The FLQ formula simulates intra-regional trade by simultaneously taking into account the size of the regional selling and purchasing industries as well as regional size. Thereby, the smaller the region is the larger is the share of imports from other regions, which is required to meet the local demand for intermediate goods and services. Thus, the FLQ formula overcomes specific disadvantages of other non-survey techniques, such as the simple location quotient, which have a tendency to underestimate imports systematically (Flegg/Webber 2000: 568).

Compared to hybrid approaches (e.g. by Kronenberg 2010) the FLQ formula has the disadvantage that it cannot account for regional specifics such as different structures of consumption or technological gaps between regions. The latter implies that the simulation is based on the assumption of regional productivity being equal to the national average. However, hybrid approaches require a lot more data than non-survey methods, such as value added data, which is not normally available on a low sectoral aggregation level.

The arbitrary parameter δ ($0 \leq \delta \leq 1$) in the FLQ formula allows for adjusting regional import patterns and thus helps to increase the accuracy of the regional input-output table. However, there is uncertainty about the 'optimal' value of δ. The findings of Kowalewski (2012) suggest that a value of $\delta = 0.15$ yields most accurate results for German regions. In contrast, Flegg and Tohmo (2011) found a value of $\delta = 0.25$ to be optimal for the simulation of Finnish regional input-output tables. A Monte-Carlo simulation by Bonfiglio (2009) suggests that a value of $\delta = 0.3$ produces satisfactory estimates.

The regional input-output indicators developed in this paper are based on a value of $\delta = 0.15$ according to Kowalewski (2012). In order to account for the uncertainty of an optimal value of δ, a subsequent sensitivity analysis is applied which covers the range of δ found optimal in the empirical literature.

4.2 Inter-industrial relations

For each labour market region an input-output table for the year 2003 – the middle of the observation period – is estimated. The general idea of the FLQ formula is that the regional input coefficient a_{ij}^{R}, which is the value of goods and services purchased by sector *j* from sector *i* divided by the total output of sector *j*, differs from the national input coefficient a_{ij}^{N} by the amount of regional imports, i.e. the imports from other regions within the country. The FLQ formula estimates the regional input coefficients by taking into account the relative size of the purchasing and selling sectors in the region and the region's relative size. The formula is defined as

$$FLQ_{ijr} = \frac{E_{ir} / E_{jr}}{\sum_r E_{ir} \Big/ \sum_r E_{jr}} \cdot \lambda^{*} \qquad (1)$$

$$\text{with } \lambda^{*} = \left[\log_2 \left(1 + \frac{\sum_i E_{ir}}{\sum_r \sum_i E_{ir}} \right) \right]^{\delta} \qquad (2)$$

where E_{ir} (E_{jr}) is the number of employees in the selling (purchasing) sector *i* (*j*) ($i = j = 1,\ldots,56$) in region *r* ($r = 1,\ldots,97$). In the special case when $i = j$ in equation (1) the FLQ_{ij} is defined as

$$FLQ_{ijr} = \frac{E_{ir} \Big/ \sum_i E_{ir}}{\sum_r E_{ir} \Big/ \sum_r \sum_i E_{ir}} \cdot \lambda^{*} \qquad (3)$$

This means, the location quotient – a common measure for regional specialization – is implemented to adjust the coefficients along the principal diagonal.

The national coefficients are multiplied by the respective FLQ_{ijr} , if it is less than one:

$$a_{ij}^{R} = \begin{cases} a_{ij}^{N} & if \; FLQ_{ijr} \geq 1 \\ FLQ_{ijr} \cdot a_{ij}^{N} & if \; FLQ_{ijr} < 1 \end{cases} \tag{4}$$

The import coefficients are given as a residual.

The value of λ^* $(0 \leq \lambda^* < 1)$ increases proportionally with the size of the region so that a greater adjustment of imports is made in a smaller region. The formula is given some flexibility by the inclusion of the exponent δ $(0 \leq \delta \leq 1)$. The higher the value of δ, the lower the value of λ^* and the higher the allowance for imports of intermediate goods from outside the region compared to the intermediate goods and services purchased within the region (Flegg/Webber 1997).

The estimated regional input-output tables are used to create indicators for the potential intensity of linkages of each industry in each of the 97 labour market regions. The method is based on a measure introduced by Peri/Cuñat (2001), who applied the national input-output table to estimate the intensities of backward and forward linkages for each industry. Afterwards they downscaled the indicators proportionally to the employment share of the respective region in each industry. In contrast, the present indicators originate from the regional input-output tables. The advantage is that both the size of the selling and the size of the purchasing industries are taken into account.

The indicator for backward linkages is constructed as

$$Input_{jr} = \sum_{i} I_{ijr} \tag{5}$$

Where I_{ijr} is the share of industry *j*'s inputs coming form industry *i* in region *r* with $i = j = 1, \ldots, 56$.

In the same way, forward linkages are constructed:

$$Output_{ir} = \sum_{j} O_{ijr} \tag{6}$$

Where O_{ijr} is the share of industry *i*'s output going to industry *j* in region *r*.

Due to the relatively high level of sectoral aggregation intra-industry supplies and deliveries are captured in the backward and forward linkages.

The input-output indicator, which will be included in the regression analysis, is defined as the average of backward and forward linkages (for *i*=*j*):

$$IO_{ir} = \frac{1}{2}\left(Input_{jr} + Output_{ir}\right) \quad (7)$$

4.3 Shift-Share Regression

The importance of inter-industrial dependences for regional employment growth in Germany is estimated by applying a shift-share regression approach. This approach provides the opportunity to consider individual industries in regions as unit of analysis. The basic idea is to separate the regional employment growth rates into different components and identify their explanatory content.

The dependent variable is the annual employment growth rate in industry *i* and region *r* at time *t* ($t = 1999, \ldots, 2007$):

$$g_{irt} = \frac{E_{irt} - E_{ir,t-1}}{E_{ir,t-1}} \quad (8)$$

A constrained weighted least square model without an intercept is used in which the employment growth rate is split into several components. The model is defined by the following equation:

$$g_{irt}\ \omega_{irt-1} = \pi_t\ \omega_{irt-1} + \alpha_i\ \omega_{irt-1} + \beta_r\ \omega_{irt-1} + \mu_j\ \omega_{irt-1} + \gamma_i\ IO_{ir,03}\ \omega_{irt-1} + \tilde{\varepsilon}_{irt}\ \omega_{irt-1} \quad (9)$$

with

π_t: time period effects represented by dummy-variables for nine periods,

α_i: industry effects represented by dummy-variables for 56 industries,

β_r: region-specific effects represented by dummy-variables for 97 labour market regions,

μ_j: settlement structure effects represented by dummy-variables for seven settlement structure types,

γ_i: input-output effects for each industry *i*,

$IO_{ir,03}$: input-output indicator for industry *i* in region *r* in the year 2003,

w_{irt-1}: a weighting factor given as the share of industry *i* in region *r* in all employees in year t-1,

$\tilde{\varepsilon}_{irt}$: an error term with the underlying assumption that $\varepsilon_{irt} = \tilde{\varepsilon}_{irt}\,\omega_{irt-1}$ and $\mathrm{cov}(\varepsilon) = \sigma$.

A set of control variables is included in the empirical model in order to correctly measure the effect of input-output linkages. The dummy variables account for business cycle movements which affect the employment growth in a specific year equally over all units (time period effect), systematic differences in industry employment growth rates (industry effect), and regional specifics which affect employment development of all industries in a region over the entire period in the same way (region-specific effect) (Wolf 2002).

The weighting factor is included in the regression equation for two reasons. Firstly, industries, which are only weakly represented in a region, might experience exorbitant growth rates although the absolute change is small. This can result in heteroscedasticity. Secondly, the average of industry or regional growth rates is not equal to the respective superior unit without a weighting factor (Blien et al. 2003). Therefore, weakly represented industries in a region are weighted less than strongly represented ones and, thus, according to their economic importance (Kowalewski 2011).

The inclusion of several sets of dummy-variables implies a third problem in the regression model. This is the perfect multicollinearity. Instead of extracting a reference variable for each category, which is a common procedure in such a case, restrictions for the weighted coefficients are included. Thereby, the weights ($\omega_{ir,03}$) refer to the year 2003, i.e. the middle of the observation period. The advantage of these constraints is that the fixed effects can be interpreted as percentage deviations from their particular mean value. The only disadvantage is that the constrained regression does not allow the calculation of an R^2. In the following the restrictions for each set of dummy-variables are introduced. Firstly, the sum of the weighted coefficients of the industry fixed effects is set equal to zero:

$$\sum_{r=1}^{97}\sum_{i=1}^{56} \omega_{ir,03}\, \alpha_i = 0 \qquad (10)$$

Secondly, the sum of the weighted coefficients of the region-specific effects is set equal to zero:

$$\sum_{r=1}^{97}\sum_{i=1}^{56}\omega_{ir,03}\ \beta_r = 0 \qquad (11)$$

Thirdly, the sum of all region-specific effects of each region type corresponds to the overall effect for this type:

$$\sum_{r=1}^{97}\sum_{i=1}^{56}\varphi_j\ \omega_{ir.03}\ \beta_r = \mu_r \qquad (12)$$

where φ_j is a selection variable. It takes a value of one for each region type and zero otherwise with $j = 1,2,\ldots,S$ for the $S = 7$ different settlement structure types. [1]

5. Estimation results

5.1 Model fit

The data set contains 48,888 observations (56 industries * 9 periods * 97 regions) with a mean value of 0.028 and a standard deviation of 2.383 (Table 1). The data contain a few outliers with very high growth rates. These growth rates stem from industries which are weakly represented in a region but experience exorbitant employment growth rates, although the absolute amount of change is small. The weighting system presented in section 4.3 accounts for the outliers by including the relative importance of each industry.

Table 1 Summarizing table

Variable	Number of observations	Mean	Standard Deviation	Minimum	Maximum
Employment Growth Rate	48,888	0.028	2.383	-1.0	459.8

The F-test indicates a significant relation between the development of overall employment and the exogenous variables. A common R^2 is not available for the applied regression approach. However, an ordinary least squares regression without constraints, which reproduces the chosen approach most precisely, reaches an R^2 of 33 percent.

5.2 Regression results

The results of the shift-share regression are presented in this section, focusing on the effect of input-output linkages on employment growth.[2] Table 2 shows the estimated coefficients and the corresponding t-values for the input-output indicator. Overall, 23 out of the 56 input-output effects are significant at least at a 10%-level.

[1] For a detailed description of the model see Kowalewski (2011).

[2] Table A1 presents the complete set of estimated coefficients.

The results show that for a majority of industries the intensity of inter-industrial dependences did not play a significant role for job creation. However, the possibility of strong inter-industrial dependences had a positive impact on regional employment growth in 16 industries between 1998 and 2007. The majority of these industries (13) belong to the service sector. The strongest positive effect is observed in Air Transport, with a coefficient of 2.3 significant at the 1%-level. This means, ceteris paribus, a one percentage point higher input-output indicator led to a 2.3 percentage points higher employment growth rate in this industry. In addition three non-service sectors show strong positive input-output effects, these are: Manufacture of Other Transport Equipment (0.501), Construction (0.398), and Agriculture and Hunting (0.337).

Table 2 Input-output effects in Germany, 1998-2007

Root MSE=0.00002

Endogenous variable: Growth rate of employment	coefficients	t-values
io_Air transport	2.414	6.49
io_Education	0.682	6.36
io_Publilc administration and defence; compulsary social security	0.552	13.92
io_Manufacture of other transport equipment	0.501	2.56
io_Construction	0.398	17.64
io_Post and telecommunication	0.373	3.31
io_Agriculture and hunting	0.337	3.5
io_Real estate activities	0.331	2.79
io_Computer and related activities	0.274	2.19
io_Activities of membership organisations	0.241	2.56
io_Health and social work	0.220	6.05
io_Recreational, cultural and sporting activities	0.205	1.64
io_Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel	0.184	2.71
io_Retail trade	0.141	6.19
io_Land transport; transport via pipelines	0.112	3.51
io_Supporting and auxiliary transportactivities	0.098	2.45
io_Insurance and pension funding	-0.086	-1.68
io_Manufacture of chemicals and chemical products	-0.164	-3.73
io_Manufacture of fabricated metal products	-0.226	-4.82
io_Manufacture of machinery and equipment	-0.286	-6.06
io_Manufacture of radio, television and communication equipment and apparatus	-0.469	-3.57
io_Manufacture of electrical motors and apparatus	-0.797	-12.48
io_Manufacture of coke, refined petroleum and nuclear fuel	-3.240	-4.54

In contrast, seven industries performed worse in regions where their employment share and the availability of backward and forward linkages was high. Six of them belong to the manufacturing sector. These are Manufacture of Coke, Refined Petroleum and Nuclear Fuel, Manufacture of Electrical Motors and Apparatus, Manufacture of Radio, Television and Communication Equipment, Manufacture of Machinery and Equipment, Manufacture of Fabricated Metal Products, and Manufacture of Chemicals and Chemical Products. Possibly, these industries profited from productivity increases through technological improvements and growth was expressed more in output than in employment, as Spencer et al. (2010) suggested for similar findings. But output data are often not available for the appropriate geographical and industrial aggregation level, which makes a verification of this hypothesis difficult to realize.

The general estimation results are unaffected by the exclusion of region-specific dummy-variables (Table A1). In contrast, excluding the industry dummy-variables results in significant changes in the input-output effects. It is found that 34 industries developed best in those regions where the availability of up- and downstream industries was high, whereas for nine industries a higher regional input-output indicator in the year 2003 lead to significantly lower employment growth rates in the observation period. However, the results are misleading as input-output effects are biased due to changes in the industrial structure being constant over the entire observation period. For example, employment in the construction sector declined more than 35% between 1998 and 2007. Without industry-specific dummy variables, the estimation results suggest a negative impact of regional cluster structures on employment growth rates (input-output effect: -0.122). Controlling for the rapid employment decline, it becomes obvious that the tendency of job losses was less severe in regions with strong inter-industrial linkages in the construction sector (input-output effect: 0.398) (Table A1).

5.2 Sensitivity analysis

The presented results on input-output linkages and their effect on industry-specific employment development depend on the previously estimated regional input-output tables. The general performance of the FLQ formula should not be in question here as its application in numerous studies has shown the accuracy of simulation results and the superiority to other regionalization techniques. Rather, a sensitivity analysis is applied to account for the uncertainty about the optimal value of δ. Thereby, $0.10 \leq \delta \leq 0.30$ covers the range of values found optimal in the empirical literature.

An increase in the value of the exponent involves a decrease in trade of intermediate goods and services within the regions and, at the same time, an increase in trade between the regions. Thus, input-output intensities within individual regions pale in comparison to the interconnectedness of regions.

The sensitivity analysis reveals that the variation in the value of δ causes only small changes in the results for input-output intensities. Only for some industries such as Financial Intermediation, Hotels and Restaurants, or Publishing, Printing an Reproduction of record media input-output effects become significant not until using higher or lower values of δ (Table 3).

Table 3 Sensitivity analysis of δ

Industry	input-output effects $\delta = 0.10$	$\delta = 0.15$	$\delta = 0.20$	$\delta = 0.25$	$\delta = 0.30$
io_Activities of membership organisations	-	0.241 (***)	0.364 (***)	0.391 (***)	0.433 (***)
io_Agriculture and hunting	0.287 (***)	0.337 (***)	0.356 (***)	0.307 (***)	0.271 (***)
io_Air transport	2.151 (***)	2.414 (***)	2.806 (***)	3.341 (***)	4.009 (***)
io_Computer and related activities	0.297 (***)	0.274 (**)	-	-	-
io_Construction	0.507 (***)	0.398 (***)	0.335 (***)	0.297 (***)	0.274 (***)
io_Education	0.586 (***)	0.682 (***)	0.900 (***)	0.938 (***)	0.968 (***)
io_Financial intermediation	-0.114 (***)	-	0.164 (***)	0.232 (***)	0.259 (***)
io_Health and social work	0.271 (***)	0.220 (***)	0.228 (***)	0.252 (***)	0.285 (***)
io_Hotels and restaurants	-	-	0.146 (**)	0.246 (***)	0.318 (***)
io_Insurance and pension funding	-0.088 (*)	-0.086 (*)	-	-	-
io_Land transport; transport via pipelines	0.098 (***)	0.112 (***)	0.131 (***)	0.148 (***)	0.165 (***)
io_Manufacture of chemicals and chemical products	-0.122 (***)	-0.164 (***)	-0.188 (***)	-0.203 (***)	-0.222 (***)
io_Manufacture of coke, refined petroleum and nuclear fuel	-2.808 (***)	-3.240 (***)	-3.664 (***)	-4.078 (***)	-4.351 (***)
io_Manufacture of electrical motors and apparatus	-0.606 (***)	-0.797 (***)	-0.558 (***)	-0.187 (***)	
io_Manufacture of fabricated metal products	-0.112 (***)	-0.226 (***)	-0.241 (***)	-0.234 (***)	-0.217 (***)
io_Manufacture of machinery and equipment	-0.239 (***)	-0.286 (***)	-0.260 (***)	-0.247 (***)	-0.228 (***)
io_Manufacture of other transport equipment	0.380 (**)	0.501 (***)	0.634 (***)	0.735 (***)	1.168 (***)
io_Manufacture of radio, television and communication equipment and apparatus	-0.521 (***)	-0.469 (***)	-0.369 (***)	-0.305 (*)	-
io_Mining of coal and lignite; extraction of peat	-	-	-	0.206 (**)	0.423 (***)
io_Post and telecommunication	0.413 (***)	0.373 (***)	0.357 (***)	0.358 (***)	0.367 (***)
io_Publilc administration and defence; compulsary social security	0.659 (***)	0.552 (***)	0.505 (***)	0.493 (***)	0.501 (***)
io_Publishing, printing and reproduction of record media	-	-	-	0.131 (*)	0.141 (*)
io_Real estate activities	0.269 (***)	0.331 (***)	0.421 (***)	0.538 (***)	0.668 (***)
io_Recreational, cultural and sporting activities	0.290 (*)	0.205 (*)	-	-	-
io_Retail trade	0.156 (***)	0.141 (***)	0.151 (***)	0.165 (***)	0.185 (***)
io_Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel	0.202 (***)	0.184 (***)	0.187 (***)	0.199 (***)	0.217 (***)
io_Sewage and refuse disposal, sanitation and similar activities	0.262 (*)	-	-	-	-
io_Supporting and auxiliary transportactivities	0.226 (***)	0.098 (***)	-0.075 (**)	-0.157 (***)	-0.183 (***)
io_Wholesale trade and commission trade (except motore vehicles)	-	-	-	-	0.061 (**)

Note: Significant at the (*) 10%-level, (**) 5%-level, (***) 1%-level.

5.3 Specific demonstration of the results

Now a comparison of the effects from regional specialization and inter-industrial dependences will be provided. The results of Kowalewski (2011) concerning the effect of regional industry-specific specialization on industry-specific employment development will be compared to the present results for the effect of regional cluster structures. Both methodologies aim to reveal whether industries benefit from the agglomeration of similar economic activities, i.e. whether they benefit from common labour market pools, specialized intermediate inputs, and knowledge spillovers. Thereby, regional specialization is measured by the location quotient and refers to the concept of Marshall (1980), whereas regional clusters refer to the concept of Porter (2000).

Table 4 summarizes the different effects of both measures on employment growth rates in the period 1998 to 2007. The earlier findings indicated that regional specialization in individual industries did not have positive effects on employment growth. Specialization rather tended to lower growth rates compared to non-specialized regions in the observation period. In contrast, the present findings show that in the same period strong regional interdependences fostered job creation in specific industries.

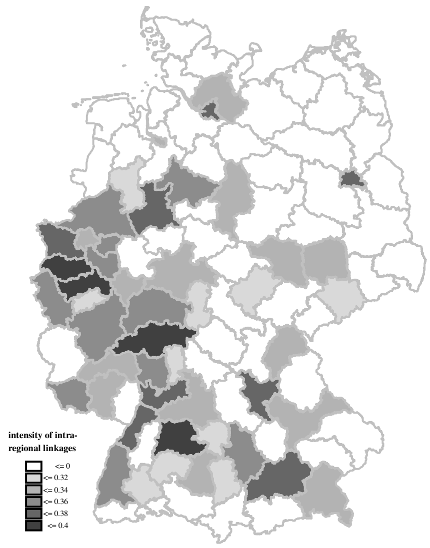
Table 4 Input-output effects versus localization effects

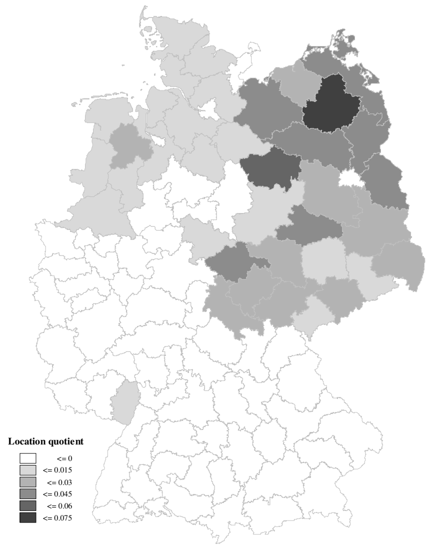
Endogenous variable: Growth rate of employment	Coefficients	
	Input-output	Location quotient
io_Air transport	2.414	-0.264
io_Education	0.682	-0.006
io_Publilc administration and defence; compulsary social security	0.552	-0.005
io_Manufacture of other transport equipment	0.501	-0.014
io_Construction	0.398	-0.004
io_Post and telecommunication	0.373	-0.030
io_Agriculture and hunting	0.337	-0.010
io_Real estate activities	0.331	-
io_Computer and related activities	0.274	-0.021
io_Activities of membership organisations	0.241	-0.005
io_Health and social work	0.220	-0.001
io_Recreational, cultural and sporting activities	0.205	-
io_Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel	0.184	-
io_Retail trade	0.141	-0.002
io_Land transport; transport via pipelines	0.112	-0.007
io_Supporting and auxiliary transportactivities	0.098	-0.006
io_Insurance and pension funding	-0.086	-
io_Manufacture of chemicals and chemical products	-0.164	-0.001
io_Manufacture of fabricated metal products	-0.226	-
io_Manufacture of machinery and equipment	-0.286	-
io_Manufacture of radio, television and communication equipment and apparatus	-0.469	-0.039
io_Manufacture of electrical motors and apparatus	-0.797	-0.002
io_Manufacture of coke	-3.240	-

Note: '–': not significant in Kowalewski (2011)
Sources: Kowalewski 2011; own calculations.

For three selected industries the following figures show the German labour market regions, which are specialized in the respective industry (Figure 1b, 2b, 3b), and the regions, in which the industry faces a great potential for backward and forward linkages (Figure 1a, 2a, 3a). The darker the regions are in the figures, the stronger are the estimated intra-regional interdependences and the specialization in the considered industry, respectively. In general, one can observe that regional specialization does not necessarily go along with an above average availability of local suppliers and consumers of intermediate goods and services. In the north-eastern regions, for example, Agriculture is an important part of the economy, i.e. the employment share of this industry is above the German average in these regions (Figure 1b). Compared to non-specialized regions, the employment development tended to be worse in these regions. However, a collocation with upstream and downstream industries, such as Manufacture of Food Products and Beverage as the most important subsequent customer of agricultural products, Manufacture of Chemical Products, or Trade, is observed more in south-western regions. In contrast to specialization, the existence of cluster structures had a positive effect on employment development in Agriculture.

Figure 1a Inter-industry linkages in Agriculture **Figure 1b Location quotient in Agriculture**





Similar developments are observed for Health and Social Work (Figure 2a, 2b), Air Transport (Figure 3a, 3b) and the other industries with positive input-output effects. It was found in Kowalewski (2011) that regional specialization in Health and Social Work tended to have a negative effect on employment growth between 1998 and 2007. In the same period, this industry performed better in regions where a lot of potential customers and suppliers were located.

Furthermore, the strongest deconcentration tendencies were observed for Air Transport, i.e. employment growth was significantly lower in specialized regions than in regions, in which Air Transport was under-represented (Kowalewski 2011). Figure 3b shows that specialization was only observed in a few labour market regions. The picture changes when inter-industry linkages in Air Transport are under consideration. A lot more regions have sector structures, which provide the opportunity for production networks in this industry (Figure 3a). Especially in Northern Germany, Western Germany and in parts of South-eastern Germany, potential up- and downstream industries are co-located. The results show that this was a localisation advantage for Air Transport.

Figure 2a Inter-industry linkages in Health and Social Work

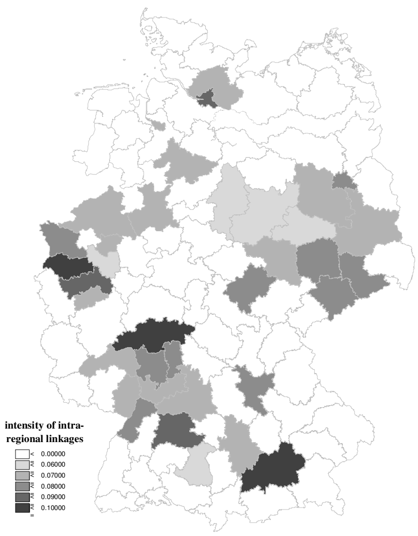


Figure 2b Location quotient in Health and Social Work

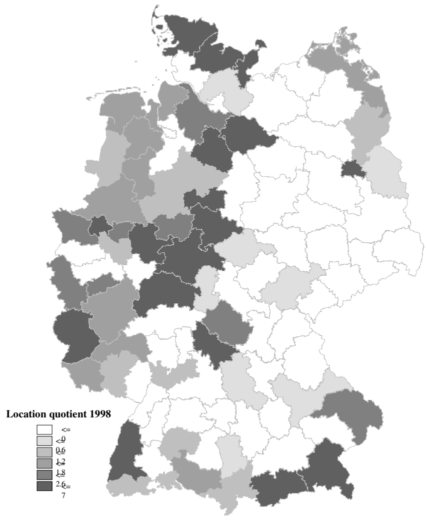


Figure 3a Inter-industry linkages in Air Transport

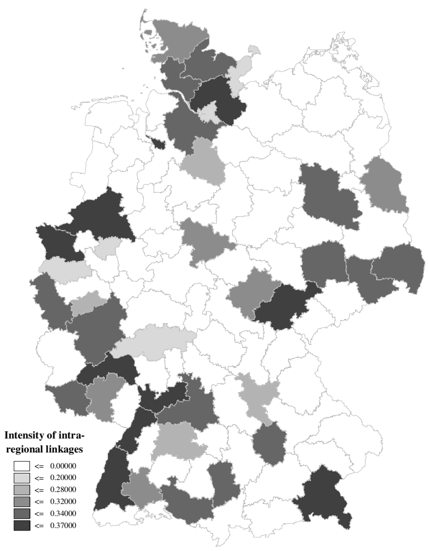
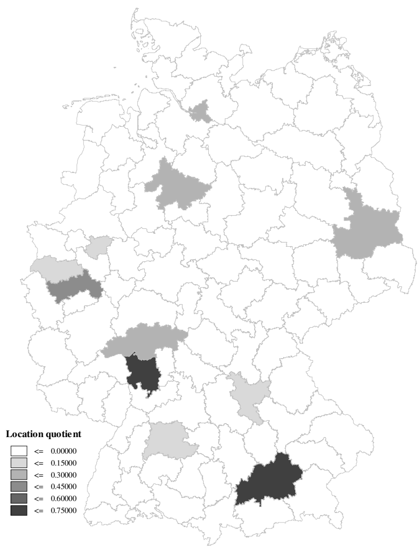


Figure 3b Location quotient in Air Transport



6. Summary and conclusions

This paper addressed the issue of regional inter-industrial relationships and their role in the creation of jobs in Germany. The question has a long tradition in regional science. First examined by Marshall (1890), who developed the theory of localization advantages, agglomeration economies have been analysed in various ways. Marshall (1980) found that the spatial concentration of similar economic activities could be explained by advantages resulting from the physical proximity to specialized intermediate products in an agglomeration. Hence, specialized regions exhibit higher economic growth than non-specialized regions and, thus, experience positive employment developments. Building on this theory, Porter (2000) developed the concept of clusters. The lowest stage of development is called a regional cluster, in which different industries are connected through supplier-buyer and buyer-supplier relationships and, thus, cooperate and also compete with each other. Porter argues that, due to the globalization of markets, easier mobility, lower transportation costs, and other global developments, the nature of agglomeration advantages has changed, shifting from the narrower industries to the cluster level.

The results of this paper show that the availability of suppliers and customers in the same region was a major engine for job creation in specific industries in the past. In the period 1998 to 2007 this was particularly observed for service sectors, such as Air Transport, Education or Health and Social Work. In these industries employment growth was higher in regions which provided a large potential for forward and backward linkages. The opposite was observed mainly in manufacturing industries. It is likely that the positive agglomeration effects were expressed in growth of output rather than employment growth in these industries. However, the results also show that for the majority of industries the intensity of inter-industrial interdependence did not play a significant role for their employment development.

Previous empirical analyses about agglomeration advantages in individual industries were often based on the concept of the location quotient. The location quotient measures the degree of regional specialization in a specific industry. In general, the definition is based on the official sector classification system and, thus, refers to agglomeration advantages according to Marshall. It was found that regional specialization in individual industries tended to have a negative effect on employment growth. However, findings appear to be both area and time-specific to some extent. Thus, the direct comparability of the present study to the results of Kowalewski (2011), due to the same spatial, industrial and time dimensions, is a major advantage of the current study. It becomes apparent from the comparison with earlier findings that agglomeration advantages are not realizable within a single industry – defined by the sector classification system. In fact, positive effects can result from the right composition of different industries that have the possibility to establish common production chains.

The results can give an orientation for regional cluster policies. They can complement in-depth studies of local geographic and industrial structures which are of vital importance for the implementation of effective strategies in order to identify the specific needs of individual clusters. The formation of clusters might vary between regions and it might as well change over time because of technological progress or varying life-cycles (Brown 2000). Still, quantitative findings provide general evidence for the impact on specific industries and, thus, help to identify interesting and promising cases of regional clusters.

The applied methodology in this paper is in general transferable to other regions. The precondition is that (national) input-output tables are available. Thereby, the analysis is not restricted to regions on the national level but it might also contain regions on the international level such as regions of the Euro-zone. Thus, it could be analysed whether regions can draw competitive advantage from cluster formation not only on the national but also on the international level. However, the results are bound to the concept of regional clusters. Cooperation beyond supply and demand of intermediate goods and services, such as innovation networks, and the impact on employment growth cannot be identified. This remains an interesting field for future research.

Appendix

TableA 1 Summary of regression results

	complete set of dummy variables		region-specific effects excluded		industry effects excluded	
Endogenous variable: Growth rate of employment	coefficients	t-values	coefficients	t-values	coefficients	t-values
Agriculture and hunting	-0.1062	-3.55	-0.1383	-4.6		
Forestry and logging	-0.0671	-0.17	-0.1207	-0.3		
Fishing and fish farming	-0.0541	-0.06	-0.0543	-0.06		
Mining of coal and lignite; extraction of peat	-0.1370	-6.89	-0.1468	-7.42		
Extraction of crude petroleum and natural gas	-0.0214	-0.05	0.0067	0.01		
Other mining and quarrying	0.0358	0.42	0.0625	0.73		
Manufacture of food products and beverage	-0.0174	-0.95	0.0274	1.49		
Manufacture of tobacco products	-0.0085	-0.12	-0.0198	-0.26		
Manufacture of textiles	-0.0188	-0.41	-0.0059	-0.13		
Manufacture of wearing apparel	-0.0374	-1.57	-0.0386	-1.6		
Tenning and dressing of leather	-0.0084	-0.10	-0.0081	-0.1		
Manufacture of wood (except furniture)	0.0312	0.30	0.0276	0.26		
Manufacture of pulp, paper and paper products	0.0411	0.56	0.0463	0.62		
Publishing, printing and reproduction of record media	-0.0402	-1.45	-0.0080	-0.28		
Manufacture of coke, refined petroleum and nuclear fuel	0.5550	4.52	0.5538	4.45		
Manufacture of chemicals and chemical products	0.0504	3.26	0.0485	3.18		
Manufacture of rubber and plastic products	0.0164	1.05	0.0281	1.78		
Manufacture of other non-metalic mineral products	-0.0352	-1.66	-0.0272	-1.28		
Manufacture of basic metals	-0.0047	-0.22	-0.0077	-0.35		
Manufacture of fabricated metal products	0.0698	5.28	0.0794	6.11		
Manufacture of machinery and equipment	0.0601	6.75	0.0829	9.62		
Manufacture of office machinery and computers	-0.0327	-0.79	-0.0317	-0.76		
Manufacture of electrical motors and apparatus	0.2168	11.79	0.2119	11.7		
Manufacture of radio, television and communication equipment	0.0881	4.26	0.0844	4.04		
Manufacture of medical, precision and optical instruments	0.0163	1.36	0.0272	2.32		
Manufacture of motor vehicles, trailers and semi-trailers	-0.0008	-0.06	-0.0073	-0.5		
Manufacture of other transport equipment	-0.0566	-1.91	-0.0562	-1.88		
Manufacture of furniture, manufacturing n.e.c.	-0.0403	-4.59	-0.0421	-4.84		
Recycling	-0.0897	-0.37	-0.1360	-0.55		
Electricity, gas, steam and hot water supply	0.0422	0.95	0.0366	0.81		
Collection, purification and distribution of water	-0.0733	-0.73	-0.0547	-0.54		
Construction	-0.1212	-26.60	-0.1496	-34.08		
Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel	-0.0079	-0.74	-0.0067	-0.62		
Wholesale trade and commission trade (except motore vehicles)	0.0087	1.20	0.0229	3.37		
Retail trade	-0.0093	-2.76	0.0000	0		
Hotels and restaurants	0.0299	4.08	0.0209	2.88		
Land transport; transport via pipelines	-0.0166	-1.86	-0.0564	-6.35		
Water transport	0.0435	0.54	0.0503	0.61		
Air transport	-0.1782	-3.65	-0.1862	-3.76		
Supporting and auxiliary transportactivities	-0.0174	-1.13	-0.0240	-1.55		
Post and telecommunication	-0.0865	-2.51	-0.0784	-2.24		
Financial intermediation	0.0004	0.03	0.0111	0.76		
Insurance and pension funding	0.0407	2.55	0.0420	2.63		
Activities auxiliary to financial intermediation	-0.0443	-0.62	-0.0462	-0.63		
Real estate activities	0.0071	0.51	-0.0332	-2.36		
Renting of machinery and equipment without operator and of personal and household goods	-0.0290	-0.17	-0.0526	-0.31		
Computer and related activities	0.0024	0.09	0.0218	0.81		
Research and development	0.0106	0.31	0.0084	0.24		
Other business activities	0.0668	12.29	0.0573	10.86		
Publilc administration and defence; compulsary social security	-0.0463	-11.87	-0.0684	-17.87		
Education	-0.0345	-3.67	-0.0195	-2.07		
Health and social work	0.0140	5.01	0.0183	6.57		
Sewage and refuse disposal, sanitation and similar activities	-0.0613	-1.43	-0.0926	-2.14		
Activities of membership organisations	-0.0235	-1.33	-0.0313	-1.77		
Recreational, cultural and sporting activities	-0.0168	-0.55	-0.0083	-0.27		
Other service activities	-0.0140	-0.30	0.0230	0.48		

TableA 1 continued

Endogenous variable: Growth rate of employment	complete set of dummy variables		region-specific effects excluded		industry effects excluded	
	coefficients	t-values	coefficients	t-values	coefficients	t-values
Aachen	0.0054	2.54			0.0095	4.47
Allgaeu	0.0084	1.73			0.0139	2.83
Altmark	-0.0228	-2.4			-0.0415	-4.33
Arnsberg	-0.0002	-0.04			0.0093	2.33
Augsburg	0.0104	3.78			0.0132	4.77
Bayerischer Untermain	0.0054	0.84			0.0082	1.26
Berlin	-0.0148	-20.07			-0.0154	-22.24
Bielefeld	0.0038	2.84			0.0067	4.93
Black Forest North	0.0079	2.08			0.0121	2.98
Bochum/Hagen	-0.0048	-3.25			-0.0016	-1.09
Bodensee-Oberschwaben	0.0145	4			0.0205	5.61
Bonn	-0.0018	-0.68			-0.0011	-0.42
Braunschweig	-0.0014	-0.83			0.0000	-0.01
Bremen	-0.0005	-0.16			0.0017	0.55
Bremerhaven	0.0095	1.49			0.0060	0.93
Central Hesse	0.0008	0.35			0.0050	2.18
Central Mecklenburg/ Rostock	-0.0122	-2.59			-0.0155	-3.26
Central Thuringia	-0.0145	-5.18			-0.0199	-7.06
Central Upper Rhine	0.0082	3.76			0.0094	4.36
Chemnitz-Erzgebirge	-0.0134	-5.8			-0.0197	-8.46
Cologne	0.0000	0			-0.0016	-1.51
Danube-Iller (BW)	0.0131	3.22			0.0176	4.28
Danube-Iller (BY)	0.0189	3.99			0.0196	4.09
Danube-Wald	0.0167	4.67			0.0188	5.2
Dessau	-0.0187	-4.28			-0.0258	-5.83
Dortmund	-0.0011	-0.53			0.0008	0.4
Duisburg/Essen	-0.0036	-3.36			-0.0036	-3.34
Dusseldorf	-0.0057	-5.99			-0.0087	-10.34
East Friesland	0.0039	0.98			0.0007	0.18
East Thuringia	-0.0181	-6.21			-0.0197	-6.68
Easthesse	0.0206	3.09			0.0224	3.35
Emscher-Lippe	-0.0002	-0.06			0.0003	0.11
Emsland	0.0285	4.99			0.0242	4.19
Environs of Bremen	0.0138	2.67			0.0122	2.33
Franconia	0.0131	5.26			0.0172	6.83
Goettingen	-0.0016	-0.41			0.0045	1.11
Halle/S.	-0.0296	-11.85			-0.0368	-14.75
Hamburg	-0.0037	-3.6			-0.0031	-3.01
Hanover	-0.0044	-2.95			-0.0029	-1.99
Havelland-Flaeming	-0.0037	-1.26			-0.0101	-3.39
Hildesheim	-0.0024	-0.45			0.0044	0.83
Hochrhein-Bodensee	0.0123	3.16			0.0156	3.95
Industrial region Central Franconia	-0.0006	-0.41			0.0040	2.73
Ingolstadt	0.0197	4.87			0.0196	4.84
Landshut	0.0151	3.42			0.0146	3.29
Luneburg	0.0086	1.08			0.0095	1.17
Lusatia-Spreewald	-0.0142	-4.33			-0.0235	-7.13
Magdeburg	-0.0250	-11.54			-0.0320	-14.81
Main-Rhön	-0.0053	-1.19			0.0048	1.1
Mecklenburgische Seenplatte	-0.0174	-2.61			-0.0271	-4.04
Mittelrhein-Westerwald	0.0066	3.27			0.0092	4.5
Muenster	0.0106	6.93			0.0135	8.85
Munich	-0.0011	-1.11			-0.0034	-3.86
Neckar-Alb	0.0095	2.77			0.0144	4.18
North Thuringia	-0.0076	-1.37			-0.0197	-3.5
Northhesse	0.0017	0.66			0.0056	2.21

TableA 1 continued

	complete set of dummy variables		region-specific effects excluded		industry effects excluded	
Endogenous variable: Growth rate of employment	coefficients	t-values	coefficients	t-values	coefficients	t-values
Oberes Elbtal/Osterzgebirge	-0.0121	-6.33			-0.0133	-6.91
Oberland	0.0115	1.96			0.0158	2.67
Oberpfalz North	0.0123	2.54			0.0149	3.06
Oderland-Spree	-0.0081	-1.62			-0.0189	-3.77
Oldenburg	0.0171	4.08			0.0153	3.61
Osnabrück	0.0133	4.07			0.0153	4.65
Ostwuerttemberg	0.0055	1.1			0.0098	1.95
Paderborn	0.0049	0.89			0.0089	1.61
Prignitz-Oberhavel	0.0002	0.03			-0.0117	-1.84
Regensburg	0.0186	5.85			0.0213	6.63
Rheinhessen-Nahe	0.0071	2.49			0.0093	3.23
Rhein-Main	-0.0091	-10.93			-0.0095	-11.85
Rheinpfalz	0.0030	1.18			0.0055	2.15
Saar	0.0044	2.14			0.0075	3.58
Schleswig-Holstein Central	0.0015	0.5			0.0015	0.49
Schleswig-Holstein East	0.0041	0.82			0.0084	1.67
Schleswig-Holstein North	0.0097	1.94			0.0089	1.76
Schleswig-Holstein South	0.0064	2.31			0.0092	3.29
Schleswig-Holstein South-West	0.0101	0.97			0.0061	0.57
Schwarzwald-Baar-Heuberg	0.0115	2.75			0.0195	4.72
Siegen	0.0085	1.86			0.0143	3.1
South environs of Hamburg	0.0218	4.46			0.0162	3.26
South Thuringia	-0.0066	-1.48			-0.0070	-1.54
South-East Upper Bavaria	0.0127	4.35			0.0149	5.03
Southern Upper Rhine	0.0090	4.22			0.0136	6.39
South-West Saxony	-0.0183	-5.29			-0.0225	-6.43
Starkenburg	0.0002	0.1			0.0006	0.25
Stuttgart	0.0016	1.68			0.0001	0.13
Suedheide	0.0143	1.86			0.0117	1.5
Trier	0.0153	3.15			0.0161	3.3
Uckermark-Barnim	-0.0037	-0.47			-0.0145	-1.83
Unterer Neckar	0.0008	0.41			0.0039	2.13
Upper Franconia East	0.0034	0.77			0.0050	1.12
Upper Franconia West	0.0046	1.2			0.0110	2.89
Upper Lusatia-Lower Silesia	-0.0234	-6.56			-0.0298	-8.28
West Saxony	-0.0212	-11.2			-0.0254	-13.34
West-Central Franconia	0.0157	2.62			0.0186	3.06
Western-Pomerania	-0.0153	-3.65			-0.0184	-4.36
Westmecklenburg	-0.0034	-0.81			-0.0144	-3.44
Westpfalz	0.0054	1.08			0.0087	1.69
Wuerzburg	0.0077	1.87			0.0129	3.08
Agglomerated areas with high population density	-0.0006	-5.04			-0.0004	-3.88
Agglomerated areas with huge centres	-0.0012	-11.88			-0.0014	-15.95
Urbanised areas of higher density	0.0007	4.93			0.0008	9.07
Urbanised areas of medium density with high level centres	0.0002	1.94			0.0001	1.66
Urbanised areas of lower density without high level centres	0.0003	3.29			0.0004	5.6
Rural areas of higher density	0.0006	6.53			0.0006	6.97
Rural areas of lower density	0.0000	-0.02			-0.0001	-2
Year 1998	0.0042	1.57	0.0139	6.29	-0.0078	-4.13
Year 1999	0.0031	1.15	0.0133	6.07	-0.0082	-4.37
Year 2000	-0.0101	-3.73	0.0001	0.06	-0.0215	-11.47
Year 2001	-0.0209	-7.74	-0.0105	-4.79	-0.0322	-17.14
Year 2002	-0.0356	-13.17	-0.0251	-11.41	-0.0468	-24.93
Year 2003	-0.0295	-10.91	-0.0189	-8.61	-0.0406	-21.64
Year 2004	-0.0260	-9.62	-0.0153	-6.98	-0.0370	-19.75
Year 2005	-0.0080	-2.95	0.0028	1.28	-0.0189	-10.09
Year 2006	-0.0074	-2.75	0.0034	1.55	-0.0183	-9.78

TableA 1 continued

	complete set of dummy variables		region-specific effects excluded		industry effects excluded	
Endogenous variable: Growth rate of employment	coefficients	t-values	coefficients	t-values	coefficients	t-values
io_Agriculture and hunting	0.3370	3.5	0.3826	3.96	0.0475	3.11
io_Forestry and logging	0.1337	0.08	0.2924	0.18	-0.0809	-0.34
io_Fishing and fish farming	0.4648	0.04	0.3140	0.02	-0.0679	-0.02
io_Mining of coal and lignite; extraction of peat	0.0843	1.09	0.0734	0.94	-0.3818	-13.63
io_Extraction of crude petroleum and natural gas	-0.0641	-0.03	-0.1634	-0.08	-0.0986	-0.27
io_Other mining and quarrying	-0.1809	-0.67	-0.2879	-1.06	-0.0366	-0.56
io_Manufacture of food products and beverage	0.0651	0.88	-0.1483	-2.01	0.0400	3.64
io_Manufacture of tobacco products	0.1463	0.08	0.1194	0.07	0.2079	0.18
io_Manufacture of textiles	-0.1943	-0.81	-0.3015	-1.25	-0.2356	-5.92
io_Manufacture of wearing apparel	-0.2938	-1.13	-0.3585	-1.36	-0.5337	-3.39
io_Tenning and dressing of leather	-0.2696	-0.39	-0.3518	-0.5	-0.2601	-1.11
io_Manufacture of wood (except furniture)	-0.1986	-0.61	-0.2031	-0.61	-0.0751	-3.01
io_Manufacture of pulp, paper and paper products	-0.1730	-0.69	-0.2158	-0.85	-0.0024	-0.09
io_Publishing, printing and reproduction of record media	0.1049	1.2	-0.0339	-0.39	0.0169	1.53
io_Manufacture of coke, refined petroleum and nuclear fuel	-3.2400	-4.54	-3.3007	-4.56	0.0245	0.25
io_Manufacture of chemicals and chemical products	-0.1643	-3.73	-0.1901	-4.38	0.0084	1.04
io_Manufacture of rubber and plastic products	-0.0487	-0.78	-0.1286	-2.06	0.0529	3.52
io_Manufacture of other non-metalic mineral products	0.0329	0.44	-0.0238	-0.32	-0.0522	-2.66
io_Manufacture of basic metals	0.0059	0.12	-0.0173	-0.33	0.0186	2.38
io_Manufacture of fabricated metal products	-0.2258	-4.82	-0.2984	-6.65	0.0460	5.45
io_Manufacture of machinery and equipment	-0.2861	-6.05	-0.4466	-10.17	0.0658	5.72
io_Manufacture of office machinery and computers	-0.0999	-0.31	-0.1758	-0.53	-0.2577	-2.59
io_Manufacture of electrical motors and apparatus	-0.7964	-12.48	-0.8175	-13.03	-0.0242	-2.32
io_Manufacture of radio, television and communication equipment and apparatus	-0.4690	-3.57	-0.5246	-3.96	0.1430	4.16
io_Manufacture of medical, precision and optical instruments	-0.0399	-0.48	-0.1921	-2.35	0.1416	5.76
io_Manufacture of motor vehicles, trailers and semi-trailers	0.0560	1.14	0.0485	1.01	0.0897	11.75
io_Manufacture of other transport equipment	0.5013	2.56	0.4149	2.1	0.2118	5.41
io_Manufacture of furniture, manufacturing n.e.c.	0.0714	0.9	0.0205	0.26	-0.1709	-3.76
io_Recycling	0.2519	0.44	0.3170	0.54	0.0739	0.92
io_Electricity, gas, steam and hot water supply	-0.1967	-1.2	-0.2309	-1.39	-0.0018	-0.09
io_Collection, purification and distribution of water	0.4790	0.64	0.2870	0.38	0.0369	0.19
io_Construction	0.3980	17.63	0.4637	23.3	-0.1218	-12.47
io_Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel	0.1839	2.71	0.0955	1.41	0.2057	11.51
io_Wholesale trade and commission trade (except motore vehicles)	-0.0052	-0.17	-0.1232	-4.24	0.0818	8.53
io_Retail trade	0.1410	6.19	-0.0220	-1.12	0.1568	10.83
io_Hotels and restaurants	0.0562	0.93	0.0046	0.08	0.3928	18.4
io_Land transport; transport via pipelines	0.1123	3.51	0.1926	5.98	0.0958	8.86
io_Water transport	-0.1279	-0.12	-0.3875	-0.35	0.5934	2.34
io_Air transport	2.4143	6.49	2.3641	6.26	1.2298	9.32
io_Supporting and auxiliary transportactivities	0.0978	2.45	0.0746	1.87	0.0830	12.26
io_Post and telecommunication	0.3735	3.31	0.2940	2.57	0.1341	8.77
io_Financial intermediation	0.0385	0.85	-0.0413	-0.92	0.0751	9.66
io_Insurance and pension funding	-0.0865	-1.68	-0.1371	-2.63	0.0826	6.73
io_Activities auxiliary to financial intermediation	0.2340	1.35	0.1965	1.11	0.1560	6.94
io_Real estate activities	0.3309	2.79	0.5082	4.24	0.4902	13.55
io_Renting of machinery and equipment without operator and of personal and household goods	0.2119	0.38	0.2357	0.42	0.1550	2.9
io_Computer and related activities	0.2738	2.19	0.1201	0.95	0.3393	22.34
io_Research and development	0.1026	0.53	0.0261	0.13	0.2260	6.44
io_Other business activities	-0.0194	-1.08	-0.0383	-2.51	0.2059	33.01
io_Publilc administration and defence; compulsary social	0.5522	13.91	0.6106	17.31	0.2058	9.51
io_Education	0.6816	6.36	0.3126	2.98	0.4427	17.53
io_Health and social work	0.2205	6.05	-0.0273	-0.99	0.5520	20.57
io_Sewage and refuse disposal, sanitation and similar activities	0.2261	1.47	0.2754	1.76	0.0531	1.78
io_Activities of membership organisations	0.2413	2.56	0.1962	2.09	0.1813	10.98
io_Recreational, cultural and sporting activities	0.2054	1.64	0.1036	0.82	0.1871	13.09
io_Other service activities	0.2534	0.93	-0.0488	-0.18	0.2404	8.02

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