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Differences in the economic capability of regions – a typology for East Germany and Poland

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Abstract

This analysis constructs a typology of regions for East Germany and Poland on the basis of indicators for economic capability and their determinants. Cluster analysis is the method applied to form the types.

The results show that in East Germany as well as Poland the strongest regions are those with or in the vicinity of the largest agglomerations. Besides high income, low unemployment rates and population gains from migration (as indicators of their economic capability) these regions have comparably large stocks of qualified labour and technical know-how. Two regional types in particular could be established as problematic types: 1) Rural regions peripheral to the agglomerations burdened by low incomes and population losses from migration, a low level of qualified labour and little technical know-how, a small industrial base and little investment. 2) Old industrialised regions that have an average or even above average level of income compared to the entire region, but at the same time high rates of unemployment and out-migration. The stocks of human capital and technical know-how are also small in these regions. However, manufacturing investment is very high, generally because the depreciated capital stock is being replaced. Indicators for investment activities are obviously not very well suited to indicating the future economic capability of regions under the circumstances of transformation.

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1. Introduction

Ten years ago the economies of many countries in Central and Eastern Europe (CEE) entered a process of transformation from centralised planned economies to decentralised market economies. The process began with the establishment of the institutions of a market economy but its main focus has since become the integration of these countries and regions into the international division of labour. The results of this integration differ from region to region. For example, the East German region of Havelland-Fläming to the south-west of Berlin had an unemployment rate of 15 percent in June 1998 whilst the adjacent region of Dessau had a much higher rate of 22 percent. The disparities in other CEE-countries are in part even more extreme. On 31 December 1998, the Polish voivodship of Warsaw had virtually full employment with an official unemployment rate of only 2.6 percent. In the bordering voivodship of Ciechanow to the north of Warsaw, unemployment was six times higher at 15.6 percent, whilst in Slupsk, to the west of Gdansk, it was almost eight times higher than in Warsaw.

It is generally quite difficult to establish which regions have the strongest economies using the indicators available, as many factors affect the data on which these indicators are based. In addition, singularities and particularities may distort the overall picture and different indicators may lead to different judgements. To avoid this and to gain an overview of the regional differences in economic capability, a typology of regions can be constructed. By considering indicators for economic capability along with indicators for their determinants, regional types can be created with specific profiles that can suggest potential factors furthering or hindering growth. As the indicators can document different economic facts on different spatial levels it is advisable to carry out such an analysis on several regional scales. Furthermore, a comparison of regional profiles across national borders can reveal something about the state of regional disparities in the transformation economies and how the framework conditions that differ between the countries influence their development.

The following section lays down a theoretical basis for understanding the economic capability of regions, explaining the process and methods used. Section 3 contains the results for the East German regions, which were defined firstly on a macro-regional level as spatial planning regions (*Raumordnungsregionen*) (3.1) and then, by way of comparison, on a micro-regional level as districts (*Landkreise*) and metropolitan areas separate from the districts (*kreisfreie Städte*) (3.2). In section 4 the East German regional profiles are compared with the profiles of Polish voivodships. A final section states the conclusions of the study.

2. Theoretical and empirical basis and methods

2.1 Indicators and determinants of economic capability

The following analysis uses the concept of *economic capability* as a measure of the economic situation in a sub-region compared to the entire region. A sub-region has a relatively high economic capability if it has a high level of income compared to the region as a whole

together with a positive net migration rate and relatively high employment.[1] Per-capita income could be a basic indicator for economic capability, but unfortunately the necessary data is often not published on a narrow spatial scale. The following analysis therefore also draws on supplementary indicators (see appendix 1) such as the gross value added per employee, wages or the local trade tax payments of businesses, all of which say something about the financial results of the economic activities in a region. Most of these indicators are however to some extent contradictory. High wages, for example, on the one hand reflect high purchasing power and a high level of regional wealth, but from the point of view of businesses they constitute a cost component and are considered rather as a hindrance to competitiveness.

The migration rate gives information about regional incomes as migration is also triggered by differentials of payments for and utilisation of labour between the regions. Looked at it in these terms, positive net migration rates indicate above average labour income. Nevertheless, it is not possible to make a direct inference about regional incomes from the net migration rate. Differences in the migration behaviour of the labour force may also be attributable to socio-cultural reasons. Furthermore, the out-migration of mobile workers can raise the employment opportunities and per-capita income of those that stay behind because of lower labour market competition (besides the sheer statistical effect of a decrease in the denominator).

A further aspect worth taking into account when determining the economic capability of a region is a high employment rate. The purpose of this is firstly to establish income distribution. Earnings from employment are on average higher than transfer payments. In other words, the higher the share of transfer payment recipients, the greater the section of the population with an income in the bottom range of the income scale. Furthermore, the rate of employment – or better still the rate of unemployment as its inverse – indicates the perspectives for growth of a region. The unemployed members of the labour force generally accumulate less knowledge than those in work and therefore a region with high unemployment tends to have a lower stock of human capital.

A region's economic capability in the past does not automatically determine its future performance; this depends rather on a multitude of determining factors (see appendix 1). These include the supply of human capital and private real capital as well as individual – in part non-economic – factors that are often combined in neo-classical economic growth theory to form a parameter of efficiency or a level of technology (in the broad sense of the term). The following aspects of this parameter of efficiency will be included as far as the available data allows for the purposes of determining economic capability in the East German and Polish regions:

- The technical know-how in a region provides the basis for product and process innovations and thereby for growing enterprises with increasing productivity. The level of tech-

[1] See also the explanations and operationalisations of regional competitiveness in Cambridge Econometrics 1998, S. 1-9; European Commission 1999.

nical know-how will be shown by patent applications, which are a result of research and development (R&D). A further indicator is the amount of qualified workers as firms are particularly reliant on these persons for their own R&D activities and in order to adopt innovations.

- Public real capital, especially business-related infrastructure, is considered to promote growth at regional level as a result of positive external effects which enable local firms to achieve the same output with a lower input of other production factors. Internationally comparable indicators for business-related infrastructure are hard to come by. The following analysis draws on local infrastructure investments for Germany and the density of the road system for Poland.
- As a pre-condition for economic success, a region needs a "critical mass" of enterprises and entrepreneurs willing to invest capital for productive purposes and to take on the risk of failure. A willingness to take risks cannot be taken as read, especially in the transformation economies. The central planned economies did not suitably reward those enterprises or entrepreneurs willing to take risks, nor did these societies promote the associated personal characteristics. The establishment of new businesses or the amount of corporate borrowing are ways of measuring the entrepreneurial initiative in a region.
- Another pre-condition for high economic capability is the existence of an industrial base. The more industrialised a region, the more its industrial firms can make use of the advantages of specialisation of other enterprises or the labour force, that is they can benefit from the increased efficiency of an industrial division of labour (agglomeration effect). The special significance of the region here lies in reduced costs for recruitment, pre-products, knowledge (innovation) and all kinds of business information. Moreover, recent regional growth analyses have established that a diversified industrial structure has long-term positive growth effects stemming from the spillover of inter-industrial knowledge.[2] In other words, the economic capability of a region is determined not only by the scale of the industrial base but also its structure.

2.2 Spatial units used in the analysis

In East Germany, the analysis was run on two spatial levels: administrative districts and towns outside of districts, and spatial planning regions.

Districts and metropolitan areas are local authorities with sovereign tasks on their territory such as traffic control, waste management, public welfare, conservation or protection of the landscape. Metropolitan areas are responsible for all of the tasks of local government whilst districts share these responsibilities with the municipalities belonging to them. Districts and

[2] However, the opposite view maintains that a highly specialised industrial structure also has growth effects driven by intra-industrial knowledge spillover. See, for example, the explanation in Glaeser et al. (1992, pp. 1130-1134). Empirical analyses tend to confirm the diversification hypothesis (Glaeser et al. 1992, p. 1144).

metropolitan areas are also the lowest administrative agency of the *Länder* and therefore carry out tasks transferred to them by the *Länder*. The following analysis includes the 112 districts and metropolitan areas in East Germany, excluding Berlin. On 31 December 1998 these had an average population of 125,000 over an average territory of 960 square kilometres.

Spatial planning regions are large territorial catchment areas containing economic and labour market centres. They are composed of these centres together with the surrounding districts and metropolitan areas. Districts are linked to a labour market centre on the basis of the commuter network. A district belongs to a spatial planning region if over 15 percent of its total labour force commutes into this region. The Federal Office for Construction and Spatial Planning draws up a proposal for the delimitation of the spatial planning regions which is then discussed with and ratified by the planning agencies of the *Länder*. Political aspects such as the borders between the *Länder* are also taken into account.[3] The present analysis includes the 22 East German spatial planning regions (excluding Berlin) which on 31 December 1998 had an average population of 640,000 and an average territory of 4,900 square kilometres.

In Poland, the 49 voivodships that existed until the regional reform of 31 December 1998 were chosen for the regional analysis.[4] As state institutions, the voivodships were purely administrative agencies of the central government until the reforms. Their head, the voivod, was appointed by central government and did not possess any democratic legitimacy through the regional population. These voivodships were more or less the same size as the East German spatial planning regions, having an average population of 790,000 over an average territory of 6,600 square kilometres.

2.3 Methodology

The purpose of regional profiles is to determine typical combinations of economic capability indicators and their determining factors. For this reason, and as most spatial units of analysis would render a detailed examination virtually impossible, it was necessary to find a way of reducing the spatial units down to a few types. With this aim in mind, the research project applied the method of *cluster analysis,* which uses an algorithm to determine the similarity of the individual objects to each other and to group together similar objects.[5]

As the results of a cluster analysis are influenced by correlation amongst the variables and outliers in the data set, these had to be identified before starting the process. Correlated variables may dominate a cluster analysis, resulting in types which are ultimately only differenti-

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[3] Thus, for example, the districts and metropolitan areas around Berlin are not included in the Berlin spatial planning region, but added to the other districts of the Land Brandenburg to create separate regions, contrary to the principle of functional delimitation.

[4] Since 1 January 1999 Poland has been subdivided into 16 larger voivodships.

[5] See, for example, the implementation of cluster analysis for regional type identification in: Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung 1999, pp. 81-84; Schmidt 1995; Sinz, Steinle 1989.

ated in a few dimensions but expressed in many variables. Highly correlated variables – those with a correlation coefficient of $r > 0.8$ – were therefore excluded from the data set of the cluster analysis. As this brought about the risk of some elements of the regional production function not being taken sufficiently into account, control cluster analyses were also carried out using factors extracted from principal component analyses with the entire set of variables. It is also advisable to exclude from the data set of a cluster analysis those records that are completely different from the others (outliers) and either do not fit into or may distort the groups. For this reason, the outlier regions were next identified, calculating for all records without missing values the (squared Euclidean) distances for each indicator and totalling these indicator-specific distances (see Buttler 1996). This calculation produced a dissimilarity matrix which made it possible to exclude those regions that differed greatly from the others.

Table 1: Statistics for the cluster analyses

	Germany		Poland
	Spatial planning regions	Districts and metropolitan areas	Voivodships
Total number of records	22	112	49
Records with missing values of which replaceable using a mean value of the data set	0 –	7 5	0 –
Outliers	1	3	1
Records included in the cluster analyses (basic variant, excluding records with missing values and outliers)	21	102	48

Source: Own statistics.

Cluster analyses were carried out for those regions remaining once the records with missing values and the outliers had been excluded. Three aspects had to be decided with regard to the cluster analyses:

1. *The measure of distance*. Different measures of distance are available to calculate distance matrices from data matrices, the most common being based on Minkowski metrics. These are the city block metric, the Euclidean distance, the squared Euclidean distance and the Chebychev distance. Clustering techniques that compute the cluster values for the variables using the mean value of the records within each cluster (see 2 below) require the squared Euclidean distance as a basis which was therefore used in the analysis.

2. *The clustering technique*. In cluster analysis, hierarchical clustering techniques that reduce the set of objects step by step through fusion (agglomerative algorithms) or increase it through division (divisive algorithms) have been established as standards. Alternative methods are more or less suitable for clustering data and variables and analysing a data matrix or a (dis)similarity matrix, and have various advantages and disadvantages. Previous analyses and simulations have identified Ward's Method as one that shows the "true" group structure of a data set quite well and also yields results that lend themselves to interpretation (see Backhaus et al. 1993, p. 298; Schmidt 1995, p. 74). This method was therefore used as a basis in the cluster analyses carried out for this study.

3. *The number of clusters*. The appropriate number of clusters was selected using the tabulated and graphic representations of the within-cluster distance.[6] In addition to the plot of within-cluster distance against the number of groups the increase in the within-cluster distance was analysed. If no clear-cut solutions emerged from these values, Lathrop and Williams' random test of the within-cluster distance (described in Bacher 1996, pp. 250-252) was conducted to see if the data set had any cluster structure at all.

The basic clustering results were then subjected to various control cluster analyses which were taken into account when interpreting the final results:

- Cluster analysis using other measures of distance and clustering techniques;
- Cluster analysis with factors extracted from the complete variable set by principal component analyses;
- Discriminant analyses of the clusters.

The mean values of the variables for the clusters, the t-values, and the F-values were used to interpret the results (see appendix 3). The t-value reveals for each variable and cluster by how many standard deviations its mean value differs from the mean value of the entire population. It makes it possible to compare the clusters for a variable and also the variables for a cluster, and thus to establish the characteristics of a cluster. Negative (positive) t-values indicate that, on average, the regions of a cluster have a lower (higher) value at a variable than the entire population. The F-value constitutes a quotient of the variances of a variable in the cluster and in the entire population. This quotient of variances makes it possible to assess how homogenous the groups are. An F-value smaller than one indicates homogeneous clusters, whilst an F-value above one represents non-homogeneous clusters (always in relative terms and compared to the entire population). A variable is then well-suited to describe a cluster if its t-value is different to 0 and its F-value is less than 1, as with this variable the cluster will differ significantly and uniformly from the composition of the entire population.

3. Economic capability in East German regions

3.1 Spatial planning regions

Clustering the 21 spatial planning regions (without the outlier Uckermark-Barnim) using Ward's clustering technique produced a five cluster solution as the best solution. Though this was confirmed by various control calculations using different clustering techniques,[7] the grouping of regions was not entirely stable. The position of four regions varied depending on

[6] Within-cluster variance (or distance): variance between the research objects across all variables that lies within the clusters. The greater the within-cluster distance the lesser the difference between the clusters and the more the individual objects within the clusters differ from each other.

[7] No control cluster analyses on the basis of principal components were carried out for the spatial planning regions. The low KMO measure of only 0.37 meant that the data set was considered inappropriate for principal components analyses.

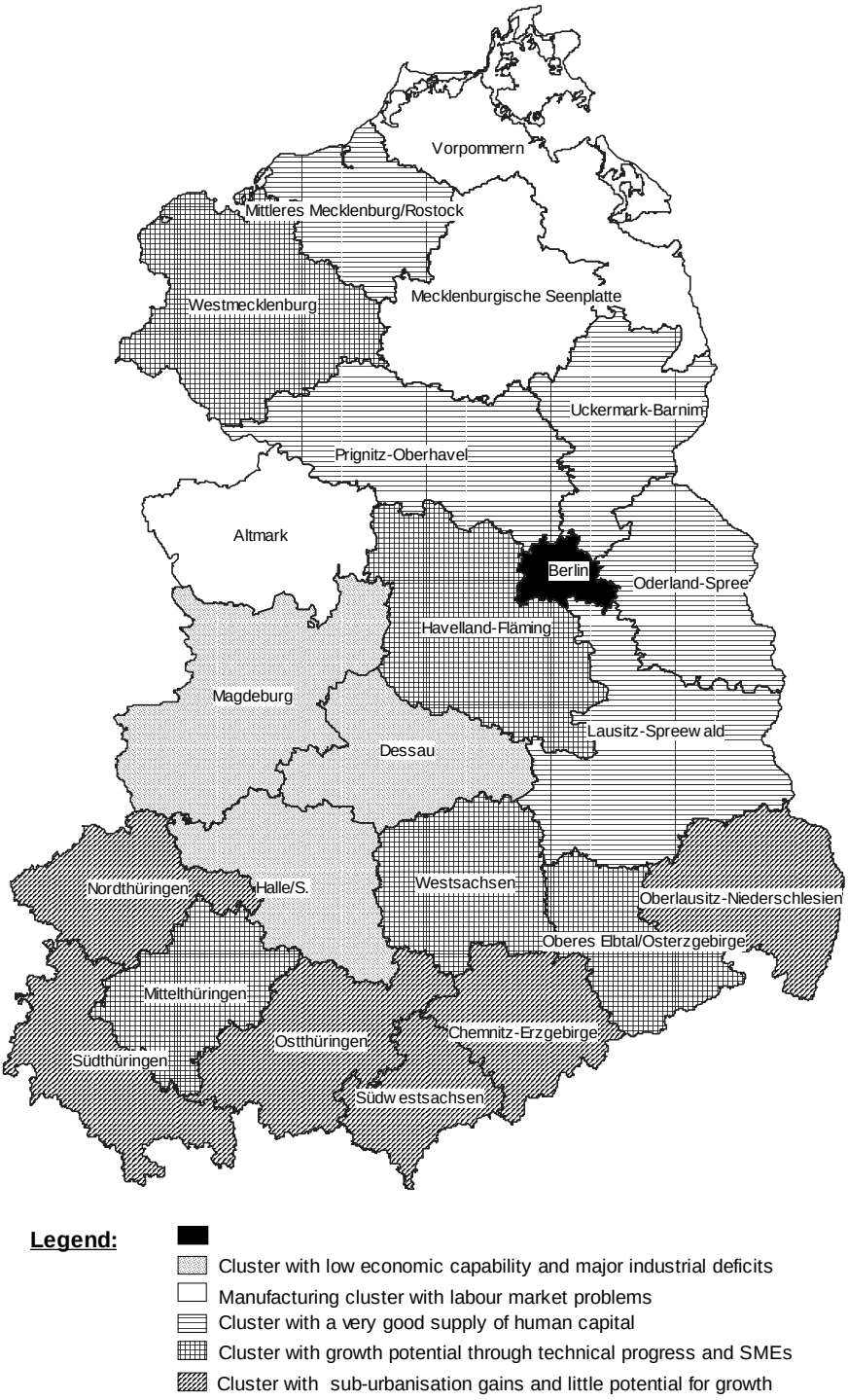
the clustering technique. Therefore, although these were initially included in the cluster analysis the positioning from the basic clustering calculation was then removed and replaced with a new positioning from a discriminant analysis which largely confirmed the initial typology from Ward's clustering method.

The grouping of spatial planning regions resulted firstly in a *cluster with low economic capability and major industrial deficits* (SPR1, see map 1 and table 2). This cluster consists of three regions with below average indicator values for income, manufacturing wages and taxable capacity for local trade tax, but above average unemployment and public welfare rates. In addition, these regions showed population losses from out-migration, e.g. in Vorpommern a loss of almost three percent from 1992 to 1998. They rarely attained the East German level with regard to most of the growth factors. Per-capita industrial investment amounted to just 50%, industrial density to two thirds and patent applications to less than 30% of the mean value of all of the spatial planning regions.

Another cluster (SPR2) could be defined as a *manufacturing cluster with labour market problems*. This cluster is also made up of three spatial planning regions. The unemployment rate in particular showed extremely unfavourable values, lying about 2 percentage points above the mean value of all the spatial planning regions. These regions also had relatively high population losses due to out-migration. Industrial investment was above average in all three regions. Halle/Saale had by far the highest value of all East German regions in this respect (2,300 DM per-capita) and Dessau ranked third (almost 1,500 DM per-capita). Entrepreneurial initiative is a potentially problematic factor as both indicators for this, i.e. net business registrations and loans granted to SMEs, lie below the mean value of the spatial planning regions as a whole. With just 200 loans supported by the KfW (*Kreditanstalt für Wiederaufbau*) and DtA (*Deutsche Ausgleichsbank*) per 10,000 inhabitants the Halle region has by far the lowest value in East Germany in this respect. The cluster fares a little better when it comes to its industrial base. Industrial density is slightly below the East German average but the industrial structure is fairly diversified.

Five spatial planning regions were grouped together to form another cluster (SPR3) that could be described as a *cluster with a very good supply of human capital*. In contrast to cluster SPR2 above this cluster shows very low unemployment and low public welfare rates – Havelland-Fläming and Oberes Elbtal/Osterzgebirge had the lowest unemployment of all the East German spatial planning regions. The high working population rates of these regions – corresponding to the low unemployment rates - are a striking feature of this cluster. Cluster SPR3 also shows above average values in terms of the level of qualification of human capital. Moreover, patent applications are above the East German average, but this is mainly due to the Oberes Elbtal/Osterzgebirge region, which ranks way ahead of all the other East German regions with 29 patent applications per 100,000 inhabitants. Other regions of the cluster perform worse with respect to this indicator, such as Westmecklenburg which only had 5.4 applications. The high tax capacity for trade tax and the population gains from migration are also significant.

Map 1: Clusters of East German spatial planning regions[a]



a The grouping reflects the results of a cluster analysis with Ward's method modified by the results of a discriminant analysis.

Source: Own calculations.

Table 2: Indicator values of the clusters of East German spatial planning regions[c]

Indicators (see appendix 1 on the definition)	Cluster SPR1 with low economic capability and major industrial deficits		Manufacturing cluster SPR2 with labour market problems		Cluster SPR3 with a very good supply of human capital		Cluster SPR4 with growth potential through technical progress and SMEs		Cluster SPR5 with sub-urbanisation gains and little potential for growth		All spatial planning regions
	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]
Industrial wages	21.0	-1.06	23.1	0.08	23.4	0.27	21.7	-0.69	25.0	1.14	22.9
General productivity	61.8	-0.27	62.5	-0.20	64.6	0.03	60.1	-0.46	71.8*	0.81	64.4
Industrial productivity	235.6	-0.59	291.5	0.18	260.9	-0.24	250.7	-0.38	347.0*	0.94	278.4
Business revenues	163.2	-0.48	188.7	0.11	219.2	0.82	145.7	-0.89	204.7*	0.48	184.1
Local authority revenues	403.1	-0.89	463.7	0.03	534.1	1.11	408.3	-0.81	487.1	0.39	461.6
Unemployment	19.7	0.63	21.0	1.26	16.9	-0.79	17.5	-0.48	18.9	0.23	18.5
Public welfare burden	24.1	0.45	27.1	1.23	21.5*	-0.21	18.7	-0.95	23.6	0.34	22.3
Net migration	-16.4	-0.89	-9.8	-0.67	26.8	0.57	-3.3	-0.45	36.5*	0.90	9.9
Working population	370*	-0.65	385	-0.16	430	1.23	375	-0.49	386	-0.16	391
Level of qualification I	5.4	-0.97	7.8	-0.04	11.0*	1.21	6.7	-0.48	7.8	-0.03	7.9
Students	6.6	-0.50	11.8	0.10	20.1	1.06	6.9	-0.47	8.8*	-0.25	11.0
Industrial investment	539	-1.05	1,600*	1.42	854	-0.31	850	-0.32	1,192	0.47	989
Business-related infrastructure	2,757*	0.28	2,366	-0.48	2,783	0.33	2,592	-0.04	2,532*	-0.16	2,613
Patents	2.9	-1.15	9.7	-0.07	13.4*	0.52	13.4	0.51	7.6	-0.40	10.1
Loans granted to SMEs	309.7	0.35	231.9	-0.88	274.4	-0.21	351.6*	1.01	244.9	-0.68	287.7
Net business registrations	109	-0.78	125	-0.15	144*	0.59	114	-0.60	147	0.68	129
Industrial density	44.5	-1.37	65.2	-0.06	65.6	-0.04	85.1	1.19	57.9	-0.53	66.2
Coefficient of industrial specialisation	0.16	0.97	0.05	-0.56	0.04	-0.76	0.06	-0.46	0.16	1.06	0.09
Population density	62.7	-1.07	158.3	0.19	184.2*	0.54	187.2	0.57	90.4	-0.70	143.6

a Arithmetic mean value. – b Negative (positive) t-values indicate that, on average, the regions of a cluster have a lower (higher) value at a variable than the entire population. – c Figures with a * have F-values above one. This indicates less homogeneity in the cluster than in the parent population for the indicated variable.

Sources: Regional data base of the IWH, Statistical offices of the East German *Länder*, Federal Employment Office, Federal Office for the Economy, DtA, KfW, German Patent Office, calculation by the IWH.

Another cluster (SPR4) is made up of six spatial planning regions in the south of East Germany. In this *cluster with growth potential through technical progress and SMEs* the gross wages in manufacturing and the local trade tax capacity are relatively low, but so are the rates of unemployment and public welfare. These regions show population losses due to out-migration, though to a much lesser extent than the regions in clusters SPR1 and SPR2. In contrast to cluster SPR3 above, the working population rate in this cluster is way below the regional average. Together with the migration losses, this implies that the fairly relaxed labour market situation could be due to out-migration rather than the creation of new employment opportunities in the regions belonging to this cluster. However, some growth factors reveal the strengths of SPR4. The regions performed relatively well in terms of technical know-how, and with the exception of Nordthüringen all had a relatively high level of patent applications. The industrial base has a fairly low level of specialisation and is the strongest of all the clusters in quantitative terms. Finally, the cluster stands out because of the high number of loans granted to SMEs. Südthüringen has the best value of all the regions here with 475 cases per 10,000 inhabitants. In this context, it is quite difficult to interpret the second indicator of entrepreneurial initiative, i.e. the net business registration rate, which is relatively low in this cluster. This can perhaps be explained by the delimitation of the regions and the effects of sub-urbanisation.

The regions bordering on Berlin and the region Mittleres Mecklenburg/Rostock form a *cluster with sub-urbanisation gains and little potential for growth* (SPR5). The indicators for income are above the mean value of the spatial planning regions of the new Bundesländer. Despite having labour market problems – as demonstrated by the unfavourable levels of unemployment and public welfare – these regions are nonetheless areas of in-migration. Berlin was the main source of the migration gains of 36.5 persons per 1,000 inhabitants from 1992 to 1998. Of the indicators that can suggest the growth potential of the cluster regions, the low and highly specialised industrial base and the low number of patent applications are the most striking. Furthermore, industrial productivity was above the East German average in all of the regions but one, with the extreme value of 550,000 DM per inhabitant in Uckermark-Barnim.[8] Capital spending in mining and manufacturing was also above average in these regions. Like cluster SPR2, this is probably due to individual locations of large investment projects, as the industrial base was fairly small.

Intermediate results: The description of the separate clusters showed a differing distribution of strengths and weaknesses amongst the regions. If the clusters are ranked with regard to their economic capability and future growth perspectives, cluster SPR1 definitely comes last,[9] followed by cluster SPR2, particularly because of its significant labour market problems and population losses due to out-migration. Clusters SPR4 and SPR5 come joint middle; SPR4

[8] This is due to oil refineries in the region that paid a large amount of taxes included in the calculation of GVA.

[9] That is also one of the results in other regional analyses of East Germany, see for example Maretzke, Irmen 1999, p. 13.

because of the relatively low burden of unemployment together with low incomes and a weak position of the growth factor human capital, and SPR5 because of above average unemployment and deficits with respect to some growth factors. Cluster SPR3 has the top ranking as its regions showed migration gains, high income, few labour market problems and a large quantity of qualified employed persons. The empirical results for the spatial planning regions indicate that specific patterns of economic capability and its determinants do exist. Of these determinants, human capital and the amount of technical know-how clearly play a crucial role.

The following section will seek to establish whether regional disparities follow a similar pattern in the 112 East German districts and metropolitan areas and whether the relationships between economic capability and their determinants can be confirmed.

3.2 Districts and metropolitan areas

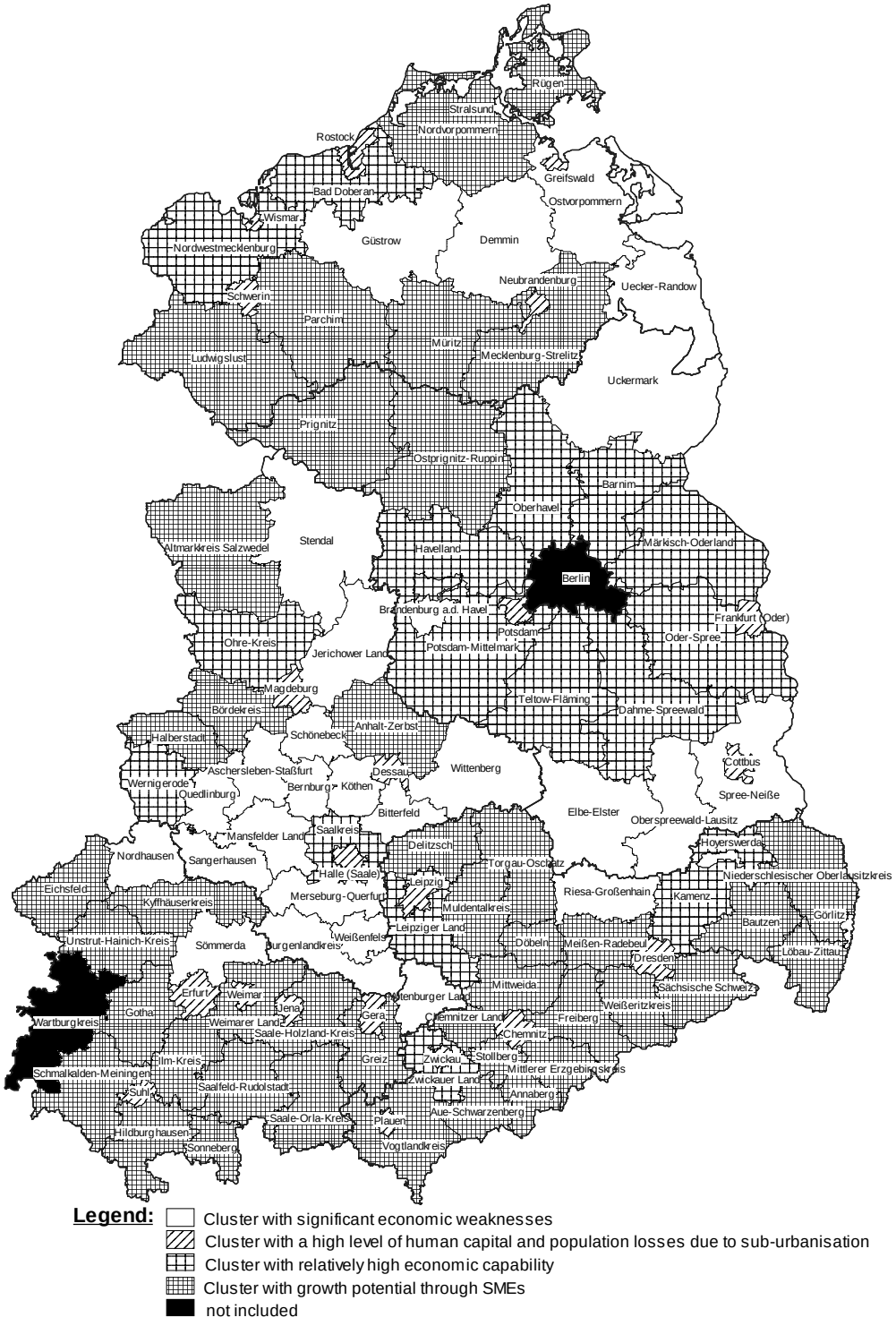
By clustering the districts and metropolitan areas four clusters emerge. From the plot of within-cluster variance against the number of groups, a sharp increase in the within-cluster variance can be discerned in the transition from the four to the three-cluster solution. A comparison with the clustering of random variables also reveals a sharp increase in the within-cluster variance. Whilst the difference between the empirical and random within-cluster variance decreases by 2-3 percent for each step in the grouping process up to the four-cluster solution, it decreases by about 9 percent when making three clusters from four.

Cluster DMA1 of the analysis contains 30 districts and metropolitan areas with *significant economic weaknesses* (see map 2 and table 3). The unemployment rate in this cluster is on average three percentage points above the mean of all the regions, and in the period from 1992 to 1998 there was more out-migration than in-migration. These districts and metropolitan areas perform fairly badly with regard to the determining factors for economic capability, with the exception of industrial investment.

A second cluster (DMA2) that can be described as a *cluster with a high level of human capital and population losses due to sub-urbanisation* contains 21 exclusively metropolitan areas. Though the supplementary indicators for regional income, gross manufacturing wages and taxable capacity are above average and unemployment rates below average in this cluster,[10] the metropolitan areas showed high population losses from migration. This is a result of the population sub-urbanisation that began in East Germany with the process of economic transformation and that can also be seen in the private sector of the economy from the low industrial capital spending and the significant decrease in industrial density in the metropolitan areas. However, despite sub-urbanisation the metropolitan areas within the cluster had a high stock of human capital and the number of patent applications was way above average. Nonetheless, the data for some other determinants of economic capability should be seen in fairly

[10] This may be due to a favourable situation on the “first” labour market but also to a high percentage of subsidised employment on the “second” labour market that receives a lot of public money.

Map 2: Clusters of East German districts and metropolitan areas[a]



a The grouping shows the results of a cluster analysis using Ward's method as modified by the results of a discriminant analysis.

Source: Own calculations.

Table 3: Indicator values of the clusters of East German districts and metropolitan areas[c]

Indicators (see appendix 1 on the definition)	Cluster DMA1 with significant economic weaknesses		Cluster DMA2 with a high level of human capital and population losses due to sub-urbanisation		Cluster DMA3 with a relatively high economic capability		Cluster DMA4 with growth potential through SMEs		All districts and met. areas[d]
	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]
Industrial wages	23.2*	0.22	25.3	0.85	23.8	0.40	20.3	-0.65	22.4
General productivity	64.4*	0.41	60.0	0.04	64.9	0.45	53.9	-0.47	59.6
Industrial productivity	325*	0.60	236	-0.18	295	0.33	208	-0.43	257
Business revenues	154.3	-0.29	248.3	0.95	252.3*	1.00	134.2	-0.55	176.1
Local authority revenues	409.4	-0.34	608.9*	1.40	491.8	0.38	381.5	-0.59	448.6
Unemployment	22.1	1.06	17.5	-0.48	17.0	-0.65	18.1	-0.29	19.0
Public welfare burden	24.8	0.42	29.8*	1.08	17.6	-0.64	18.2	-0.55	21.9
Net migration	-11.4	-0.32	-72.9	-1.23	116.8	1.57	27.1	0.25	10.3
Working population	355	-0.37	545	1.80	351	-0.42	351	-0.41	387
Level of qualification I	6	-0.28	16	1.71	7	-0.12	5	-0.53	8
Industrial investment	1,577*	0.53	700	-0.30	1,117	0.09	751	-0.25	1,019
Business-related infrastructure	2,041	-0.36	1,797	-0.57	2,543	0.06	3,032*	0.47	2,469
Patents	5.6	-0.41	21.4*	0.95	8.0	-0.21	9.6	-0.07	10.4
Loans granted to SMEs	248	-0.51	224	-0.77	271	-0.24	360	0.76	293
Net business registrations	96	-0.63	129	0.14	180	1.31	117	-0.13	123
Industrial density	67	-0.25	66	-0.28	71*	-0.03	78*	0.33	72
Coefficient of industrial specialisation	0.84*	0.35	0.88	0.39	0.33	-0.22	0.22	-0.34	0.53
Population density	229.1	-0.23	1,011.7	1.65	115.0	-0.51	138.3	-0.45	326.4

a Arithmetic mean value. – b Negative (positive) t-values indicate that, on average, the regions of a cluster have a lower (higher) value at a variable than the entire population. – c Figures with a * have F-values above one. This indicates less homogeneity in the cluster than in the parent population for the indicated variable. – d Differences between tables 2 and 3 appear as no weights were used when calculating the arithmetic mean values.

Sources: Regional data base of the IWH, Statistical offices of the East German *Länder*, Federal Employment Office, Federal Office for the Economy, DtA, KfW, German Patent Office, calculation by the IWH.

negative terms, especially the low level of supported loans, below average infrastructure investment, and low labour productivity in mining and manufacturing (despite wages being relatively high).

The third cluster (DMA3) has *a relatively high economic capability*. This cluster contains all of the districts around Berlin, the areas around Leipzig, Halle, Rostock and Zwickau and other districts bordering on cities. All of the indicators for economic capability rank above the East German average. The districts of this cluster show the worst results where the cities perform well, that is with regard to the stock of human capital and technical know-how. Cities and their surroundings therefore have a symbiotic relationship and are closely linked in many different ways.

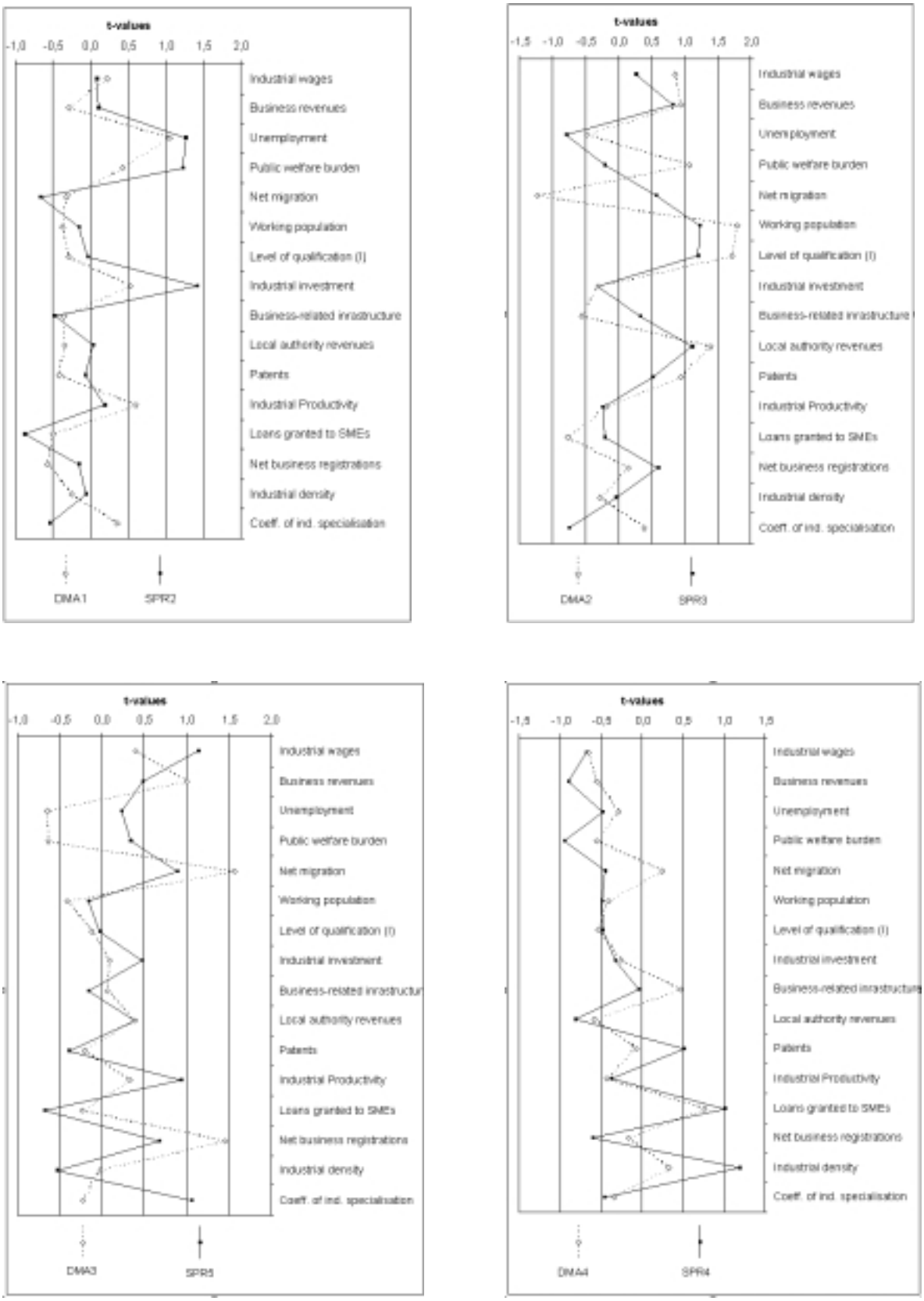
Finally, cluster DMA4 could be called the *cluster with growth potential through SMEs*. It contains 43 districts with a fairly low income. Nonetheless, unemployment rates are also relatively low and the migration rate reveals that these regions are in-migration areas, showing population gains from migration of an average 2.7 percent in the period from 1992 to 1997. The most notable determinant of economic capability is the high take-up rate for loans to SMEs, this being a quarter above the East German average. The industrial base shows relatively good values: industrial density is above average and the low coefficient of specialisation is indicative of a high resistance towards industry-specific crises.

There are some similarities between the clusters at district level and those on the level of the spatial planning regions (see figures 1-4):

Cluster DMA1, which has major economic weaknesses, corresponds in many respects to SPR2, the manufacturing cluster with labour market problems. One difference is that, in contrast to SPR2, the taxable capacity of local trade tax is below average in DMA1 (t-value < 0), whilst the coefficient of specialisation lies above average (t-value > 0). In addition, the rates of public welfare and manufacturing investment are lower in DMA1 than in SPR2, although still above the regional average. When it comes to the latter indicators, DMA1 shows similarities with SPR1 and SPR5. A locational comparison using the two maps makes it clear that the districts and metropolitan areas in DMA1 are located primarily in the spatial planning regions belonging to cluster SPR2, but also in those belonging to SPR1 and SPR5.

With regard to several indicators the cluster DMA2, having a high level of human capital and population losses due to sub-urbanisation, shows similar values to the cluster SPR3, which has a very good supply of human capital. DMA2 differs in terms of its very high public welfare burden and migration losses, low capital spending for business-related infrastructure and the high coefficient of specialisation, all of which are characteristic for East German cities. The favourable supply of some determinants of economic capability (human capital, technical know-how) in the regions of cluster SPR3 also exists in other regions to a smaller spatial extent.

Figures 1-4: Economic profiles of selected East German clusters on regional and district level



Source: Own calculation.

Similarities also exist between the cluster DMA3, which has a high economic capability, and cluster SPR5, where there are gains from sub-urbanisation but only little potential for growth. The gains in population and business associated with sub-urbanisation are, in particular, also to be found in the areas surrounding other East German cities outside cluster SPR5. Cluster DMA3 has much lower rates of unemployment and public welfare than SPR5, the reason being that the latter also contains some of the districts of the cluster DMA1 which shows major labour market problems. A comparison of the maps suggests that the sub-urbanisation effects are on a smaller spatial level than it would appear from map 1 and that there is broad internal differentiation in the regions of cluster SPR5 between those territories close to the cities and those further away.

Finally, there is some congruence between the districts of DMA4 and the regions of SPR4, each having growth potential from small and medium-sized enterprises. However, the clusters differ when it comes to the migration rate and investment in business-related infrastructure, which were higher in DMA4, and patent applications, which were more frequent in SPR4. The reason is that many of the districts in DMA4 are located in the vicinity of metropolitan areas, which themselves are not included in DMA4 but in DMA2. Whilst the characteristics of the metropolitan areas are limited to cluster DMA2 on a district level, they affect both SPR3 and SPR4 on a regional level.

Intermediate results: As it could have been expected, the analysis at district level shows significant intra-regional differences in economic capability and its determinants *within* the spatial planning regions. Firstly, the economic spillover of metropolitan areas such as Berlin is more spatially confined than the results for the large spatial planning regions would suggest.[11] Secondly, the less economically capable regions also contain "islands of high capability" and vice versa. In general, the relationship between economic capability and its determinants is similar at district and at regional level, but there are some notable differences, for example with respect to migration and the stock of human capital (see section 5).

Taking Poland as an example, section 4 below will examine whether the pattern of regional disparities and the relationship between economic capability and its determinants are specific to East Germany, or whether other transformation economies display similar characteristics.

4. Profiles of the Polish voivodships

As the data set for the Polish voivodships was characterised by strong correlation amongst the variables, and even the exclusion of some variables did not lead to satisfactory results, the cluster analysis was preceded by a principal components analysis. This allowed five principal components to be extracted, the values of which were estimated for the voivodships. The clustering of 48 voivodships – Warsaw was identified as an outlier and therefore excluded at

[11] In the case of Berlin, even the districts are probably too big to distinguish those areas that benefit from being located close to Berlin from those that are not at all or only marginally affected by this relative proximity.

the beginning – with the principal components values using Ward's clustering technique resulted in six clusters. The results were also relatively stable when using other clustering techniques. The Warsaw region was subsequently added to cluster V4.

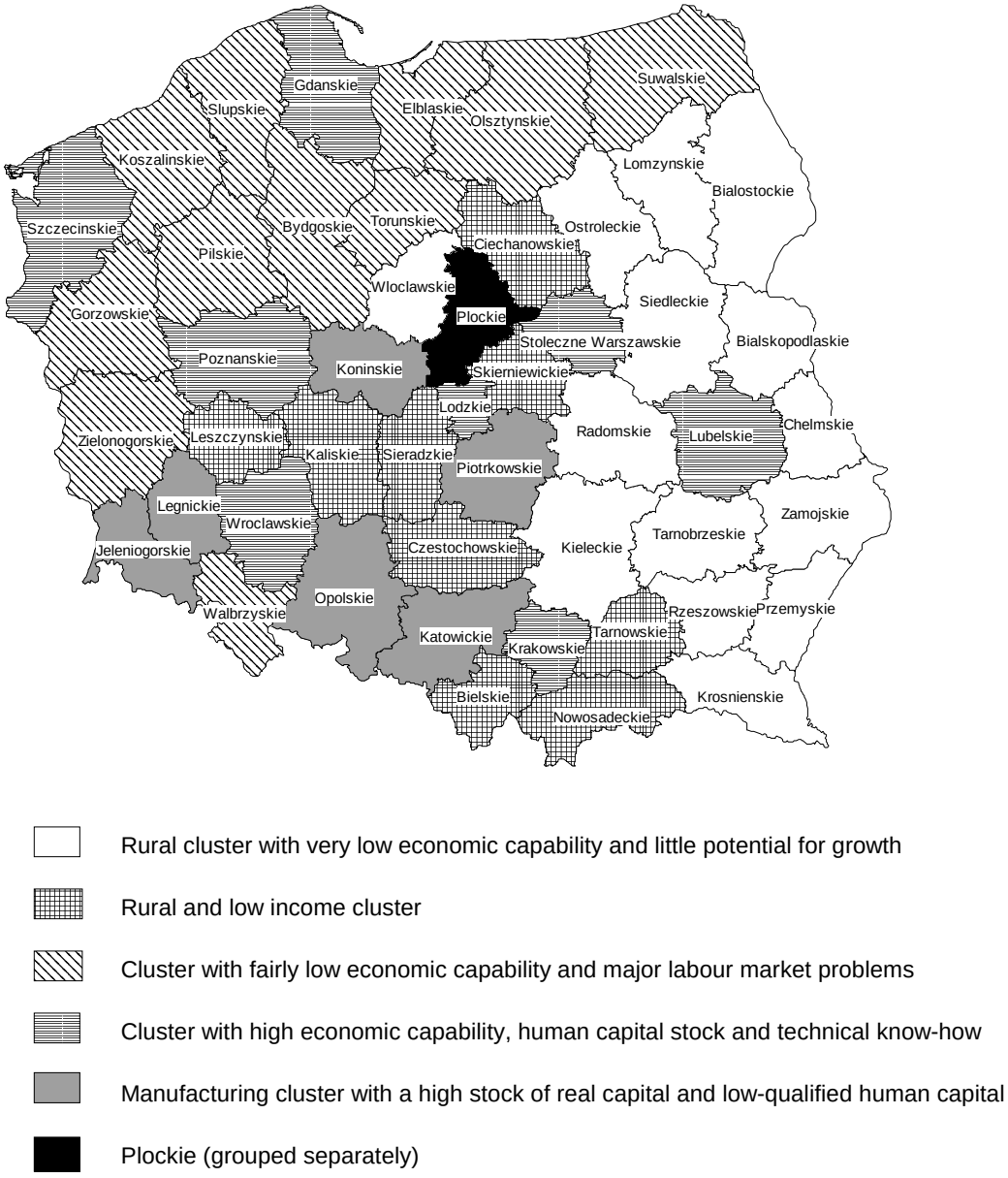
The *rural cluster with a very low economic capability and little potential for growth* (V1) contains 14 voivodships in eastern Poland. It had the lowest GDP per-capita, productivity figures and local public revenues, very low gross manufacturing wages and salaries, as well as the highest population losses from migration (more than twice the average of the voivodships). On the basis of these indicators the cluster can clearly be identified as the one with the lowest economic capability. However, the unemployment rate (12.1 percent) was more or less equal to the average of the voivodships, and the working population rate was even the highest of all the clusters with 444 employed persons per 1,000 inhabitants. These seemingly contradictory figures can be explained by the high share of employed persons working in the agricultural sector (around 50 percent). This sector only generated a low income but it guaranteed employment and constituted a "safety net" for those who had lost jobs in other sectors (see Korcelli 1997, p. 213). The low level of qualification of the human capital can also be deduced from the other two indicators, the coefficient of localisation of employment in R&D and the student rate. The industrial base of the cluster was very small, reflecting the importance of the primary sector. This can be seen in the low share of employment in the manufacturing sector as well as the low level of investment in manufacturing. The regions in this cluster also showed very poor values with regard to the indicators of technical know-how.

Nine voivodships located mainly in central and southern Poland were grouped together into a *rural and low income cluster* (V2) that resembles cluster V1 with respect to many indicators – in some control calculations these clusters were fused. V2 and V1 are alike in that per-capita income, productivity, the supply of technical know-how and the qualification of human capital are low and the importance of agriculture high. However, V2 has slightly better values for each of the indicators. Its lower migration losses and unemployment rate – the latter below the mean value of 12.0 percent in eight of the nine voivodships – also puts cluster V2 in a more favourable position than V1. Like V1, V2 shows a lack of specific strengths when it comes to the determinants of economic capability; only the industrial density – which is equal to the Polish average – could be interpreted as such.

Another 11 voivodships, mainly located in northern and western Poland, were combined to form a very homogeneous *cluster with fairly low economic capability and major labour market problems* (V3). Here, per-capita income was slightly below the average for the voivodships, although productivity and local public revenues were a little above average. All of the regions in this cluster experienced more out-migration than in-migration. This cluster stands out from the rest because of its very high unemployment rate and the low working population rate. The qualification of human capital was also slightly below the Polish average according to the low coefficient of localisation of R&D personnel and the student rate. However, the share of employment in the primary sector was relatively low, all the more remarkable as cluster V3, like cluster V1, is made up of sparsely populated voivodships. The high unem-

ployment rate and the low share of employment in the agricultural sector may have been caused by the former agricultural structure in these voivodships. Before 1990, they were dominated by government-owned farms which subsequently cut jobs or were frequently shut down (see Gorzelak 1998, p. 161; Korcelli 1997, p. 220). The stock of real capital together with manufacturing investment and patent applications were below average. Another obvious weakness seems to be the low supply of paved roads (in table 4 as business-related infrastructure), this showing the lowest figure of all the clusters.

Map 3: Clusters of Polish voivodships



Source: Own calculations.

Table 4: Indicator values of the clusters of Polish voivodships[c]

Indicators (see appendix 1 on the definition)	Rural cluster V1 with a very low economic capability and little potential for growth		Rural and low income cluster V2		Cluster V3 with fairly low economic capability and major labour market problems		Cluster V4 with high economic capability, human capital stock and technical know-how		Manufacturing cluster V5 with a high stock of real capital and low-qualified human capital		Plock	All voivodships
	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Mean value[a]	t-value[b]	Value	Mean value[a]
Regional income	8,544	-0.66	9,743	-0.31	9,926	-0.26	14,848*	1.16	12,000	0.34	23,029	10,822
Industrial wages	1,072	-0.47	1,052	-0.58	1,072	-0.47	1,306	0.74	1,474*	1.61	1449	1,163
General productivity	17,643	-0.99	20,480	-0.51	25,505	0.33	30,033	1.09	28,270	0.80	30,691	23,519
Industrial productivity	84.1	-0.49	100.9	0.04	93.3	-0.20	119.6*	0.62	99.3	-0.02	225.4	99.8
Local authority revenues	298.9	-0.74	325.2	-0.56	418.5	0.09	609.9*	1.42	477.3	0.50	433.3	405.9
Unemployment	12.1	0.04	9.9	-0.50	16.4	1.08	6.8	-1.25	12.9	0.23	14.2	12.0
Net migration	-12.5	-0.64	-5.1	0.13	-8.4	-0.21	8.1	1.54	-8.9	-0.26	-12.9	-6.4
Working population	444.3	0.74	428.4	0.40	353.2	-1.17	418.3*	0.19	385.7	-0.49	425.4	409.1
Level of qualification I	0.3	-0.38	0.3	-0.41	0.4	-0.23	2.1*	1.81	0.2	-0.48	0.6	0.6
Level of qualification II	50.3	1.05	40.8	0.47	22.2	-0.67	14.6	-1.13	25.2	-0.49	40.5	33.2
Students	10.5	-0.38	8.0	-0.51	15.0	-0.13	51.0	1.80	8.8	-0.47	11.9	17.5
Fixed assets	25,901	-0.45	24,246	-0.66	26,499	-0.37	37,887*	1.11	36,734	0.96	41,241	29,328
Industrial investment	5,544	-0.55	7,174	-0.18	6,478	-0.34	8,228	0.06	15,001	1.58	21,286	7,970
Business-related infrastructure	71.3	-0.40	101.8*	0.52	60.1	-0.73	109.1*	0.73	102.7*	0.54	77.6	84.5
Patents	0.4	-0.36	0.2	-0.61	0.4	-0.34	1.9*	1.85	0.5	-0.11	0.6	0.6
Industrial density	66.3	-0.90	89.4*	0.19	87.8	0.11	97.5	0.57	104.6	0.91	78.7	85.4
Size of businesses	1.0	-0.27	1.2*	0.57	1.2	0.52	1.1	0.19	0.8	-1.31	0.9	1.1
Population density	88.1	-0.40	127.2	-0.12	83.6	-0.43	317.8*	1.21	192.3*	0.33	101.9	144.8

a Arithmetic mean value. – b Negative (positive) t-values indicate that, on average, the regions of a cluster have a lower (higher) value at a variable than the entire population. – c Figures with a * have F-values above one. This indicates less homogeneity in the cluster than in the parent population for the indicated variable.

Sources: GUS (Statistical Office of Poland), Stryjakiewicz 1999, S. 175 f., calculation by the IWH.

Another separate *cluster with high economic capability, human capital stock and technical know-how* (V4) is formed from nearly all the voivodships that contain the larger cities.[12] Warsaw can be added here, but with some reservations as it shows extreme values for some of the indicators. In this cluster, all of the income indicators lie above the Polish average, unemployment rates were relatively low and the regions were areas of in-migration. Although the employment level was only average, the supply of human capital was relatively good, as the level of qualification was by far the best of all the clusters. This is reflected by a rate of 51 students per 1,000 inhabitants (17.5 on average) and a coefficient of localisation of R&D employment of 2.1 (0.6 on average). Patent applications suggest a high quantity of technical know-how.

The *manufacturing cluster with a high stock of real capital and low-qualified human capital* (V5) consists of six voivodships to the south and west of Warsaw. Per-capita incomes, productivity and local public incomes were generally above the average of all the voivodships. Though the income situation seemed to be quite good, the voivodships lost a lot of population to out-migration from 1991 to 1998. In addition, unemployment rates were above the Polish average, except in Katowice and Opole. The indicators for human capital suggest a rather unfavourable supply of this production factor, qualifications in particular were much worse than in other regions (see also Gorzelak 1998, p. 56). On the other hand, the real capital supply was well above average and fixed assets and industrial investment far exceeded the mean value of all the voivodships. Other indicators related to mining and manufacturing, such as employment and gross wages and salaries, were also comparatively high. By contrast, patent registrations and the employment share of SMEs with less than 500 employed persons were relatively low. The indicators related to real capital, the industrial base and the labour market in particular point to a predominance of old industrialised regions in V5.[13]

The Plock voivodship closely resembles cluster V5 with a high stock of real capital and a low qualification of the human capital. Due to its extremely high manufacturing turnover of 225,000 zloty per employed person, the high industrial investment figure and the high coefficient of localisation for R&D personnel it was excluded from cluster V5; in control calculations it was also constantly confirmed as a separate cluster. In the outlier analysis it was

[12] A 1995 analysis by J.M. Dabrowski et al. which classified voivodships in terms of the investment climate placed highest those voivodships that correspond fairly well to this cluster V4 (see J.M. Dabrowski et al., cited in Korcelli 1997, p. 226). Gorzelak called them the “definite leaders of transformation” (1998, p. 145). Using industry-related indicators Stryjakiewicz states that the regions grouped together in V4 and three additional regions (Bielsko, Bydgoszcz and Opole) have a high level of industry, a high innovation potential and an adaptable industry-structure (1999, S. 181).

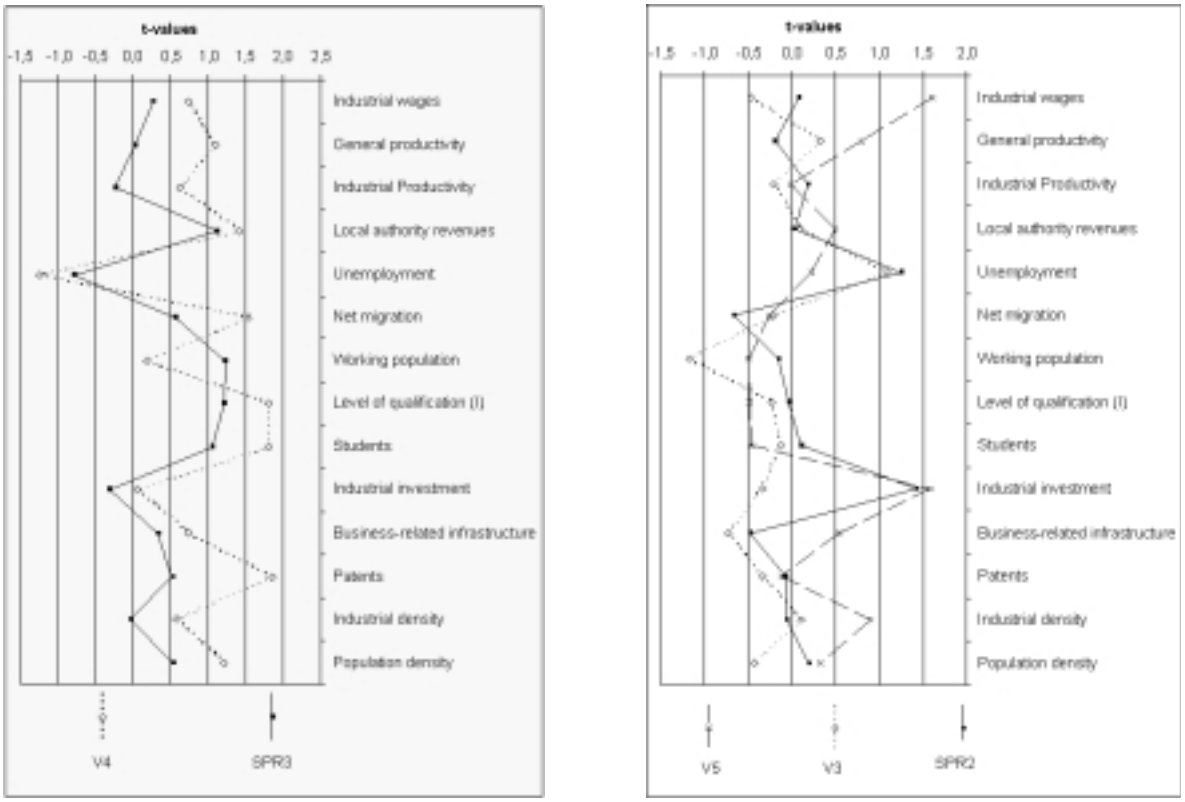
[13] Stryjakiewicz’s analysis which was already mentioned above additionally classifies some more regions among the type of regions that has a high level of industry, a high innovation potential and a low adaptability of industry-structure - Krosno, Rzeszow, Tarnobrzeg, Torun and Walbrzych (1999, S. 181). The differences between both analyses could be due to the broader sectoral range of the present study that also contains indicators that are not directly related to industry.

ranked second after Warsaw and could also have been excluded. The specific values for some indicators are due to the oil refineries in the voivodship.

It is interesting to note that some of the Polish and East German clusters resemble each other at regional level (see figures 5 and 6):

There are fairly large similarities between the East German cluster SPR3 (with a very good supply of human capital) and the Polish cluster V4 (with high economic capability, human capital supply and technical know-how). These clusters had the best economic capability, with low unemployment rates and high population gains from migration, a high level of qualification of the human capital and a high value for the patent indicator. Investment in manufacturing was a little below average in both groups. One striking difference is that the employment level is *relatively high* in the East German cluster SPR3 and *relatively low* in the Polish cluster V4, though the figures per inhabitant only differ by 3 percent (see tables 2 and 4). The industrial density and the manufacturing turnover per employed person also differ but the other way round: here the Polish voivodships of cluster V4 have higher and the East German spatial planning regions of SPR3 lower values.

Figures 5-6: Economic profiles of selected clusters of Polish voivodships and East German regions



Source: Own calculation.

The Polish clusters V3 and V5 and the East German cluster SPR2 also have some points in common. V3 has a similar position to SPR2 in respect to the income indicators and the unemployment rate as well as to some of their determinants (business-related infrastructure, patents and industrial density); both clusters are equivalent to or a little bit below the average for their respective regions as a whole. V5 resembles SPR2 closely in its very high industrial investment, but the incomes, unemployment and industrial density are notably different between these two clusters.

Intermediate results: The Polish cluster with the best economic capability is definitely V4, that is the voivodships containing the major cities. It performs very well for most of the indicators; with regard to the determinants of economic capability this is especially the case for the qualification of human capital and technical know-how. All of the other clusters lag far behind and have major labour market problems (V3) or show a need for comprehensive restructuring of the industrial sector (V5) or the primary sector (V1 and V2 to a lesser extent).

The primary sector is very important for employment, especially in the eastern part of Poland. This is one of the main differences between Poland and East Germany, where even in rural areas the primary sector contains much less than 10 percent of the working population. As the unemployment rate in the lagging behind regions of cluster V1 was already on the Polish average, further job losses in agriculture, for example because of decreasing sales and increasing food imports, may become a significant problem for the Polish labour market.

Compared to the East German spatial planning regions, the Polish voivodships have a high level of employment not only in agriculture but also in mining and manufacturing. Cluster V4, with a comparatively good economic capability, had a higher industrial density than its East German counterpart SPR3, the same holds for V5 compared to SPR2. This could be due to varying national circumstances and histories of market integration. In East Germany, markets were opened up with virtually no transition period, which led to the closure of many manufacturing companies that were not (yet) competitive on an international scale, whilst in Poland the process has taken place step by step. As its markets are opened up further, Poland may – despite large-scale investment – experience an inevitable decline in industrial density, especially in the old industrialised regions.[14] There is also the danger that incomes – which are comparatively high at present – will fall, that unemployment will grow, and that the regions will experience major restructuring problems because of the low level of qualification of the labour force. Bearing this in mind, it is plausible that the results of past research, which established an “L” of economically capable regions from Gdansk via Wroclaw/Legnica towards Krakow (Gorzelak 1998, p. 65), could not be confirmed with newer data. Some of the old industrialised regions are located on the West-East axis of that “L” in particular.

The results of the cluster analyses don’t justify to attribute a leading position in terms of development to the border regions with Germany or a “western belt” of development. There

[14] Some commentators anticipate that this will occur in the Upper Silesia conurbation. On this, see e.g. Gorzelak 1998, pp. 150-151; Korcelli 1997, p. 221.

are rather two poles with Szczecin and the area of Jelena Gora/Legnica, the northern pole seeming to grow and the southern pole to contract in respect to its economic capability. In between, Gorzow and Zielona Gora are faced with the burden of high unemployment. The regions along the western border have undoubtedly been preferred investment locations for foreign, especially German, investors (see Gorzelak 1998, pp. 80-82) and these investment projects have perhaps even increased employment in the manufacturing industries. However, investment has not (yet) triggered any broad effects that would make these regions significantly better off than the other voivodships in the north-west of Poland or Poland on average.

5. Conclusions

A high economic capability corresponds to a high stock of human capital and a relatively good position with regard to technical progress in the East German and Polish regions. The indicators for economic capability (income, unemployment, migration) have relatively good values where the rate of employment and, to an even greater extent, the qualification of human capital and technical know-how are relatively high.[15] On the smaller spatial level of the East German districts these correlations are obscured by other influences which are also reflected in the indicators. For example, the stock of human capital, that correlates positively with migration and negatively with public welfare for the East German spatial planning regions, has a significant but contrary correlation for the districts. This is unlikely to be caused by a lower economic capability of the cities, but rather other, socio-cultural factors. In the case of migration, for example, these could include the preference of out-migrants to live in the countryside, or when it comes to public welfare rates the preference of claimants for the anonymity of a city or a lower willingness to claim public welfare in rural areas. The preferred spatial level for an analysis is therefore one that incorporates the interconnections between cities and the surrounding areas.

The relationships between economic capability and industrial investment, entrepreneurial initiative and the industrial base are ambivalent:

- Neither in Germany nor in Poland are those regions with the highest investment those with the highest economic capability, instead large-scale investment goes hand in hand with fairly high unemployment and population losses due to out-migration. This may be attributable to the fact that a good deal of investment is taking place in the old industrialised regions in order to renew the depreciated capital stock. This has increased productivity but not employment. Of course, this does not mean that the investment should not have been undertaken: the old industrialised regions possibly would be even worse off if it had not. However, under the conditions of transition, the indicators for real capital and investment

[15] Similarly the German Council of Economic Experts *(Sachverständigenrat für die Begutachtung der gesamtwirtschaftlichen Entwicklung)* got the result that East German regions with high economic performance had a good supply of human capital (1999, S. 129).

are clearly poorly suited to indicate anything about the economic capability of regions in the future.

- Entrepreneurial initiative, which could only be included in the analysis of East German regions, has a negative correlation with the income indicators but also with the public welfare rate. This could reflect the explanation for industrial investment, i.e. that the positive labour market effect of the entrepreneurial initiative has but few income effects in the short term. However, in the long term these should be substituted by income increases due to successful and growing enterprises in those regions with a high level of initiative.
- The existence of an industrial base is associated with high economic capability at regional level and for the East German example it is possible to ascertain advantages for a diversified industrial structure. Nevertheless, in both countries the most industrialised regions were not those with the highest economic capability. The service sector is a necessary prerequisite for a high economic capability in addition to the industrial base.

The supply of public infrastructure is connected to economic capability in Germany as well as in Poland. However, it is not clear whether infrastructure increases economic capability or vice versa. This problem of being able to clearly determine cause and effect holds for the other indicators as well and can only be solved using other methods. These require an improved selection of data (in particular covering a longer time period) which is still difficult to obtain in the transformation economies.

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Appendix

Appendix 1: Indicators used in the analysis

	Germany	Poland
Economic capability		
Regional income	–	Gross domestic product per capita (1997, in zloty)
Industrial wages	Gross hourly wage in mining and manufacturing firms of generally 20 or more employed persons (1998, in DM)	Gross monthly wages and salaries per industrial employee (1998, in zloty)
General productivity	Gross value added per member of the working population (1996, in 1,000 DM)	Gross value added per employed person[d] (1997, in zloty)
Industrial productivity	Sales to market per employed person in mining and manufacturing firms with generally 20 or more employed persons (1998, in 1,000 DM)	Sold production of industry per employed person[d] (1998, in 1,000 zloty)
Business revenues	Inter-regionally comparable taxable capacity for trade tax per capita (1997, in DM)	–
Local authority revenues	Local authority income from principal taxes (trade tax, share of income tax, tax on real estate) per capita (1997)	Own revenues of local authorities (especially tax on real estate, receipts from sales of local government property and treasury fee) and share of corporate and personal income taxes per capita (1996)
Unemployment	Unemployment rate on 31/12/1998[a]	Unemployment rate on 31/12/1998
Public welfare burden	Non-institutionalised public welfare claimants per capita (public welfare rate) on 31/12/1997	–
Net migration	Net migration of persons per 1,000 inhabitants (1992-1998[b] accumulated)	Net migration of persons per 1,000 inhabitants (1991-1998 accumulated)
Stock of human capital		
Working population	Yearly average of employed persons per 1,000 inhabitants (1997)	Employed persons per 1,000 inhabitants on 30/09/1998[d]
Level of qualification I	Persons subject to social insurance contributions employed in human capital intensive professions (engineers, chemists, mathematicians, physicists, professionals in the humanities and natural sciences) per 1,000 inhabitants (1998)	Coefficient of localisation of employment in R&D to total industrial employment (1996)
Level of qualification II	–	Share of persons employed in agriculture, hunting and forestry in all employed persons on 30/09/1998[d]
Students	Students at universities and technical colleges per 1,000 inhabitants during the winter semester 1997-98	Students at higher education institutions per 1,000 inhabitants (1996)

continued

Private and public real capital		
Fixed assets	–	Gross value of fixed assets per capita on 31/12/1998
Industrial investment	Investment expenditure in mining and manufacturing firms with generally 20 or more employed persons (per capita in DM, yearly average 1993-97)[c]	Industrial investment expenditure per capita in zloty, total for 1991-98[c]
Business-related infrastructure	Business-related infrastructure investment of local authorities promoted by the joint programme on "Improving the regional economic structure" (German abbreviation: GRW) (per capita in DM, 1990-1997 accumulated)	Hard surface public roads per 100 square kilometres of total area on 31/12/1998 (kilometres)
Technical know-how		
Patents	Patent applications per 100,000 inhabitants (1992-1994 accumulated)	Coefficient of localisation of patents per industrial employee (1995)
Entrepreneurial initiative		
Loans granted to SMEs	Number of (publicly supported) loans granted within the framework of the loan programmes for small and medium-sized enterprises (SMEs) of the *Deutsche Ausgleichsbank* (DtA) and the *Kreditanstalt für Wiederaufbau* (KfW) per 10,000 inhabitants (1990-1997 accumulated)	–
Net business registrations	Net business registrations per 10,000 inhabitants (1993-1997 accumulated)	–
Industrial base		
Industrial density	Employed persons subject to social insurance contributions working in the mining and manufacturing industries (per 1,000 inhabitants, 1998)	Industrial employees per 1,000 inhabitants on 30/09/1998[d]
Coefficient of industrial specialisation	Coefficient of specialisation in mining and manufacturing industries (based on the share of employed persons in 55 industries found in the employment statistics, see appendix 2 for the calculation) (1998)	–
Size of businesses	–	Coefficient of localisation of employment in industrial firms with up to 500 employed persons to total industrial employment (1994)
Additional indicator (only for cluster description)		
Population density	Inhabitants on 31/12/1997 per square kilometre	Inhabitants on 31/12/1997 per square kilometre

a For spatial planning regions, June 1998. – b For administrative districts and towns outside of districts, 1997. – c In the Land Saxony, 1994-97. – d Excluding budgetary entities of the Ministries of National Defence, the Interior and Administration and the Office of State Protection.

Source: adapted from Barjak, Franz, Heimpold, Rosenfeld 2000.

Appendix 2: Calculation of the coefficient of specialisation

The coefficient of specialisation CS_i compares the concentration of m industries in a sub-region i with the concentration of these industries in the entire region to which i belongs. The smallest value 0 points to a complete congruence of the industrial structure of the sub-region with that of the entire region. The bigger CS_i becomes, the more specialised the sub-region is.

The commonly used method of calculation (see for example Schätzl 1994, p.65) was supplemented with a weighting factor in this case due to the heterogeneity of the aggregation of industries within the sample. The method of calculation used is as follows:

$$CS_i = 100 * \sum_{j=1}^{m} \left(\frac{L_{ij}}{\sum_{j=1}^{m} L_{ij}} * \left(\frac{L_{ij}}{\sum_{j=1}^{m} L_{ij}} - \frac{\sum_{i=1}^{n} L_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{m} L_{ij}} \right)^2 \right)$$

With:

L_{ij}	Employment in industry j in sub-region i
$\sum_{j=1}^{m} L_{ij}$	Total employment in sub-region i
$\sum_{i=1}^{n} L_{ij}$	Employment in industry j in the entire region
$\sum_{i=1}^{n} \sum_{j=1}^{m} L_{ij}$	Total employment in the entire region

Appendix 3: Calculation of t- and F-values of the clusters (see Backhaus, K. et al. 1993, pp. 310-311)

t-value of variable v:

$$t_v = \frac{\overline{X}_v^C - \overline{X}_v}{\sqrt{Var_v}}$$

F-value of variable v:

$$F_v = \frac{Var_v^C}{Var_v}$$

$\overline{X}_v^C$ mean of variable v in cluster C

$\overline{X}_v$ mean of variable v in the entire population

Var_v^C Variance of variable v in cluster C

Var_v Variance of variable v in the entire population