

Blien, Uwe; Tassinopoulos, Alexandros

Conference Paper

Forecasting Regional Employment with the ENTROP Method

39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Blien, Uwe; Tassinopoulos, Alexandros (1999) : Forecasting Regional Employment with the ENTROP Method, 39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/114395>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Uwe Blien

Alexandros TASSINOPOULOS¹

Institut fuer Arbeitsmarkt- und Berufsforschung
(Institute for Employment Research - IAB)

Postfach, D-90327 Nuernberg,

Tel.: +49-(0)911-179-3035 or -3269; Fax: +49-(0)911-179-3297

Email: Uwe.Blien@iab.de; Alexandros.Tassinopoulos@iab.de

Related theme: 'Regional migration and labour markets'

Forecasting Regional Employment with the ENTROP Method

Paper prepared for presentation at the European Congress of the Regional Science Association, Ireland; August 23-27 1999

Abstract:

Forecasting methods require the identification of causal processes and stable trends. Here a combination of top down and bottom up methods is used to estimate the development of employment in all 327 (western) German districts for a time span of two years.

In a first step, employment is forecasted independently according to several dimensions (type of region, industry and federal state), which are selected according to theoretical considerations. The results are used to generate a forecast additionally based on autonomous trends of the respective regions and on experts' judgements about singular developments. The different sources of information are combined using the ENTROP method.

ENTROP is an entropy optimizing procedure, a generalization of common RAS-techniques, newly developed for the estimation of matrices from heterogeneous information. In a defined sense the estimated matrix is the most probable one. The method chosen uses any available information extensively. Therefore, the estimates are reliable, as is shown in an ex-post forecast.

There is a double purpose for the forecast of employment: first, it helps to gain insights in the causal processes generating regional developments and regional disparities on labour

¹ Friedrich Graef (Institute for Applied Mathematics at the University of Erlangen-Nuernberg) is thanked for his work in the development of the ENTROP method and for his help in its application. The responsibility for the analysis remains with the authors.

markets. Second, it is useful for the bugetary planning of the Federal Employment Services. Then, the assignment of money to the local units of this administration can be done according to current and future labour market developments.

1. The basic approach

The institutions carrying out labour market policy in Germany (the Federal Employment Services, the Ministry of Labour and the local institutions of the state) and in other countries continuously demand forecasts about the labour market. Statistical information is only available with a lag. Therefore, the allocation of money to the various programs and regions is based on information about the past. To counteract imbalances on the labour market, however, information about the future is necessary, which is only available from forecasts.

There is also a scientific motivation to develop forecasts. It is due to the fact that forecasts include the identification of stable trends and of causal processes extended from the past or the present to the future. Both motivations, that related to labour market policy and that concerning scientific explanations, are relevant in the present context, which deals with regional forecasts of employment in western Germany for a time horizon of two years.

The technique chosen here is a mixture of following trends and of identifying causal structures. Some stable trends are used for the projections of basic economic variables, e. g. for the future development of the structure of industries. On the other hand, employment in a region is seen as being determined by the same basic variables, by the type of the respective region, the industry structure and the development of larger regional units.

The technique used is a combination of top down and bottom up methods. On the one hand, in the forecast of the employment for 1999 for the 327 districts (Stadt- und Landkreise) of western Germany, autonomous developments of these regional units are relevant. On the other hand, a projection of global employment is broken down into small regional units. There are global influences affecting employment in all regions in nearly the same way, for example the interaction of the business cycle with the institutions of the Federal Republic of Germany. Apart from this, spatial autocorrelation is important. There are spill-overs from the economic activity in one region to the activity of adjacent regions. It can be argued that the global component of regional development is of special relevance in Germany (with the exception that it is always necessary to discriminate between the western and the eastern part of the country), since important economic processes affect the whole country. Wage bargaining for example is rather centralized, since it takes place at the level of industries, not at the level of regions or of firms. Therefore, it would be misleading to realize a forecast for the country on the basis of regional information only.

The contrary would also be misleading, since it is not possible to see regional developments as entirely determined by general influences. Large variation in the level of local unemployment rates indicates large disparities on regional labour markets. The unemployment rate (average for the country for 1997) in western Germany was 10.8 % with the extreme values of 4.4 % (district of Erding) and of 20.1 % (district of Bremerhaven). It is therefore necessary to identify the sources of this variation and to supplement the top down method by bottom up strategies.

For the top down part of the forecast three dimensions are identified that are regarded as crucial for the development of employment, according to theoretical considerations. These dimensions concern the industries present in a region, the type of the region and the larger area it belongs to. The importance of the industrial structure is known from the bulk of literature on shift-share analyses (Braun 1969, Holden et al. 1989, Patterson 1991, Selting 1994). The business cycle affects different industries in differing ways. Especially manufacturing reflects slumps and peaks in the demand on the world market to a greater extent than the service sector of the economy.

The business cycle of an industry is synchronized because of spill-over effects. An especially interesting example is Germany's automobile industry. Phases of relatively good competitiveness compared to car production in other major countries (e. g. in Japan) are followed by phases of relatively low productivity and falling shares in sales on the world market. Though the performance of the individual companies in a country differs, there is a common trend affecting all car producers. The spill-over effects between the companies are described in general terms by the new growth theory (Lucas 1988, Romer 1986) and in more detail by evolutionary economics (Nelson, Winter 1982, Dodi, Nelson 1994, Nelson 1995). The growth perspectives of industries also differ as can easily be seen from the growing share of employment which is absorbed by the service sector and is described as tertiarization of the economy.

Another basic dimension of employment development which is used in the forecast is a typology of the regions, which is defined here by a cross-tabulation of centrality and population density. The relevance of the type of the respective region can be seen from current discussions of urban economics e. g. about the decline and recovery of the large cities. In Germany, as will be shown below, differing types of regions are markedly different and show markedly stable developments.

The third relevant dimension concerns the larger regional unit, i. e. the federal state of which a small region is a part. It is important to look at large areas, since there are spill-overs between adjacent small regions, which produce spatial autocorrelation. Again, theoretical arguments can be taken over from new growth theory. Additionally older arguments from the theory on growth poles and on polarization effects (e. g. due to Myrdal and Kaldor) and newly popularized ideas from Krugman's trade theory (1991) can be used. In trade theory, the location of a region is important. If it is close to areas established as centers of production in a specific industry there are positive effects on its development. This can be due to labour market pooling, technological spill-overs and the use of common intermediate products. Finally, the importance of the proximity of a region to the sources of supply and demand is considered by location theory (cf. Puu 1997 for a recent overview).

Information that can be exploited for the forecast ends mainly in 1997, so the time horizon is two years. The methods used are centered around a special entropy-optimizing procedure called ENTROP and developed for the purposes of the IAB. It is the first time that it has been applied in a forecast. Since the method has the advantage of extensively taking into account any available information it is preferable to standard shift-share or regression techniques.

2. Data

The data used in the forecast is from the employment statistics of western Germany. The data base is not a sample; it comprises a sequence of complete cross-sections of all people employed on any 30 June of the period between 1987 and 1997 (statistics based on location of the workplace).

The employment statistics include information about the entire population of people in gainful employment and covered by the social insurance system, i. e. about 80% of all employment in Germany. Two main groups of people whose data is not included are civil servants and workers with an income lower than DM 620 a month.

The employment statistics give continuous information on employment spells, earnings, job and personal characteristics. It is based on microdata delivered by individual firms about their individual employees. For every employee a new record is generated every year. The same is done if he or she changes establishment. From 1975 to 1995, over 600 million records about

the employment of individual workers are included in the files of the Federal Employment Services (Bundesanstalt für Arbeit, see Bender et al. 1996).

Originally, the data was collected for administrative purposes of the social security system. Since they are used to calculate the pensions of retired people, the income and duration information is very reliable. No problem of recalling from memory and reporting is encountered, as is the case in population surveys.

Since the employment statistics contain detailed regional information, an assessment of regional employment is possible. Every employed person is registered at his or her place of work. Several additional variables are available. Here the information about the respective industry is used. This variable has 11 categories (cf. Table 1) The classification of industries follow the work on structural change (Dietz 1988) and has the advantage of separating in particular the various components of the service sector. The evaluation of the data of the tertiary sector showed that the overall gains are not equally distributed among all types of services. Especially the financial services and the services for the society (e.g. education, health service, research) show - in contrast to other types - a relative increase of people employed in their area. This implies a crucial differentiation between the types of service in order to forecast the growing importance of this sector with more accuracy. To control for industry-specific business cycles the forecast is based on a calculation of the prospects of each industry.

Table 1: Selected categories of regional development

I. Federal States:

| | |
|--------------------------------|----------------------------------|
| 1. Schleswig-Holstein/ Hamburg | 5. Rhineland-Palatinate/Saarland |
| 2. Lower-Saxony/Bremen | 6. Baden-Württemberg |
| 3. North Rhine-Westphalia | 7. Bavaria |
| 4. Hesse | |

II. Industries (IAB-typology):

| | |
|---|--------------------------|
| 1. Primary sector | 7. Construction |
| 2. Energy/Mining | 8. Distributive Services |
| 3. Goods-producing industry | 9. Financial services |
| 4. Capital goods | 10. Household services |
| 5. Consumer goods | 11. Services for society |
| 6. Manufacture of food products and beverages | |

III. Type of county (BfLR/BBR-typology):

| | |
|-------------------------------------|-------------------------------|
| A. Regions with urban agglomeration | 1. Central cities |
| | 2. Highly urbanized districts |
| | 3. Urbanized districts |

| | |
|--|-------------------------------|
| B. Regions with tendencies towards agglomeration | 4. Rural districts |
| | 5. Central cities |
| | 6. Highly urbanized districts |
| | 7. Rural districts |
| C. Regions with rural features | 8. Urbanized districts |
| | 9. Rural districts |

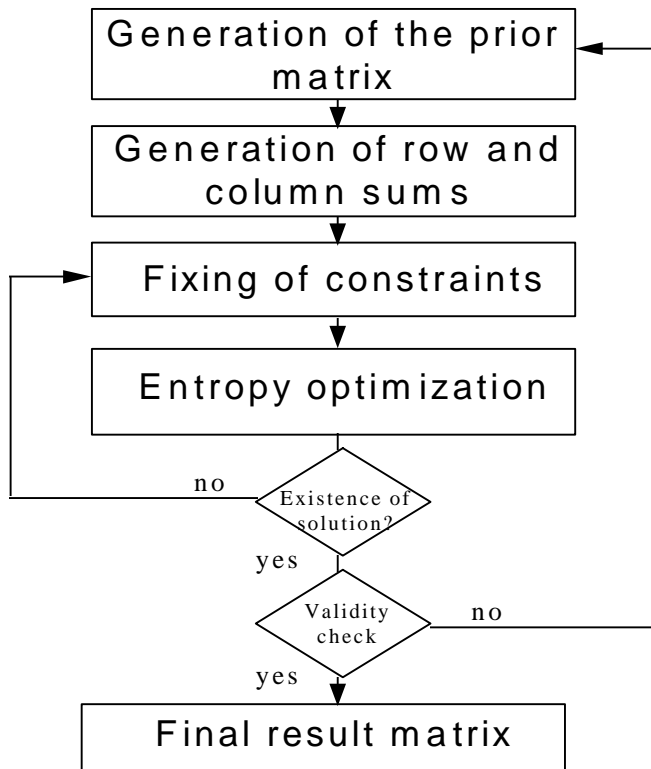
Additionally, a categorization of the respective region is used. Each of the 327 districts is classified according to a scheme developed by the BBR (Bundesanstalt für Bauwesen und Raumordnung, Bonn, former name: Bundesforschungsanstalt für Raumordnung und Landeskunde, BfLR). The classification (Görmar, Irmen 1991) uses a cross-tabulation of two dimensions: centrality and population density (cf. Table 1). It is known that this classification describes many dimensions of regional disparities with a surprising accuracy (Blien, Mederer 1998). The types of regions gained from it are correlated with local price and wage levels. The rates of employment growth differ markedly between these types (Tassinopoulos 1996). Shift-share analyses show that the BfLR/BBR-categorization creates relatively homogeneous groups. Especially shifts of employment which are caused by suburbanization effects (Seitz 1995) are to be considered for regional forecasts.

The third selected dimension concerns the federal states. There are ten of them in western Germany.

3. The making of the forecast

The regional forecast is aimed at the development of regions relative to the development of employment in the entire country of western Germany. The absolute figures of employment are used for the calculations, but they are not reported. Therefore, it is possible to avoid the effects of the business cycle to some degree. The calculation of the forecast requires several steps which are explained below in the context of the forecast for 1999. The combination of the single steps can be seen from Figure 1.

Figure 1: The steps of the forecast



The single steps of the forecast are:

a) Calculation of autonomous regional trends ("Generation of the prior matrix"): it is known that regions follow relatively autonomous trends, which cannot be reduced to developments of industries and show up in the locational component of shift-share analyses (cf. Tassinopoulos 1996 for western Germany). Therefore, in a first step a matrix \mathbf{R} for 1999 is generated which is a cross-tabulation of the 11 industries and the 327 counties of western Germany and shows the distribution of employment according to the current employment trend in the individual regions. The single elements r_{jk} of the matrix \mathbf{R} are obtained in the following way:

$$r_{jk}^{99} = m_{jk}^{97} \left(1 + 0,5 \ln \left(\frac{m_{jk}^{97}}{m_{jk}^{93}} \right) \right) \quad (1)$$

In this equation the m_{jk} are elements of matrices \mathbf{M} with data about past employment. 97 and 93 indicate the years 1997 and 1993, j is an index for the region, k for the industry.

This procedure takes elements of a bottom-up approach into account, since individual regional employment trends in defined industries are used.

b) Inclusion of trends for industries, region types and federal states ("Generation of row and column sums"): it is not sufficient to base the forecast solely on the regional trends. These trends partly reflect special developments of the recent past, which are not stable and should not be extended to the future.

Instead, global trends are additionally used to determine the development of the regions. The employment in a single region is at least partly determined by its industry structure, its type and the development of surrounding regions. Especially the trends for the region types are remarkably stable (cf. Figure 2a, 2b). To include spatial autocorrelation the federal states are used (small states are combined with neighbouring large states). This construction implies the advantage of including differences in regional economic policies between the federal states. The third dimension which is regarded as important is the industry structure, normally used in shift-share analyses.

For all the categories of the three dimensions shown in Table 1, trends are estimated for the proportion of people employed in the particular status. The estimation of the trends is done by simple linear regression analyses using the first differences between years. In most cases stable trends were observed. These cases led to a 1999 projection of their relative share of employment of the federal state, the industry employment and the employment in each type of county.

Since the extrapolation of employment according to the three stated dimensions is done for proportions only, it is necessary to use a forecast for global employment in addition. Based on a general macro-forecast (source: Autorengemeinschaft 1998, IAB) of the expected growth of employment for 1997-1998 $M_{98\text{prog}}$ the number of total people employed in each category (federal state/type of region) is calculated. The result was used to generate $M_{99\text{prog}}$.

Because of individual unstable trends, several industries are combined into 5 groups: primary sector, manufacturing, manufacture of food products and beverages, construction and services. Since the size of total employment is taken over from an external source, the proceeding of the forecast includes a top down element.

c) Inclusion of heterogeneous information ("Fixing of additional constraints"): from various sources information is available which refers to a more recent date than most of the data included. Additionally, since information is available about special developments in particular industries in particular regions, it is necessary to correct the forecast to take into account these special pieces of information. In some cases the global figures for the trends calculated in step b) have to be corrected in order to be consistent. Finally, it is necessary to include restrictions in the forecast to rule out developments which can be regarded as improbable or very unlikely. Examples of this kind are relations between the growth rates of differing industries.

In most cases these additional restrictions on the results of the forecasts can be given the form of linear equations or linear inequalities. This is another element of a bottom-up approach.

d) Entropy optimization and check of results: The problem of obtaining a forecast can be formulated as follows: The aim is to estimate a matrix \mathbf{X} with regions indexed by j ($j = 1 \dots 327$) and industries indexed by k ($k = 1 \dots 11$) for 1999 on the basis of a matrix \mathbf{R} which has the same dimension and represents the trends for the individual regions (equation 1). The results based on global trends estimated for three dimensions (type of region, industry, federal state) can be expressed as sums over elements of the matrix \mathbf{X} .

The general case reads:

$$\sum a_{iz} x_i \leq b_z \quad (2a)$$

In our case is

$$b_k^{(1)} = \sum_{j=1}^{327} x_{jk} \quad \text{sum over regions for every industry } k, (k=1 \dots 11). \quad (2b)$$

$$b_f^{(2)} = \sum_{j \in F_f} \sum_{k=1}^{11} x_{jk} \quad \text{sum over regions which are part of federal state } F_f, \quad (2c)$$

$$F_f = \{ j \mid j \text{ in the federal state } f \} \quad f=1,2,\dots,7.$$

$$b_p^{(3)} = \sum_{j \in P_p} \sum_{k=1}^{11} x_{jk} \quad \text{sum over regions which are classified into type } P_p \quad (2d)$$

$$P_p = \{ j \mid j \text{ of type } p \} \quad p=1,2,\dots,9.$$

All the types of b_z are obtained by extending the global trends from the past to the year 1999.

The heterogeneous information about matrix \mathbf{X} , specified in step c, can be given the form of general linear equations and inequalities. The problem of obtaining a forecast can then re-stated as an optimization problem. If a distance function between the elements of \mathbf{X} and \mathbf{R} is defined,

this measure can be minimized to preserve as much of the information incorporated in the trends of single regions as possible. The minimization has to be done subject to the restrictions (4) and further linear equations and inequalities specified in step c. Therefore, the forecast problem can be redefined as follows:

$$\text{Min: } d = d(\mathbf{X}, \mathbf{R}), \quad (3)$$

$$\text{subject to: } b_{1z} \leq \mathbf{x}' \mathbf{a}_z \leq b_{2z} \quad \text{for some } z = 1 \dots Z. \quad (4)$$

Here d is the distance function between \mathbf{X} and \mathbf{R} . The vectors $\mathbf{x} = \text{vec}(\mathbf{X})$ are formed by stacking over the columns of \mathbf{X} . For all elements x_{zjk} which are not included in the specific restriction, the corresponding coefficients $a_{zjk} = 0$. The b_1 and b_2 are the boundaries in linear inequalities. They are equal if the restriction z represents an equation like (2b-2d). To obtain a forecast a distance function d has to be specified and minimized. The form of d , the properties of the algorithm and the properties of the solution are discussed in the following section.

The restrictions indexed by z have to be consistent. If they are not, they have to be redefined until a solution could be calculated (cf. Figure 1). The second crucial question is whether the solution produced is compatible with external knowledge about regional development. At this stage intense experience of the forecaster is demanded. Comparisons based on the knowledge of regional case studies have to be taken into account. It is necessary to collect information from external regional experts to explain striking results of some regions. Singular developments (e. g. due to the closure of a large plant) in some regions, which can not be expected to last in the future, should be identified, e. g. seen from trend matrix \mathbf{R} . In these cases single elements of \mathbf{R} have to be altered. This intervention has to be carried out for all counties for which a too optimistic or too pessimistic estimated trend is visible.

This check of results as well as the alternation of constraints and the modification of the matrix \mathbf{R} is repeated in loops until the forecast is compatible with all available information (cf. Figure1).

4. The ENTROP method

The procedure used to solve the problem of optimization under the constraints (4) is the ENTROP algorithm. The distance function to be minimized is the relative entropy, which has some advantages in the forecast problem and in related cases. Entropy optimizing methods have a long tradition in information theory and statistics (Shannon, Weaver 1949, Kullback 1968) and especially in regional sciences, where they have been used extensively in gravity models (Wilson 1970, cf. Batten, Boyce 1986 and Batten 1983).

From a different point of view, the ENTROP method is one of a class of procedures designed to solve problems which are called "inverse" (cf. Golan, Judge, Miller 1996). A basic equation of an inverse problem could be the following:

$$\mathbf{y} = \mathbf{X}\mathbf{b} \quad (5)$$

If \mathbf{y} and \mathbf{X} were given and we added an error term, (5) would be an ordinary regression equation. However, in an "inverse" problem, the matrix \mathbf{X} is not known and the vectors \mathbf{y} , \mathbf{b} are given. Since, normally, \mathbf{X} has more entries than both vectors elements, no deterministic solution is feasible. If there are assumptions available concerning the structure of \mathbf{X} , it could be estimated using \mathbf{y} and \mathbf{b} .

In the present case a matrix \mathbf{R} is used which incorporates some information about \mathbf{X} . A distance measure is calculated and the estimation of \mathbf{X} is done by minimizing the distance between \mathbf{X} and \mathbf{R} . The prior matrix \mathbf{R} represents additional information about the matrix to be estimated. In a sense which will become clearer soon the estimated matrix is 'similar' to the prior matrix. A form of constrained optimization is applied in order to secure that the result satisfies (1).

In the present case \mathbf{R} is the matrix of employment gained by following the autonomous regional trends. The single equations of (5) form restrictions \mathbf{X} has to satisfy. In fact, we need a generalization of (5), since the restrictions are not only equations but also inequalities:

$$b_{1z} \leq \mathbf{x}'\mathbf{a}_z \leq b_{2z} \quad \text{for some } z = 1 \dots Z \quad (6)$$

The distance measure between the basis matrix \mathbf{R} and \mathbf{X} chosen here is the relative entropy:

$$d = E_R(\mathbf{X}) = \sum_{i=1}^I x_i \ln \left(\frac{x_i}{r_i} \right) \quad (7)$$

Here the index i represents the index pairs of j and k . The estimation of \mathbf{X} is done in minimizing (3), subject to the restrictions (6). Blien, Graef (1998) give an overview of the properties of the resulting \mathbf{X}_E :

- *"Maximization of probability"*: if the entries of the prior matrix are normalized by the sum $\sum_i r_i$ they can be regarded as "a priori probabilities" for the distribution of units over the entries of \mathbf{X} . If the probability P_x of a specific matrix \mathbf{X} can be described by a multinomial distribution, the matrix \mathbf{X}_E gained by maximizing E_R maximizes P_x . This results from the general property that the minimization of the relative entropy E_R is approximately equivalent to maximizing P_x .
- *"Conservation of structure"*: small (large) elements r_i are represented by small (large) x_i which corresponds to the same fixed i .
- *"Conservation of zeros"*: elements i which are zero in the basis matrix \mathbf{R} are zero in the resulting matrix \mathbf{X}_E .
- *"Equivalence to a weighted least squares estimate"*: It can be shown that the minimization of the relative entropy E_R is approximately equivalent to an estimate based on a minimization of a sum of weighted squared differences (χ^2 - statistic) (cf. Kadas, Klafsky 1976):

$$c^2 = \sum_i \frac{(u_i - w_i)^2}{w_i} \quad (8)$$

with

$$u = \frac{x_i}{\sum_j x_j} \quad w = \frac{r_i}{\sum_j r_j}$$

Therefore, the decision to solve the problem at hand by optimizing the relative entropy has some advantages.

There are many possibilities to find the optimum \mathbf{X}_E of E_R , but it is necessary to avoid computationally demanding procedures. To solve large problems for matrices with about 30,000 entries a special algorithm has been developed which is called the ENTROP method (Blien, Graef 1998). It uses F. Graef's generalization of an optimization algorithm proposed by Bregman (1967), Censor & Lent (1981) as a crucial element. The method was designed to estimate transition matrices in the Educational Accounting System (Bildungsgesamtrechnung - BGR) of the IAB (cf. Blien, Tessaring 1992).

The algorithm is an iterative procedure. Its starting values are:

$$x_i = r_i e^{-l} \quad \text{for all } i \quad \blacksquare$$

and

$$\mathbf{m}_z = 0 \quad \text{for all } z. \quad \blacksquare$$

Each step in the iteration process includes the following operations:

i. Computation of the entropy-projection on the z^{th} restriction: compute a $\delta\mu_z$ so that:

$$\sum_i a_{zi} x_i e^{d\mathbf{m}_z a_{zi}} = b_z \quad \blacksquare \quad (9)$$

ii. Correction of the sign: if $\delta\mu_z > \mu_z$, set $\delta\mu_z = \mu_z$.

iii. Updating the values for x_j and μ_z :

$$x_i := x_i e^{d\mathbf{m}_z a_{zi}} \quad \blacksquare \quad \text{for all } i \quad (10.1)$$

$$\mathbf{m}_z := \mathbf{m}_z - d\mathbf{m}_z \quad \blacksquare \quad (10.2)$$

The μ_z are the dual variables associated with each restriction z .

The algorithm is a generalization of the RAS-method (which is identical to the iterative proportional fitting algorithm IPF of statistics) often used in input-output analysis and especially in regional sciences (cf. Bacharach 1965). The steps carried out in ENTROP are identical to those performed in RAS if the only restrictions on \mathbf{X} are row and column sums.

5. Discussion of the results

In Figure 1 the individual steps in the forecast are translated into operations (put in brackets) carried out within the ENTROP procedure. To test the reliability of the results an ex post forecast for 1995 is calculated. In this case no additional corrections according to step c) are carried out in order to have the best possible conditions for the reliability of the method. Some of the trend extrapolations are slightly altered to simulate the influx of external knowledge, available at the time of the ex post forecast. A mean squared error is used to assess the quality of this forecast:

$$MSE = \sum_j \frac{(w_j^{95f} - w_j^{95})^2}{w_j^{95}} \quad (11)$$

with: w_j^{95} : proportion of people employed in county j in 1995 (real),

w_j^{95f} : proportion of people employed in county j in 1995
(forecast).

The mean squared error of the ex post forecast is smaller than that obtained with a simple trend (1991 to 1993 extended to 1995). The figures are 0.00052 to 0.00098. Therefore, it can be concluded that the method used for the forecast is a reliable one. The same conclusion was drawn in an ex post forecast for the regions of eastern Germany, which was carried out as a first test of the method chosen (Blien, Graef 1996).

The results of the forecast for 1999 are shown in Table 2 and Figure 3. Figure 3 (the map) shows that in the western part of Germany changes of labour market disparities are of a relatively low scale. It can be seen that especially in the western part of the country further problems are to be expected. Here, the regions of the Ruhr area, which have an obsolete industry structure and reveal high unemployment rates, will have a further reduction in employment. For Baden-Württemberg in the southeast of the country the times of high growth rates will probably not return, while prospects are relatively favourable for the Bavarian regions and - this might be a surprise - for parts of the north of western Germany.

Of course, the forecast is produced under the assumption that no structural changes occur. Another limitation is that the forecast is based on aggregate data. Especially in a market economy, which is based on the decentralized decisions of people only ex post synchronized by the market, the inclusion of the individual decision processes is important. Therefore, it would be interesting to develop a forecast in a multilevel structure (Blien 1995, 1996) integrating information about labour markets with data about individual economic agents. At the moment this technique is not available for the projection of regional employment.

Apart from these limitations there is a basic one concerning all attempts to assess the future behaviour of people. Since human beings are able to make their own decisions, they might be able to decide differently in identical circumstances. This element of a "free will" is hardly taken into account in economic reasoning. If a free will exists (researchers who try to model artificial intelligence debate this point, cf. Penrose 1989 and 1997) forecasts are affected by an additional source of fluctuation.

6. Conclusion

Though the limitations mentioned above might be relevant, the results of the forecast using the ENTROP method give useful insights. This technique provides improvements compared with standard methods, such as an estimation based solely on trend extrapolations. The ex post forecast shows the advantage of the method based on entropy optimization.

By using this forecast technique it might be possible to improve the allocation of the funds of labour market policy to the regions of the country. The IAB is involved in the process of calculating indicators which reflect the current problems on local labour markets. The distribution of funds for active labour market policy (in 1998 about DM 25 Billion, cf. Blien

1998) is done according to these indicators. They might be calculated in the future by using this forecast of regional employment.

Besides the political purpose the identification of stable trends done in the preparation of the forecast is helpful for purely scientific interests, since it improves our understanding of the development of regional labour markets.

Figure 2a:

Annual change (difference of percentage points) of the proportion of people employed in district types (typology of the BfLR/BBR) on West-Germany: 1988-1997 with the forecast for 1999

(Source: employment statistics of the Federal Employment Services - (West) Germany, Berlin excluded, own calculations)

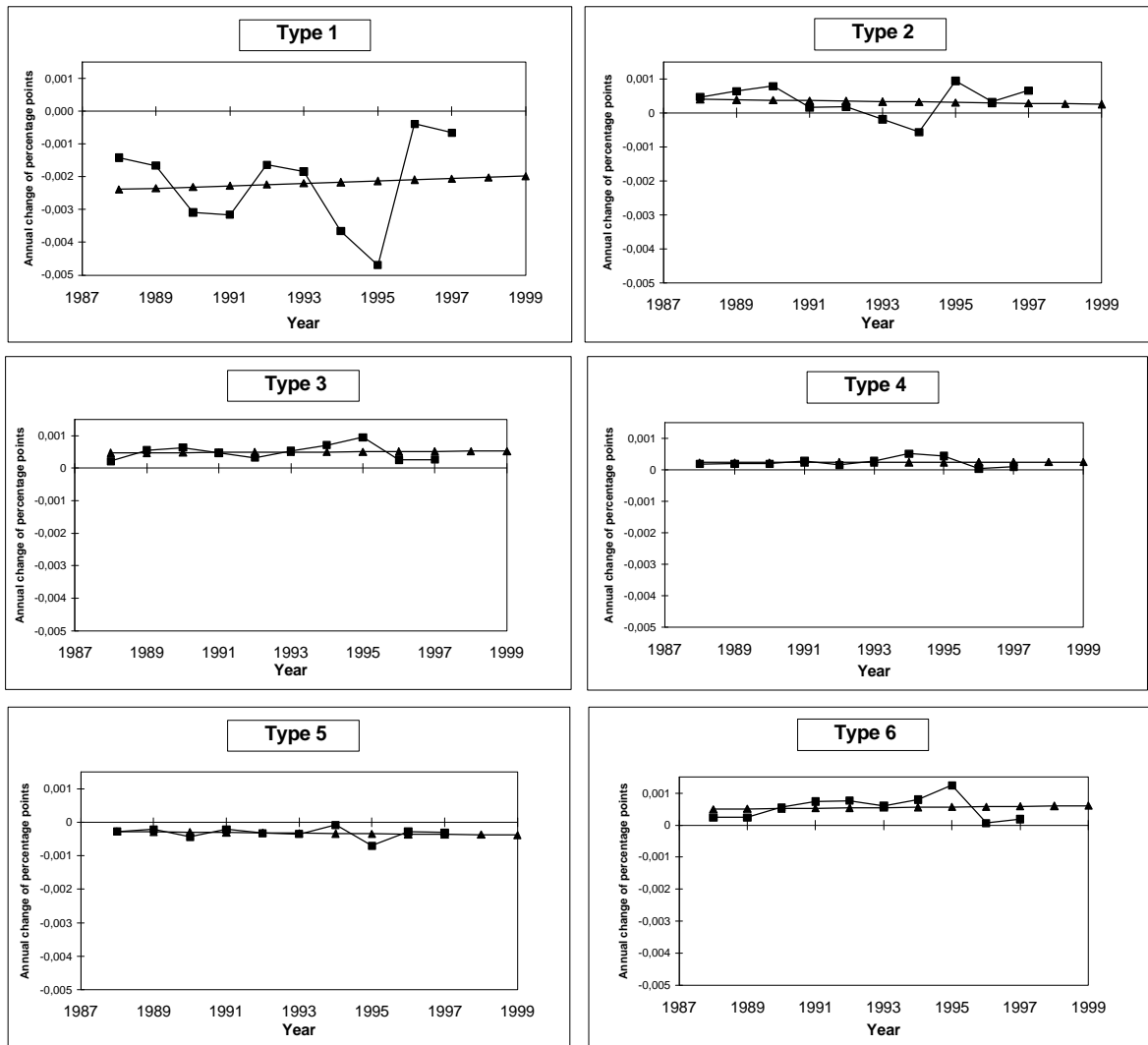
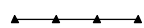
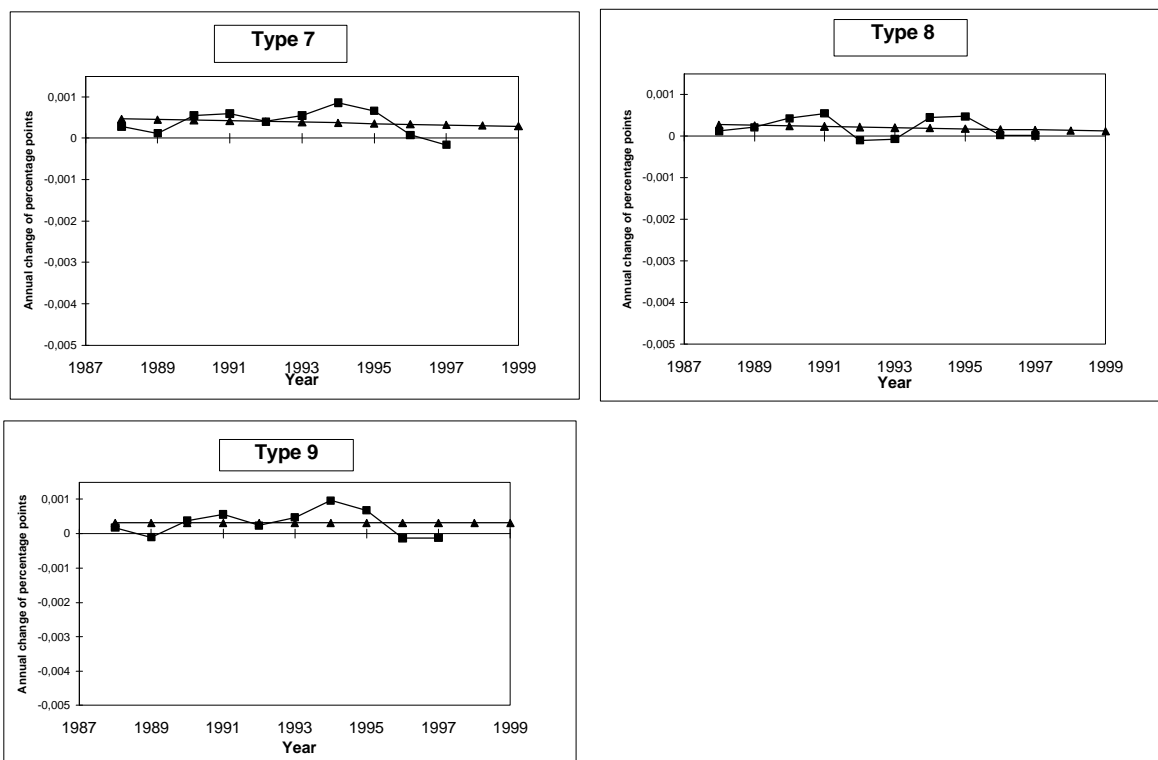
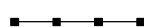


Figure 2b:



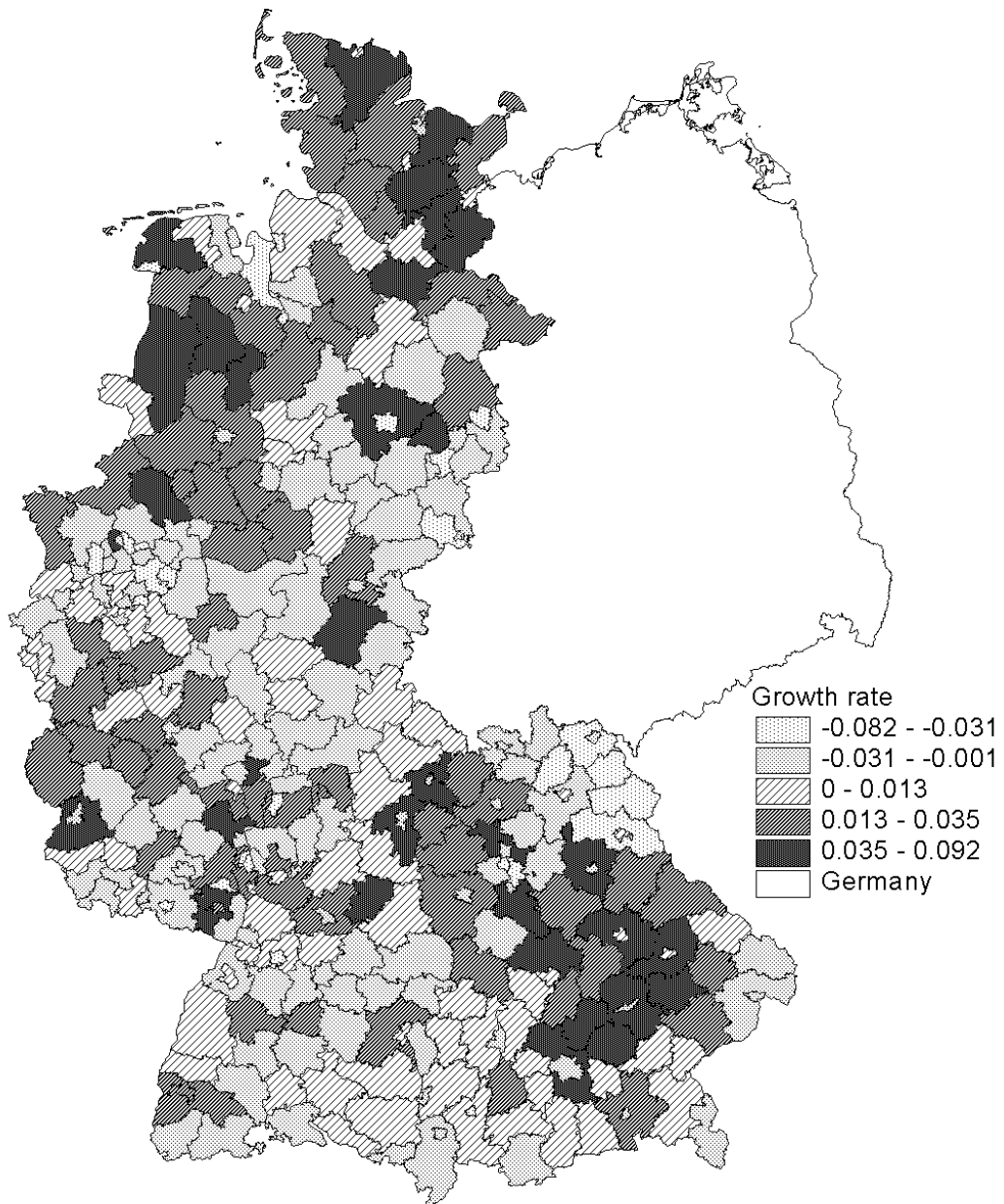
linear regression analysis



proportion of people employed in each type of region on total employment of West-Germany (Berlin excluded)

Figure 3:

Forecast of the Regional Structure of Employment - Growth Rate of Relative Employment 1997/99 -



References:

- Autorengemeinschaft (1998): "Der Arbeitsmarkt in der Bundesrepublik Deutschland in den Jahren 1997 und 1998"; in: Mitteilungen aus der Arbeitsmarkt- und Berufsforschung 1: 5-57
- Bacharach, M. (1965): "Estimating Nonnegative Matrices from Marginal Data"; in: International Economic Review 6: 294-
- Balderjahn, Ingo; Mathar, Rudolf; Schader, Martin (1998) (Eds.): "Classification, Data Analysis, and Data Highways"; Berlin et al.: Springer
- Batten, David F. (1983): "Spatial Analysis of Interacting Economics"; Boston et al.: Kluwer-Nijhoff
- Batten, David F.; Boyce, David E. (1986): "Spatial interaction, transportation, and interregional commodity flow models"; in: Nijkamp (1986)
- Bender, Stefan; Hilzendegen, Jürgen; Rohwer, Götz; Rudolph, Helmut (1996): "Die IAB-Beschäftigtenstichprobe 1975-1990. Eine praktische Einführung"; Beiträge zur Arbeitsmarkt- und Berufsforschung 197, Nürnberg: Bundesanstalt für Arbeit
- Blien, Uwe (1995): "The Impact of Unemployment on Wage Formation. Estimating Wage Curves for Western Germany with Multilevel Linear Models"; in: Gerlach, Schettkat (1995)
- Blien, Uwe (1996): "The wage curve in Germany 1981-1990. A multilevel analysis with the IAB Employment Sample"; paper presented at the EALE Conference at Chania
- Blien, Uwe (1998): "Die regionale Mittelverteilung für den Eingliederungstitel: Politikberatung des IAB für Zwecke der Steuerung von Maßnahmen der aktiven Arbeitsförderung"; in: Mitteilungen aus der Arbeitsmarkt- und Berufsforschung (forthcoming)
- Blien, Uwe; Graef, Friedrich (1996): "Die Ermittlung und Prognose regionaler Beschäftigung mit dem ENTROP-Verfahren. Eine Anwendung auf Arbeitsmärkte in Ostdeutschland"; in: Seminarberichte der Gesellschaft für Regionalforschung
- Blien, Uwe; Graef, Friedrich (1998): "Entropy Optimizing Methods for the Estimation of Tables"; in: Balderjahn et al. (1998): 3-15
- Blien, Uwe; Mederer, Anita (1998): "Regional Determinants of Gender Specific Wages"; in: Haslinger, Stöner-Venkatarana (1998)
- Blien, Uwe; Tessaring, Manfred (1992): "Transitions between education and the labour market in Germany. The application of the ENTROP procedure in the Educational Accounting System"; Unpublished paper presented at the EALE-Conference at the University of Warwick
- Braun, H.J. (1969): "Shift-share projections of regional economic growth: An empirical test"; in: Journal of Regional Science, 9:1-18
- Bregman, L. (1967): "The relaxation method of finding the common point of convex sets and its application to the solution of problems in convex programming"; in: Comp. Math. and Math. Phys. Vol. 7/3:200-

- Censor, Yair; Lent, A. (1981): "An iterative row-action method for interval convex programming"; in: Journal of Optimization Theory and Applications, Vol. 34:321-
- Dietz, Frido (1988): "Strukturwandel auf dem Arbeitsmarkt. Entwicklung bei den sozialversicherungspflichtig beschäftigten Arbeitnehmern nach Wirtschaftszweigen, Berufen und Qualifikationen zwischen 1974 und 1986"; in: Mitteilungen aus der Arbeitsmarkt- und Berufsforschung 1:115-152
- Dosi, Giovanni; Nelson, Richard R. (1994): "An introduction to evolutionary theories in economics"; in: Journal of Evolutionary Economics, 4: 153-172
- Gerlach, Knut; Schettkat, Ronald (1995) (Eds.): "Determinanten der Lohnbildung. Theoretische und empirische Untersuchungen"; Berlin: Edition Sigma
- Golan, Amos; Judge, George; Miller, Douglas (1996): "Maximum Entropy Econometrics. Robust Estimation with Limited Data"; New York etc.: John Wiley and Sons
- Görmar, Wilfried; Irmen, Eleonore (1991): "Nichtadministrative Gebietsgliederungen und -kategorien für die Regionalstatistik. Die siedlungsstrukturelle Gebietstypisierung der BfLR"; in: Raumforschung und Raumordnung 49/6: 387-394
- Haslinger, Franz; Stöner-Venkatarama, Oliver (1998) (Eds.): "Aspects of the Distribution of Income"; Marburg: Metropolis
- Holden, Darryl R.; Nairn, Alasdair; G.M.; Swales, J.K. (1989): "Shift-share Analysis of Regional Growth and Policy: a Critique"; in: Oxford bulletin of economics and statistics, 51, 1:15-34
- Kadas, S. A.; Klafsky, E. (1976): "Estimation of the Parameters in the Gravity Model for Trip Distribution: a New Model and Solution Algorithm"; in Regional Science and Urban Economics Vol. 6:439-
- Krugman, Paul (1991): "Geography and Trade"; Cambridge (Mass.) etc.: MIT Press
- Kullback, Salomon (1968): "Information Theory and Statistics"; 2nd ed., New York: Dover
- Lucas, Robert E. (1988): "On the Mechanics of Economic Development"; in: Journal of Monetary Economics 22: 3-42
- Möller, Joachim; Tassinopoulos, Alexandros (1998): "Zunehmende Spezialisierung oder Strukturkonvergenz? Eine Analyse der sektoralen Beschäftigungsentwicklung auf regionaler Ebene"; Universität Regensburg, Regensburger Diskussionsbeiträge Nr.306
- Nelson, Richard R. (1995): "Recent Evolutionary Theorizing About Economic Change"; in: Journal of Economic Literature 33/1: 48-90
- Nelson, Richard R.; Winter, Sidney G. (1982): "An Evolutionary Theory of Economic Change"; Cambridge (Mass.), London: Belknap
- Nijkamp, Peter (1986) (Ed.): "Handbook of regional and urban economics, Vol. I: Regional economics"; Amsterdam usw.: North-Holland

Patterson, Murray G. (1991): "A note on the formulation of a full-analogue regression model of the shift-share method"; *Journal of regional science* 31, 2:211-216

Penrose, Roger (1989): "The emperor's new mind"; New York

Penrose, Roger (1997): "The large, the small and the human mind"; Cambridge (Mass.) etc.: Cambridge University

Puu, Tönu (1997): "Mathematical Location and Land Use Theory"; Berlin etc.: Springer

Romer, Paul M. (1986): "Increasing returns and long-run growth"; in: *Journal of Political Economy* 94/5: 1002-1038

Seitz, Helmut (1995): „Die Suburbanisierung der Beschäftigung: Eine Analyse unter besonderer Berücksichtigung des süddeutschen Raumes“; Universität Mannheim, Discussion Paper 519-95

Selting, Anne (1994): "Testing dynamic shift-share"; in: *Regional science perspectives*, 24: 23-41

Shannon, Claude E.; Weaver, Warren (1949): "The Mathematical Theory of Communication"; Urbana: University of Illinois Press

Tassinopoulos, Alexandros (1996): "Regionale Beschäftigungsprognose 1996/97 für die alten Bundesländer"; in: *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 3: 363-377

Wilson, Alan G. (1970): "Entropy in urban and regional modelling"; London: Pion Ltd.

—

Table2:

Results of the forecast of regional employment 1999

| No. | District | District-ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 |
|-----|-----------------------------|-------------|-----------------|--|--|
| 1 | Flensburg (municipality) | 1001 | 37547 | 0,18% | 0,7% |
| 2 | Kiel (municipality) | 1002 | 102161 | 0,48% | -0,1% |
| 3 | Luebeck (municipality) | 1003 | 80390 | 0,38% | 0,4% |
| 4 | Neumuenster (municipality) | 1004 | 31786 | 0,15% | 0,9% |
| 5 | Dithmarschen | 1051 | 35371 | 0,17% | 3,3% |
| 6 | Herzogtum Lauenburg | 1053 | 38497 | 0,19% | 4,2% |
| 7 | Nordfriesland | 1054 | 46960 | 0,23% | 3,4% |
| 8 | Ostholstein | 1055 | 52379 | 0,25% | 3,5% |
| 9 | Pinneberg | 1056 | 74724 | 0,36% | 2,7% |
| 10 | Ploen | 1057 | 23376 | 0,12% | 5,3% |
| 11 | Rendsburg-Eckernfoerde | 1058 | 63769 | 0,31% | 3,0% |
| 12 | Schleswig-Flensburg | 1059 | 42472 | 0,21% | 4,9% |
| 13 | Segeberg | 1060 | 74758 | 0,36% | 4,0% |
| 14 | Steinburg | 1061 | 34051 | 0,16% | 1,8% |
| 15 | Stormarn | 1062 | 62772 | 0,31% | 3,6% |
| 16 | Hamburg | 2000 | 732322 | 3,45% | 0,4% |
| 17 | Braunschweig (municipality) | 3101 | 107796 | 0,50% | -1,5% |
| 18 | Salzgitter (municipality) | 3102 | 46728 | 0,21% | -5,4% |
| 19 | Wolfsburg (municipality) | 3103 | 73363 | 0,32% | -6,6% |
| 20 | Gifhorn | 3151 | 30670 | 0,15% | 1,4% |
| 21 | Goettingen | 3152 | 88346 | 0,41% | -0,1% |
| 22 | Goslar | 3153 | 48270 | 0,22% | -2,4% |
| 23 | Helmstedt | 3154 | 21015 | 0,10% | -1,3% |
| 24 | Northeim | 3155 | 42806 | 0,20% | -1,9% |
| 25 | Osterode am Harz | 3156 | 28288 | 0,13% | -4,6% |
| 26 | Peine | 3157 | 28290 | 0,14% | 3,6% |
| 27 | Wolfenbuettel | 3158 | 22069 | 0,10% | -0,3% |
| 28 | Hannover (municipality) | 3201 | 279345 | 1,27% | -3,4% |
| 29 | Diepholz | 3251 | 50474 | 0,24% | 2,5% |
| 30 | Hameln-Pyrmont | 3252 | 50438 | 0,23% | -1,8% |
| 31 | Hannover | 3253 | 147891 | 0,72% | 4,1% |
| 32 | Hildesheim | 3254 | 84871 | 0,39% | -2,3% |
| 33 | Holzminden | 3255 | 23075 | 0,11% | -1,6% |
| 34 | Nienburg (Weser) | 3256 | 32081 | 0,15% | -1,1% |
| 35 | Schaumburg | 3257 | 40289 | 0,19% | -1,4% |
| 36 | Celle | 3351 | 48361 | 0,22% | -1,6% |
| 37 | Cuxhaven | 3352 | 39691 | 0,19% | 0,4% |
| 38 | Harburg | 3353 | 42352 | 0,21% | 3,9% |
| 39 | Luechow-Dannenberg | 3354 | 12858 | 0,06% | 2,7% |
| 40 | Lueneburg | 3355 | 44466 | 0,21% | 2,2% |
| 41 | Osterholz | 3356 | 19843 | 0,09% | -0,2% |
| 42 | Rotenburg (Wuemme) | 3357 | 41552 | 0,20% | 2,2% |
| 43 | Soltau-Fallingbostel | 3358 | 39419 | 0,19% | 0,7% |
| 44 | Stade | 3359 | 48229 | 0,23% | 1,3% |
| 45 | Uelzen | 3360 | 26074 | 0,12% | -0,5% |

| <u>No.</u> | <u>District</u> | <u>District- ID</u> | <u>Employment 1997</u> | <u>Forecast of the proportion of people employed 1999</u> | <u>Growth rate of the proportion of people employed 1997-1999</u> |
|------------|---------------------------------|-------------------------|----------------------------|---|---|
| 46 | Verden | 3361 | 37841 | 0,18% | 3,3% |
| 47 | Delmenhorst (municipality) | 3401 | 18840 | 0,08% | -4,2% |
| 48 | Emden (municipality) | 3402 | 25845 | 0,11% | -5,3% |
| 49 | Oldenburg (municipality) | 3403 | 62778 | 0,30% | 0,7% |
| 50 | Osnabrueck (municipality) | 3404 | 78059 | 0,36% | -0,7% |
| 51 | Wilhelmshaven (municipality) | 3405 | 26280 | 0,12% | -2,8% |
| 52 | Ammerland | 3451 | 30139 | 0,14% | 2,3% |
| 53 | Aurich | 3452 | 40691 | 0,20% | 3,7% |
| 54 | Cloppenburg | 3453 | 38917 | 0,19% | 4,6% |
| 55 | Emsland | 3454 | 86152 | 0,42% | 4,8% |
| 56 | Friesland | 3455 | 24009 | 0,11% | -0,7% |
| 57 | Grafschaft Bentheim | 3456 | 34131 | 0,16% | 0,5% |
| 58 | Leer | 3457 | 33534 | 0,16% | 2,2% |
| 59 | Oldenburg (Oldenburg) | 3458 | 24872 | 0,12% | 3,1% |
| 60 | Osnabrueck | 3459 | 90747 | 0,43% | 1,7% |
| 61 | Vechta | 3460 | 40631 | 0,20% | 4,7% |
| 62 | Wesermarsch | 3461 | 24830 | 0,11% | -3,5% |
| 63 | Wittmund | 3462 | 12814 | 0,06% | 0,2% |
| 64 | Bremen (municipality) | 4011 | 237371 | 1,09% | -2,1% |
| 65 | Bremerhaven (municipality) | 4012 | 45244 | 0,20% | -4,6% |
| 66 | Duesseldorf (municipality) | 5111 | 333553 | 1,54% | -1,3% |
| 67 | Duisburg (municipality) | 5112 | 157511 | 0,71% | -4,6% |
| 68 | Essen (municipality) | 5113 | 217237 | 1,02% | 0,0% |
| 69 | Krefeld (municipality) | 5114 | 87811 | 0,41% | -1,6% |
| 70 | Moenchengladbach (municipality) | 5116 | 83503 | 0,38% | -2,3% |
| 71 | Muelheim a.d.R. (municipality) | 5117 | 59144 | 0,27% | -0,9% |
| 72 | Oberhausen (municipality) | 5119 | 59315 | 0,28% | 0,1% |
| 73 | Remscheid (municipality) | 5120 | 48410 | 0,22% | -4,3% |
| 74 | Solingen (municipality) | 5122 | 49793 | 0,23% | -2,5% |
| 75 | Wuppertal (municipality) | 5124 | 129764 | 0,59% | -2,3% |
| 76 | Kleve | 5154 | 72752 | 0,35% | 1,7% |
| 77 | Mettmann | 5158 | 165183 | 0,78% | 0,3% |
| 78 | Neuss | 5162 | 123564 | 0,58% | 0,4% |
| 79 | Viersen | 5166 | 80576 | 0,38% | 1,1% |
| 80 | Wesel | 5170 | 113940 | 0,53% | -0,4% |
| 81 | Aachen (municipality) | 5313 | 104805 | 0,50% | 0,7% |
| 82 | Bonn (municipality) | 5314 | 143212 | 0,69% | 3,4% |
| 83 | Koeln (municipality) | 5315 | 432112 | 2,05% | 1,0% |
| 84 | Leverkusen (municipality) | 5316 | 67227 | 0,31% | -2,2% |
| 85 | Aachen | 5354 | 69684 | 0,33% | 0,4% |
| 86 | Dueren | 5358 | 70090 | 0,33% | -0,9% |
| 87 | Erftkreis | 5362 | 110002 | 0,53% | 2,9% |
| 88 | Euskirchen | 5366 | 44186 | 0,21% | 2,8% |
| 89 | Heinsberg | 5370 | 48792 | 0,23% | -0,3% |

| | | | | | |
|----|----------------------|------|-------|-------|------|
| 90 | Oberbergischer Kreis | 5374 | 82929 | 0,39% | 0,3% |
|----|----------------------|------|-------|-------|------|

| No. | District | District-ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 |
|-----|-------------------------------|-------------|-----------------|--|--|
| 91 | Rheinisch-Bergischer Kreis | 5378 | 62668 | 0,29% | 0,3% |
| 92 | Rhein-Sieg-Kreis | 5382 | 118574 | 0,57% | 2,8% |
| 93 | Bottrop (municipality) | 5512 | 31306 | 0,15% | 4,1% |
| 94 | Gelsenkirchen (municipality) | 5513 | 82036 | 0,37% | -4,4% |
| 95 | Muenster (municipality) | 5515 | 118065 | 0,56% | 1,6% |
| 96 | Borken | 5554 | 106481 | 0,51% | 2,7% |
| 97 | Coesfeld | 5558 | 49307 | 0,24% | 4,7% |
| 98 | Recklinghausen | 5562 | 160441 | 0,74% | -1,2% |
| 99 | Steinfurt | 5566 | 114230 | 0,54% | 1,6% |
| 100 | Warendorf | 5570 | 80363 | 0,39% | 2,4% |
| 101 | Bielefeld (municipality) | 5711 | 127342 | 0,59% | -1,3% |
| 102 | Guetersloh | 5754 | 126681 | 0,60% | 1,4% |
| 103 | Herford | 5758 | 88174 | 0,41% | 0,2% |
| 104 | Hoexter | 5762 | 41032 | 0,19% | 0,4% |
| 105 | Lippe | 5766 | 106807 | 0,50% | 0,0% |
| 106 | Minden-Luebbecke | 5770 | 109441 | 0,52% | 0,9% |
| 107 | Paderborn | 5774 | 88812 | 0,43% | 3,0% |
| 108 | Bochum (municipality) | 5911 | 132192 | 0,61% | -1,3% |
| 109 | Dortmund (municipality) | 5913 | 196727 | 0,92% | -0,7% |
| 110 | Hagen (municipality) | 5914 | 70976 | 0,32% | -3,3% |
| 111 | Hamm (municipality) | 5915 | 51809 | 0,24% | -1,9% |
| 112 | Herne (municipality) | 5916 | 41441 | 0,19% | -3,6% |
| 113 | Ennepe-Ruhr-Kreis | 5954 | 99045 | 0,45% | -3,5% |
| 114 | Hochsauerlandkreis | 5958 | 90171 | 0,42% | 0,1% |
| 115 | Maerkischer Kreis | 5962 | 153950 | 0,71% | -1,9% |
| 116 | Olpe | 5966 | 44196 | 0,21% | 1,4% |
| 117 | Siegen | 5970 | 100650 | 0,46% | -2,0% |
| 118 | Soest | 5974 | 91061 | 0,43% | 1,4% |
| 119 | Unna | 5978 | 101958 | 0,48% | -0,3% |
| 120 | Darmstadt (municipality) | 6411 | 83736 | 0,38% | -4,5% |
| 121 | Frankfurt a.M. (municipality) | 6412 | 452363 | 2,10% | -1,1% |
| 122 | Offenbach a.M. (municipality) | 6413 | 45529 | 0,21% | -2,6% |
| 123 | Wiesbaden (municipality) | 6414 | 115698 | 0,54% | -0,8% |
| 124 | Bergstrasse | 6431 | 60818 | 0,28% | -0,8% |
| 125 | Darmstadt-Dieburg | 6432 | 59385 | 0,29% | 2,9% |
| 126 | Gross-Gerau | 6433 | 90411 | 0,43% | 1,5% |
| 127 | Hochtaunuskreis | 6434 | 68200 | 0,32% | 0,0% |
| 128 | Main-Kinzig-Kreis | 6435 | 109361 | 0,51% | -1,5% |
| 129 | Main-Taunus-Kreis | 6436 | 73723 | 0,36% | 5,0% |
| 130 | Odenwaldkreis | 6437 | 25275 | 0,12% | -0,7% |

| | | | | |
|---------------------------|------|--------|-------|-------|
| 131 Offenbach | 6438 | 101939 | 0,48% | -0,1% |
| 132 Rheingau-Taunus-Kreis | 6439 | 40380 | 0,19% | -0,5% |
| 133 Wetteraukreis | 6440 | 68580 | 0,32% | 0,0% |
| 134 Giessen | 6531 | 82939 | 0,39% | 0,8% |
| 135 Lahn-Dill-Kreis | 6532 | 79666 | 0,37% | -0,7% |

| No. District | District-ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 |
|---------------------------------------|-------------|-----------------|--|--|
| 136 Limburg-Weilburg | 6533 | 43182 | 0,20% | 1,0% |
| 137 Marburg-Biedenkopf | 6534 | 73709 | 0,35% | 0,5% |
| 138 Vogelsbergkreis | 6535 | 29894 | 0,14% | 0,0% |
| 139 Kassel (municipality) | 6611 | 92444 | 0,42% | -3,0% |
| 140 Fulda | 6631 | 70151 | 0,33% | 1,2% |
| 141 Hersfeld-Rotenburg | 6632 | 40182 | 0,19% | -1,6% |
| 142 Kassel | 6633 | 58947 | 0,28% | 1,5% |
| 143 Schwalm-Eder-Kreis | 6634 | 45006 | 0,22% | 5,1% |
| 144 Waldeck-Frankenberg | 6635 | 53676 | 0,25% | -0,1% |
| 145 Werra-Meißner-Kreis | 6636 | 31687 | 0,15% | -1,5% |
| 146 Koblenz (municipality) | 7111 | 61283 | 0,29% | -0,6% |
| 147 Ahrweiler | 7131 | 28567 | 0,14% | 0,9% |
| 148 Altenkirchen (Westerwald) | 7132 | 33373 | 0,16% | -0,2% |
| 149 Bad Kreuznach | 7133 | 43063 | 0,20% | -1,5% |
| 150 Birkenfeld | 7134 | 25342 | 0,12% | -2,4% |
| 151 Cochem-Zell | 7135 | 16219 | 0,08% | 2,0% |
| 152 Mayen-Koblenz | 7137 | 50693 | 0,24% | 1,9% |
| 153 Neuwied | 7138 | 52737 | 0,25% | 0,9% |
| 154 Rhein-Hunsrück-Kreis | 7140 | 27637 | 0,13% | 1,4% |
| 155 Rhein-Lahn-Kreis | 7141 | 27759 | 0,13% | -0,1% |
| 156 Westerwaldkreis | 7143 | 54750 | 0,26% | 1,9% |
| 157 Trier (municipality) | 7211 | 47297 | 0,22% | -1,6% |
| 158 Bernkastel-Wittlich | 7231 | 31596 | 0,15% | -0,2% |
| 159 Bitburg-Prüm | 7232 | 23062 | 0,11% | 1,4% |
| 160 Daun | 7233 | 15225 | 0,07% | 2,9% |
| 161 Trier-Saarburg | 7235 | 22468 | 0,11% | 5,0% |
| 162 Frankenthal (Pf.) (municipality) | 7311 | 15531 | 0,07% | -3,6% |
| 163 Kaiserslautern (municipality) | 7312 | 49272 | 0,22% | -2,8% |
| 164 Landau i.d.Pfalz (municipality) | 7313 | 16629 | 0,08% | 1,5% |
| 165 Ludwigshafen a.Rh. (municipality) | 7314 | 96268 | 0,44% | -3,5% |
| 166 Mainz (municipality) | 7315 | 95135 | 0,45% | 0,2% |
| 167 Neustadt a.d.W. (municipality) | 7316 | 15670 | 0,07% | -6,5% |
| 168 Pirmasens (municipality) | 7317 | 20001 | 0,09% | -8,2% |
| 169 Speyer (municipality) | 7318 | 21981 | 0,10% | 1,1% |
| 170 Worms (municipality) | 7319 | 25621 | 0,12% | -2,7% |
| 171 Zweibrücken (municipality) | 7320 | 13197 | 0,06% | 0,0% |

| | | | | | |
|-----|-----------------------|------|-------|-------|-------|
| 172 | Alzey-Worms | 7331 | 19175 | 0,09% | 5,0% |
| 173 | Bad Duerkheim | 7332 | 26488 | 0,13% | 2,5% |
| 174 | Donnersbergkreis | 7333 | 16698 | 0,08% | -0,1% |
| 175 | Germersheim | 7334 | 33530 | 0,16% | -1,1% |
| 176 | Kaiserslautern | 7335 | 17894 | 0,08% | -1,3% |
| 177 | Kusel | 7336 | 12662 | 0,06% | 1,6% |
| 178 | Suedliche Weinstrasse | 7337 | 23923 | 0,12% | 8,8% |
| 179 | Ludwigshafen | 7338 | 21094 | 0,10% | 1,6% |
| 180 | Mainz-Bingen | 7339 | 38813 | 0,19% | 2,8% |

| No. District | District- ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 | |
|--------------|----------------------------|--------------------|---|--|-------|
| 181 | Pirmasens | 7340 | 16921 | 0,08% | -0,8% |
| 182 | Stuttgart Stadtkreis | 8111 | 338430 | 1,55% | -2,1% |
| 183 | Boeblingen | 8115 | 142288 | 0,65% | -2,3% |
| 184 | Esslingen | 8116 | 175206 | 0,81% | -1,5% |
| 185 | Goepingen | 8117 | 80158 | 0,37% | -2,0% |
| 186 | Ludwigsburg | 8118 | 158381 | 0,75% | 0,3% |
| 187 | Rems-Murr-Kreis | 8119 | 125118 | 0,58% | -0,7% |
| 188 | Heilbronn Stadtkreis | 8121 | 61392 | 0,29% | -0,6% |
| 189 | Heilbronn | 8125 | 87015 | 0,42% | 3,0% |
| 190 | Hohenlohekreis | 8126 | 38856 | 0,19% | 4,2% |
| 191 | Schwaebisch Hall | 8127 | 59164 | 0,28% | 1,0% |
| 192 | Main-Tauber-Kreis | 8128 | 43658 | 0,21% | 0,5% |
| 193 | Heidenheim | 8135 | 48044 | 0,22% | -1,8% |
| 194 | Ostalbkreis | 8136 | 98079 | 0,46% | -0,4% |
| 195 | Baden-Baden Stadtkreis | 8211 | 26202 | 0,12% | 0,6% |
| 196 | Karlsruhe Stadtkreis | 8212 | 142954 | 0,67% | -0,5% |
| 197 | Karlsruhe | 8215 | 112401 | 0,53% | 0,5% |
| 198 | Rastatt | 8216 | 72874 | 0,34% | -0,6% |
| 199 | Heidelberg Stadtkreis | 8221 | 71880 | 0,34% | 1,0% |
| 200 | Mannheim Stadtkreis | 8222 | 162594 | 0,75% | -1,3% |
| 201 | Neckar-Odenwald-Kreis | 8225 | 40363 | 0,19% | 0,3% |
| 202 | Rhein-Neckar-Kreis | 8226 | 130302 | 0,62% | 1,4% |
| 203 | Pforzheim Stadtkreis | 8231 | 52818 | 0,24% | -4,2% |
| 204 | Calw | 8235 | 40360 | 0,19% | -0,3% |
| 205 | Enzkreis | 8236 | 48695 | 0,23% | 0,8% |
| 206 | Freudenstadt | 8237 | 38876 | 0,19% | 1,8% |
| 207 | Freiburg im Breisgau Stadt | 8311 | 91437 | 0,44% | 3,3% |
| 208 | Breisgau-Hochschwarzwald | 8315 | 59504 | 0,28% | 1,8% |
| 209 | Emmendingen | 8316 | 39389 | 0,19% | 1,1% |
| 210 | Ortenaukreis | 8317 | 140701 | 0,66% | 0,2% |
| 211 | Rottweil | 8325 | 45524 | 0,21% | -0,1% |
| 212 | Schwarzwald-Baar-Kreis | 8326 | 73652 | 0,34% | -1,5% |

| | | | | | |
|-----|-----------------|------|-------|-------|-------|
| 213 | Tuttlingen | 8327 | 45853 | 0,22% | 0,4% |
| 214 | Konstanz | 8335 | 80010 | 0,38% | 0,1% |
| 215 | Loerrach | 8336 | 65065 | 0,30% | -1,2% |
| 216 | Waldshut | 8337 | 44768 | 0,21% | -1,5% |
| 217 | Reutlingen | 8415 | 91651 | 0,43% | -0,8% |
| 218 | Tuebingen | 8416 | 57679 | 0,28% | 2,1% |
| 219 | Zollernalbkreis | 8417 | 63853 | 0,29% | -1,9% |
| 220 | Ulm Stadtkreis | 8421 | 72860 | 0,34% | 0,3% |
| 221 | Alb-Donau-Kreis | 8425 | 44075 | 0,21% | 2,4% |
| 222 | Biberach | 8426 | 56249 | 0,27% | 1,3% |
| 223 | Bodenseekreis | 8435 | 64756 | 0,30% | 0,2% |
| 224 | Ravensburg | 8436 | 88235 | 0,42% | 1,1% |
| 225 | Sigmaringen | 8437 | 39789 | 0,19% | 1,1% |

| No. District | District- ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 | |
|--------------|---------------------------|--------------------|---|--|-------|
| 226 | Ingolstadt (municipality) | 9161 | 62821 | 0,30% | 0,2% |
| 227 | Muenchen (municipality) | 9162 | 637155 | 2,92% | -2,3% |
| 228 | Rosenheim (municipality) | 9163 | 28141 | 0,13% | -0,3% |
| 229 | Altoetting | 9171 | 37276 | 0,18% | 0,8% |
| 230 | Berchtesgadener Land | 9172 | 29965 | 0,14% | -0,7% |
| 231 | Bad Toelz-Wolfratshausen | 9173 | 29941 | 0,14% | 1,0% |
| 232 | Dachau | 9174 | 24953 | 0,12% | 3,8% |
| 233 | Ebersberg | 9175 | 24021 | 0,11% | 0,5% |
| 234 | Eichstaett | 9176 | 22925 | 0,11% | 4,7% |
| 235 | Erding | 9177 | 23458 | 0,11% | 4,4% |
| 236 | Freising | 9178 | 54984 | 0,28% | 9,2% |
| 237 | Fuerstenfeldbruck | 9179 | 36881 | 0,17% | 0,6% |
| 238 | Garmisch-Partenkirchen | 9180 | 25809 | 0,12% | -0,1% |
| 239 | Landsberg am Lech | 9181 | 23972 | 0,12% | 2,7% |
| 240 | Miesbach | 9182 | 25455 | 0,12% | 0,7% |
| 241 | Muehdorf am Inn | 9183 | 28870 | 0,14% | 0,2% |
| 242 | Muenchen | 9184 | 135514 | 0,67% | 5,4% |
| 243 | Neuburg-Schrobenhausen | 9185 | 23814 | 0,11% | 0,8% |
| 244 | Pfaffenhofen an der Ilm | 9186 | 24601 | 0,12% | 3,5% |
| 245 | Rosenheim | 9187 | 57154 | 0,28% | 2,6% |
| 246 | Starnberg | 9188 | 32459 | 0,15% | 1,1% |
| 247 | Traunstein | 9189 | 51183 | 0,24% | 1,3% |
| 248 | Weilheim-Schongau | 9190 | 35229 | 0,17% | 0,8% |
| 249 | Landshut (municipality) | 9261 | 28619 | 0,13% | -2,5% |
| 250 | Passau (municipality) | 9262 | 29803 | 0,14% | -0,5% |
| 251 | Straubing (municipality) | 9263 | 21036 | 0,10% | 0,8% |
| 252 | Deggendorf | 9271 | 37923 | 0,18% | 1,7% |
| 253 | Freyung-Grafenau | 9272 | 21978 | 0,10% | 0,0% |

| | | | | | |
|-----|---------------------------------|------|-------|-------|-------|
| 254 | Kelheim | 9273 | 29902 | 0,14% | 1,8% |
| 255 | Landshut | 9274 | 31902 | 0,16% | 3,8% |
| 256 | Passau | 9275 | 46721 | 0,22% | -1,3% |
| 257 | Regen | 9276 | 22605 | 0,11% | 0,9% |
| 258 | Rottal-Inn | 9277 | 31120 | 0,15% | 2,3% |
| 259 | Straubing-Bogen | 9278 | 17683 | 0,09% | 5,4% |
| 260 | Dingolfing-Landau | 9279 | 38606 | 0,19% | 5,2% |
| 261 | Amberg (municipality) | 9361 | 23295 | 0,11% | -1,2% |
| 262 | Regensburg (municipality) | 9362 | 82125 | 0,39% | 0,3% |
| 263 | Weiden i.d.Obpf. (municipality) | 9363 | 23891 | 0,11% | 0,6% |
| 264 | Amberg-Sulzbach | 9371 | 22733 | 0,11% | 4,0% |
| 265 | Cham | 9372 | 37956 | 0,18% | 2,7% |
| 266 | Neumarkt i.d.Oberpfalz | 9373 | 35505 | 0,17% | 1,8% |
| 267 | Neustadt a.d.Waldnaab | 9374 | 23272 | 0,10% | -4,3% |
| 268 | Regensburg | 9375 | 29056 | 0,14% | 4,1% |
| 269 | Schwandorf | 9376 | 40113 | 0,19% | 1,5% |
| 270 | Tirschenreuth | 9377 | 22655 | 0,10% | -3,2% |

| No. District | District-ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 | |
|--------------|-----------------------------|-----------------|--|--|-------|
| 271 | Bamberg (municipality) | 9461 | 44327 | 0,20% | -1,4% |
| 272 | Bayreuth (municipality) | 9462 | 39085 | 0,18% | 0,5% |
| 273 | Coburg (municipality) | 9463 | 27139 | 0,13% | -1,4% |
| 274 | Hof (municipality) | 9464 | 24943 | 0,11% | -2,8% |
| 275 | Bamberg | 9471 | 25137 | 0,12% | 3,3% |
| 276 | Bayreuth | 9472 | 23759 | 0,11% | -1,3% |
| 277 | Coburg | 9473 | 31179 | 0,14% | -2,2% |
| 278 | Forchheim | 9474 | 21619 | 0,10% | 0,1% |
| 279 | Hof | 9475 | 36563 | 0,16% | -3,9% |
| 280 | Kronach | 9476 | 28189 | 0,13% | -2,0% |
| 281 | Kulmbach | 9477 | 26234 | 0,12% | -3,1% |
| 282 | Lichtenfels | 9478 | 28067 | 0,13% | -0,1% |
| 283 | Wunsiedel im Fichtelgebirge | 9479 | 30670 | 0,14% | -5,8% |
| 284 | Ansbach (municipality) | 9561 | 20493 | 0,10% | -0,5% |
| 285 | Erlangen (municipality) | 9562 | 68931 | 0,32% | -1,2% |
| 286 | Fuerth (municipality) | 9563 | 40238 | 0,18% | -4,7% |
| 287 | Nuernberg (municipality) | 9564 | 257074 | 1,17% | -3,3% |
| 288 | Schwabach (municipality) | 9565 | 12836 | 0,06% | -2,1% |
| 289 | Ansbach | 9571 | 48555 | 0,23% | 1,7% |
| 290 | Erlangen-Hoechstadt | 9572 | 29793 | 0,15% | 7,8% |
| 291 | Fuerth | 9573 | 19929 | 0,09% | -1,2% |
| 292 | Nuernberger Land | 9574 | 43844 | 0,21% | -0,1% |
| 293 | Neustadt a.d.Aisch-Bad Win. | 9575 | 23658 | 0,11% | 1,8% |
| 294 | Roth | 9576 | 28075 | 0,14% | 4,6% |

| | | | | | |
|-----|--------------------------------|------|--------|-------|-------|
| 295 | Weissenburg-Gunzenhausen | 9577 | 27630 | 0,13% | -1,4% |
| 296 | Aschaffenburg (municipality) | 9661 | 38979 | 0,19% | 1,5% |
| 297 | Schweinfurt (municipality) | 9662 | 43629 | 0,20% | -1,6% |
| 298 | Wuerzburg (municipality) | 9663 | 76561 | 0,36% | -0,4% |
| 299 | Aschaffenburg | 9671 | 43523 | 0,21% | 2,8% |
| 300 | Bad Kissingen | 9672 | 32204 | 0,15% | 0,3% |
| 301 | Rhoen-Grabfeld | 9673 | 27273 | 0,13% | 0,2% |
| 302 | Hassberge | 9674 | 22727 | 0,11% | 2,6% |
| 303 | Kitzingen | 9675 | 24934 | 0,12% | 1,7% |
| 304 | Miltenberg | 9676 | 36280 | 0,17% | -1,7% |
| 305 | Main-Spessart | 9677 | 38724 | 0,18% | 0,7% |
| 306 | Schweinfurt | 9678 | 18578 | 0,09% | 4,7% |
| 307 | Wuerzburg | 9679 | 26159 | 0,13% | 4,5% |
| 308 | Augsburg (municipality) | 9761 | 121534 | 0,56% | -2,5% |
| 309 | Kaufbeuren (municipality) | 9762 | 15104 | 0,07% | -4,3% |
| 310 | Kempten (Allg.) (municipality) | 9763 | 29795 | 0,14% | -0,2% |
| 311 | Memmingen (municipality) | 9764 | 22256 | 0,10% | -0,5% |
| 312 | Aichach-Friedberg | 9771 | 27197 | 0,13% | 1,1% |
| 313 | Augsburg | 9772 | 49784 | 0,24% | 0,8% |
| 314 | Dillingen a.d.Donau | 9773 | 26154 | 0,12% | 0,9% |
| 315 | Guenzburg | 9774 | 38390 | 0,18% | 1,2% |

| No. District | District-ID | Employment 1997 | Forecast of the proportion of people employed 1999 | Growth rate of the proportion of people employed 1997-1999 | |
|----------------------------|---------------------------|-----------------|--|--|-------|
| 316 | Neu-Ulm | 9775 | 48714 | 0,23% | -1,1% |
| 317 | Lindau (Bodensee) | 9776 | 24182 | 0,11% | -0,2% |
| 318 | Ostallgaeu | 9777 | 35219 | 0,17% | 1,0% |
| 319 | Unterrallgaeu | 9778 | 36063 | 0,17% | 0,5% |
| 320 | Donau-Ries | 9779 | 42718 | 0,20% | 1,4% |
| 321 | Oberallgaeu | 9780 | 39230 | 0,18% | -0,3% |
| 322 | Saarbruecken Stadtverband | 10041 | 144132 | 0,67% | -0,4% |
| 323 | Merzig-Wadern | 10042 | 26443 | 0,12% | 0,3% |
| 324 | Neunkirchen | 10043 | 34120 | 0,16% | -0,5% |
| 325 | Saarlouis | 10044 | 60440 | 0,28% | 0,0% |
| 326 | Saar-Pfalz-Kreis | 10045 | 53832 | 0,26% | 1,0% |
| 327 | Sankt Wendel | 10046 | 20317 | 0,10% | 1,3% |
| Summe Bund-W.(ohne Berlin) | | | 21320896 | 100,00% | |