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Forecasting Regional Employment with the ENTROP Method

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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

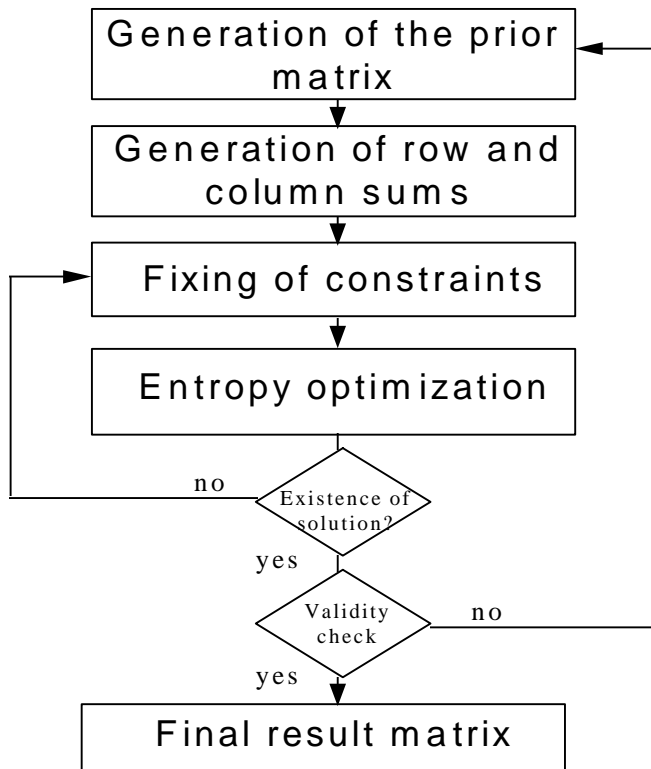
Additionally, a categorization of the respective region is used. Each of the 327 districts is classified according to a scheme developed by the BBR (Bundesanstalt für Bauwesen und Raumordnung, Bonn, former name: Bundesforschungsanstalt für Raumordnung und Landeskunde, BfLR). The classification (Görmar, 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)

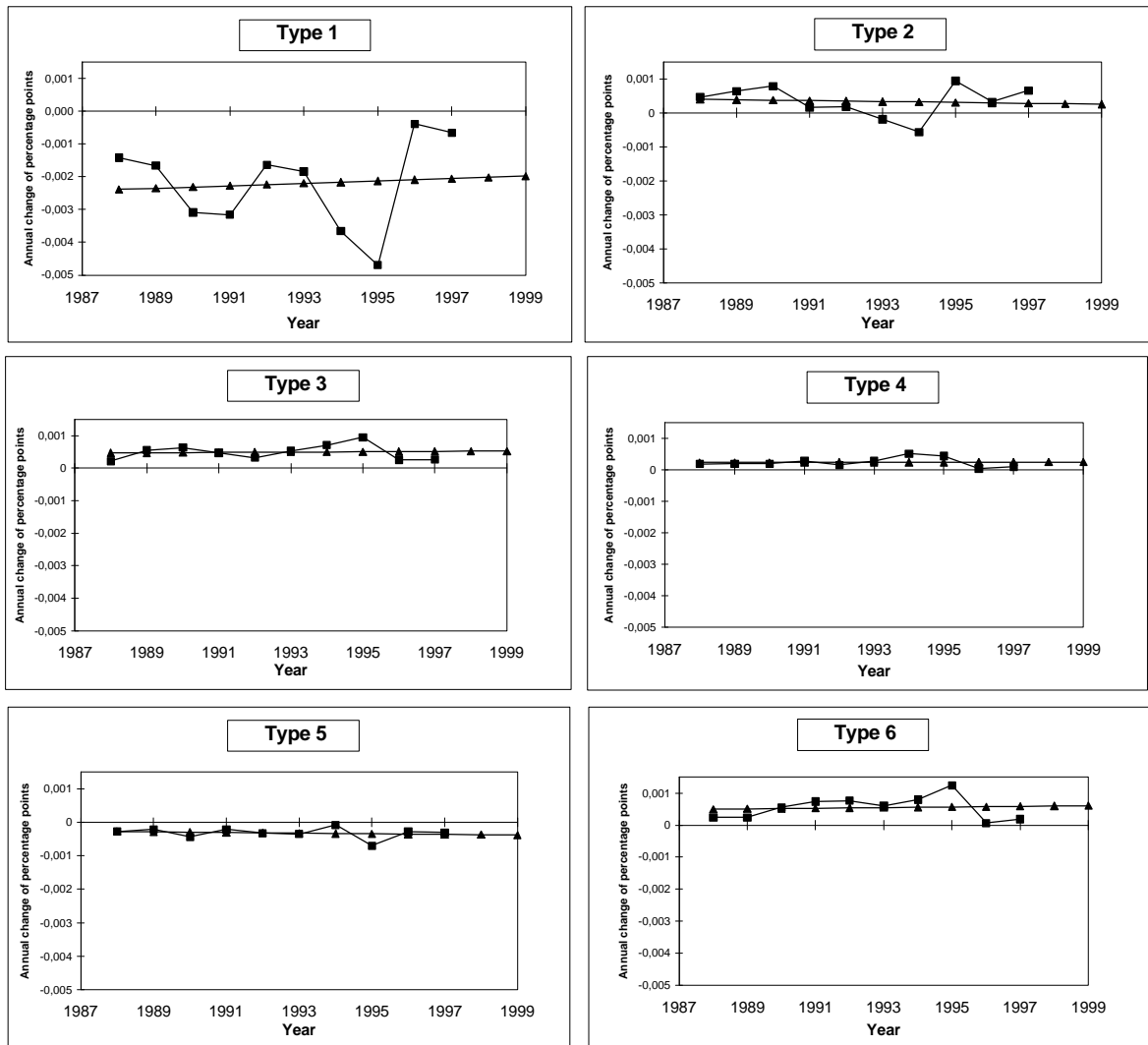
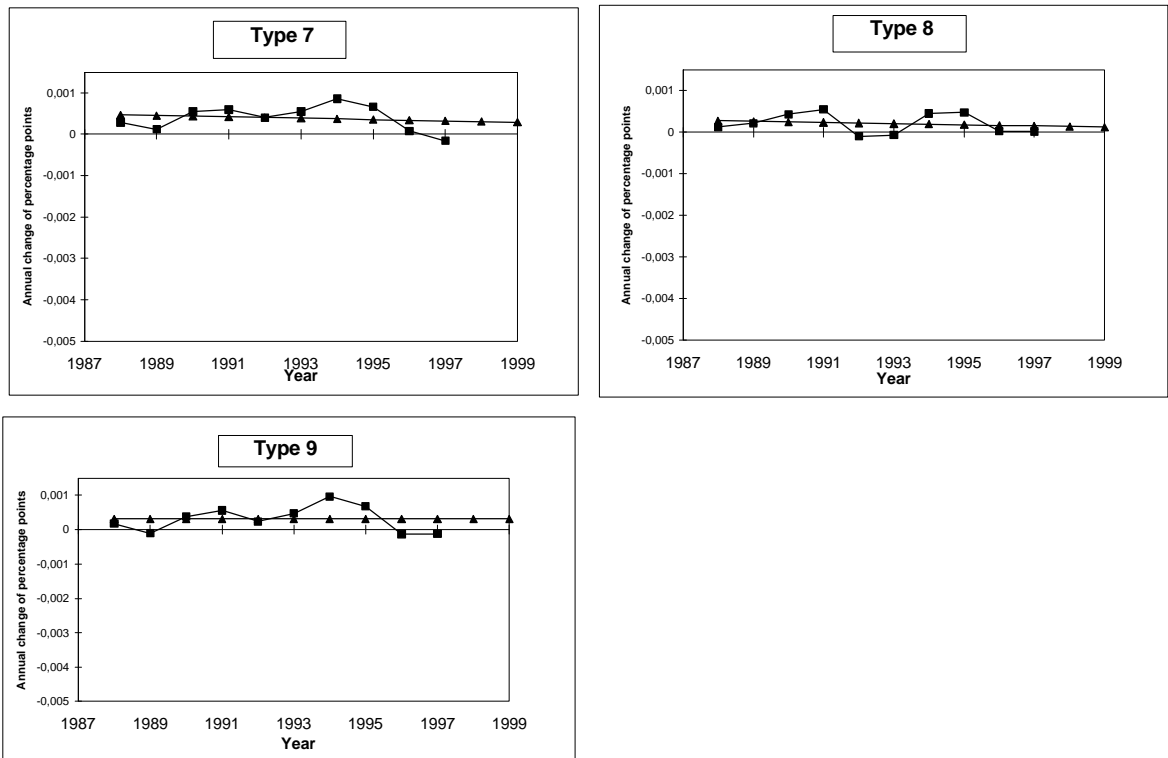


Figure 2b:

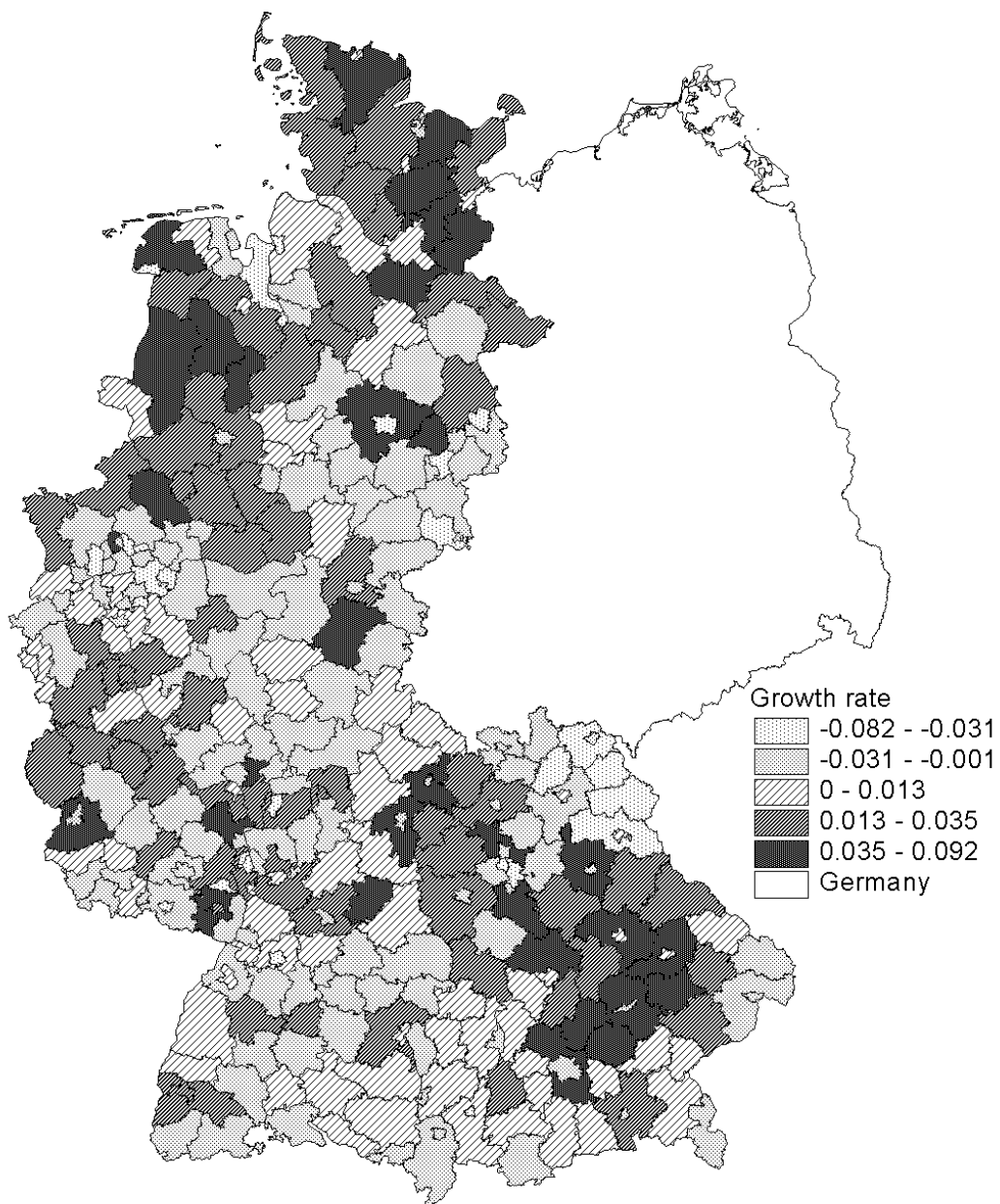


▲▲▲▲ linear regression analysis

■ ■ ■ ■ 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 -



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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	Hamel-Pyrmont	3252	50438	0,23%	-1,8%
31	Hannover	3253	147891	0,72%	4,1%
32	Hildesheim	3254	84871	0,39%	-2,3%
33	Holz Minden	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	Erfthkreis	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%
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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%	