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RESEARCH PAPER

# More than just one labor market cycle in Germany? An analysis of regional unemployment data

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**Abstract** We analyze unemployment dynamics for Germany on a regional basis by means of an approximate factor model. We first estimate the number of factors corresponding to the number of cycles. At least for the pre-"Hartz" reform data we find strong evidence for more than just one dynamic labor market cycle present in German regions. Thus, labor market dynamics are driven by more than a single nationwide business cycle. Next, we look for regional partitions reflecting the different cycles best. Our results indicate pronounced differences between East and West Germany for 1997 to 2004 and ongoing but reduced differences between 2005 and 2010. A convergence process is found to have taken place up until late 2001. There is evidence for the differences observed before 2004 to be driven by active labor market policy, which thus had a volatility-increasing effect on the labor market.

**Keywords** Approximate factor model · Regional distribution · Labor market cycles

**JEL Classification** C23 · E24 · E32 · J08

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**Mehr als ein Arbeitsmarktzyklus in Deutschland? Eine Analyse regionaler Daten zur Arbeitslosigkeit**

**Zusammenfassung** Wir analysieren die Dynamik der Arbeitslosigkeit in Deutschland auf regionaler Ebene mittels eines approximativen Faktormodells. Zunächst schätzen wir die Anzahl der Faktoren, die mit den Zyklen in der Entwicklung der Arbeitslosenzahlen korrespondieren. Zumindest für die Zeit vor den "Hartz IV"-Reformen zeigen die Daten deutlich die Präsenz von mehr als einem dynamischen Arbeitsmarktzyklus in den Landkreisen Deutschlands. Das bedeutet, dass der deutsche Arbeitsmarkt von mehr als einem bundesweiten Konjunkturzyklus bestimmt ist. Anschließend betrachten wir regionale Partitionen, die die unterschiedlichen Zyklen bestmöglich widerspiegeln. Unsere Ergebnisse deuten auf starke Unterschiede zwischen Ost- und Westdeutschland zwischen 1998 und 2004 hin, die sich zwischen 2005 und 2010 verringern, aber qualitativ bestehen bleiben. Ein Konvergenzprozess kann bis Ende 2001 beobachtet werden. Es kann angenommen werden, dass die Unterschiede, die vor 2004 beobachtet werden, durch aktive Arbeitsmarktpolitik verursacht wurden, die somit einen volatilitätssteigernden Effekt auf den Arbeitsmarkt hatte.

## 1 Introduction

Data from the past recession shows that not just unemployment levels, as already noted by Bade (1991), but also unemployment dynamics differ substantially among the NUTS-3 regions of Germany. While unemployment has risen dramatically in some south-western counties over the one-year period from September 2008 to September 2009, several counties in the North and East have even seen a decline in unemployment over the same period. The insight that the behavior of some counties partly deviates substantially from a single nationwide cycle is well known. Several studies on the so-called cyclical sensitivity of regional unemployment figures have been conducted; see Elhorst (2003: 715 ff.) for an overview.

Cyclical sensitivity analysis dates back to the studies by Thirlwall (1966) and Brechling (1967). According to Brechling, regional umemployment rates can be divided into a regional structural part, a cyclical part driven by the national cycle measured by the national unemployment rate and a region specific cycle identified as residual. Thirlwall's approach is slightly different as his study considers first differences of unemployment rates. These differences should be mainly driven by cyclical forces. Differentiation eliminates the structural disparities, which are known to be highly persistent; compare e.g. Blien and Phan thi Hong (2008). The regional first differences are regressed on the nationwide first differences yielding regional sensitivities with respect to the nationwide cycle. This approach has also been adopted by Blanchard and Katz (1992: 25 ff.) for analyzing data of US states, by Decressin and Fatas (1995) for data from the EC-12, and more recently by Kunz (2009) for German annual data at NUTS-3 level. However, these analyses all assume a single nationwide cycle vs. idiosyncratic cycles and do not consider interrelations between the idiosyncratic cycles.

We assess the regional dimension of the labor market dynamics by means of an approximate factor model for German unemployment data at the county level, or NUTS-3 level. Factor models in regional or spatial econometrics have been applied e.g. by Eickmeier and Breitung (2005) for analyzing the common business cycles of members of the European Union. Such an analysis is an extension of the cyclical sensitivity analysis in several respects. First, a factor analysis overcomes the shortcoming that regional data is regressed on its sum and thus an endogenous regressor by construction, and second, while a single factor model may correspond to the notion of a national cycle, the division of the cyclical part of unemployment into a single nationwide and a purely idiosyncratic part may be too restrictive. The putative idiosyncrasies can also be interrelated, a point made e.g. by Kosfeld and Dreger (2006). Accordingly this analysis allows considering several nationwide cycles that affect regions differently where the number of cycles is related to the number of factors. Detection of more than one cycle would not just provide a better insight into the nature of regional unemployment dynamics, but may also help to improve short-run regional unemployment projections.

Thus a core element of our analysis is the determination of the number of static as well as dynamic factors within the data set. While static factors describe the contemporaneous movements, dynamic factors can be interpreted as primitive shocks. Thus the number of dynamic factors can be lower than the number of static ones, as a static factor can be a representation of other lagged static factors. Consequently, the hypothesis of a single nationwide business cycle governing labor market dynamics corresponds to a single dynamic factor. Such a finding would also relate to recent literature on US employment data where the importance of a single nationwide cycle is stressed (Hamilton and Owyang 2009).

Our analysis is done for two samples of monthly unemployment data on NUTS-3 level: The first sample ranges from December 1997 until December 2004 and the second from January 2005 until May 2010. Changes in legislation due to the "Hartz" labor market reforms render a joint analysis of the whole sample unsuitable. There is evidence for at least four static and at least three dynamic factors in the first sample. In the second sample, the number of both static and dynamic factors is reduced, with one of the criteria pointing at only a single dynamic factor here. Based on the estimated number of factors, we use rotation techniques to test whether the higher than expected number of factors can at least partly be traced back to differences between East and West German labor market dynamics. We find strong evidence for regional differences along this dimension. While the "West factor" is closely related to the business cycle, measured by the ifo business climate index for West Germany, the "East factor" does not even respond to the East German ifo business climate index. This finding is stronger within the first sample, but does not fully vanish in the second one. However, inspection of the "East" and "West factors" yields the insight that a process of cyclical convergence took place until late 2001. Afterwards both factors seem to be more closely connected. Up to this convergence, East German labor market dynamics were apparently driven rather by political cycles than by the business cycle.

This convergence of cyclicality between East and West provides evidence that cyclicality is at most mildly affected by structural differences between regions, which is in line with the findings of classification approaches of regional labor markets in Germany. In their analyses, Blien et al. (2004) and Dauth et al. (2008) find that the labor markets in East and West Germany are sufficiently different along the line of several structural variables for time periods before and after 2005. Their results do not change much in time.

The rest of this paper is structured as follows. In Sect. 2, we describe the data set. Section 3 then analyzes the reasonably partitioned samples using the rotation techniques explained before. Section 4 looks at the relation between the identified labor market cycles and the business cycle, and Sect. 5 concludes.

## 2 The data: unemployment figures between 1997 and 2010

The data used here was obtained from the website of the *Bundesagentur für Arbeit*. From December 1997 till December 2004, there is a panel data set for the 439 NUTS-3 regions, or counties, of Germany that includes both unemployment rates and absolute unemployment figures on a monthly basis. Starting in January 2005, monthly data sets are available. We combine the data for 65 months, the last being May 2010. We make some adjustments in order to deal with changes in the county structure. With restructuring taking place in Saxony-Anhalt in 2007 and in Saxony in 2008, the number of NUTS-3 regions has now been reduced to 412. For the data prior to the restructurings, we remodel the current counties from the data of communities, smaller entities, with every county containing between 50 and 100 of them. Changes in the structure of these communities as well as minor restructuring of counties are also accounted for in the data set.

We will look at the growth rate of absolute unemployment figures instead of unemployment rates as they are not affected by the numbers of people in employment, which are only available at a lower frequency. Thus, let $n_{i,t}$ denote the number of registered unemployed people in county $i$ at time $t$. Our data is then

$$y_{i,t} = \frac{n_{i,t} - n_{i,t-1}}{n_{i,t-1}}, \quad \forall i : 1 \to N,\ t : 2 \to T \tag{1}$$

representing monthly growth rates of unemployment for all NUTS-3 regions.

All unemployment data in this analysis is then seasonally adjusted by X-12 ARIMA. The seasonal pattern is calculated as the average amplitude of the extracted seasonal pattern and reaches from 0.0525 to 0.7813, with its median at 0.1313 in the first sample and from 0.0616 to 0.9266, with its median at 0.171 in the second sample. Strong seasonal effects can be observed in North East Bavaria and coastal regions at the Baltic and North Sea. This holds for both samples. It is obvious that mainly regions with a high level of tourism activity are exposed to strong seasonal variations.

For the purpose of a factor analysis, each county series is demeaned and standardized. The mean growth rate in the first sample is negative for 45% of all observations and for 55% of the East German counties. The mean of all means for counties located in the West is 0.000242 or roughly 0.3% on an annual basis, indicating a slight increase in unemployment. The mean for all East German counties remains almost unchanged. In the second sample, the mean growth rate is negative for all observations except one, namely Remscheid. The number of unemployed decreases much faster in the Eastern counties. On an annual basis, the mean of the mean growth rate was −10.2% for Eastern and −7.4% for Western Counties. Note, as the data is demeaned, these differences in trend do not enter the following analysis. Standard deviations are also much smaller in the first sample, with the mean at 0.0174 and the median at 0.0167, than in the second one, with 0.0265 and 0.025, respectively. This increase is mainly due to the counties in the West, however, whereas volatility of those in the East increases only slightly. Due to the differentiation, the levels of unemployment are eliminated from the data. In addition, the demeaning removes possible linear trends. The standardization, in turn, takes away the differences in amplitude. In the adjusted data, only cyclical differences remain, and the resulting factor loadings represent the relative impact of the nationwide factors.

The "Hartz IV" labor market reforms, taking effect in January 2005, had a strong impact on the statistics: Many people that were receiving social benefits but were not registered as seeking for work are counted as unemployed afterwards. In addition, statistics about the long-term unemployed are maintained by the local authorities—generally in cooperation with the *Bundesagentur*, but in the case of 69 counties, all tasks are performed by the local authorities exclusively. It is highly likely that the data before and after the "Hartz" reforms are not comparable with each other in several aspects. To determine whether this concern is actually relevant for our kind of analysis, we apply the LM-test for structural stability of static as well as dynamic factors recently proposed by Breitung and Eickmeier (2009) that indicates a structural break in 2005. Thus, we treat both parts separately. In turn, tests on the resulting subsamples yield no evidence for further structural breaks.

## 3 Common patterns and their regional distribution

### 3.1 The number of common factors

We assume that the standardized and demeaned growth rates of the number of unemployed are driven by r factors as follows:

$$Y_{(T\times N)} = F_{(T\times r)} L'_{(r\times N)} + U_{(T\times N)} \tag{2}$$

Estimation is done via principal components. This is consistent even when idiosyncratic errors are not white noise, see Bai (2003). To determine the number of static factors we apply the criteria of Bai and Ng (2002, 2008) and Onatski (2005). Bai and Ng propose several versions of their criterion. Here we only report the results for the criteria that performed best in a preliminary simulation study with same sample sizes as in the empirical setting.[1] It should be pointed out that in simulations with high variance in the idiosyncratic component, the Onatski criterion performed better than the Bai–Ng criterion, which tended to underestimate

[1]The reported Bai–Ng criterion is proposed in Bai and Ng (2008) as number 3.

**Table 1** Bai–Ng and Onatski criteria for the number of static factors

| Number of factors | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Bai-Ng[a] | | | | | | |
| 1997–2004 sample | −0.2528 | −0.3095 | −0.3172 | **−0.3217** | −0.3135 | −0.3031 |
| 2005–2010 sample | −0.3947 | −0.4104 | **−0.4134** | −0.3977 | −0.3810 | −0.3653 |
| 06.2005–2010 sample | −0.4184 | **−0.4296** | −0.4180 | −0.3996 | −0.3830 | −0.3613 |
| Onatski[b] | | | | | | |
| 1997–2004 sample[c] | **9270.21** | **2816.62** | **1428.32** | **1274.58** | 943.03 | 859.39 |
| 2005–2010 sample[c] | **9304.35** | **1291.7** | **1009.52** | 689.95 | 644.35 | 625.79 |
| 06.2005–2010 sample[c] | **9052.59** | **1161.84** | 768.78 | 648.57 | 637.48 | 561.69 |

[a]Numbers in bold face indicate the minima for each sample

[b]Numbers in bold face indicate eigenvalues exceeding the threshold

[c]Thresholds for the eigenvalues are: 948.2, 982.95, 860.99, and 819.43

**Table 2** Bai–Ng and Onatski criteria for the number of dynamic factors

| Number of factors | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Bai–Ng[a] | | | | | | |
| 1997–2004 sample | −0.4584 | −0.4869 | **−0.4949** | −0.4920 | −0.4806 | −0.4649 |
| 2005–2008 sample | **−0.6388** | −0.6324 | −0.6220 | −0.6070 | −0.5885 | −0.5685 |
| 05.2005–2008 sample | **−0.5841** | −0.5771 | −0.5664 | −0.5471 | −0.5242 | −0.5014 |
| Onatski[b] | | | | | | |
| 1997–2004 sample | **6219.58** | **2363.65** | **1574.84** | **1238.74** | 1001.09 | 870.31 |
| 2005–2008 sample | **6840.89** | **1021.37** | 955.39 | 789.58 | 711.58 | 674.43 |
| 05.2005–2008 sample | **6027.66** | **1034.42** | 875.61 | 694.51 | 674.43 | 631.79 |

[a]Numbers in bold face indicate the minima for each sample

[b]Numbers in bold face indicate eigenvalues exceeding the threshold

[c]Thresholds for the eigenvalues are 1103.95, 1123.37, 960.97, and 957.33

the number of factors. We find four static factors in the 1997 to 2004 sample and three in the 2005 to 2010 sample if we use the Onatski criterion. For the Bai–Ng criterion, we get the same results for both samples. It can be argued that during the first few months of 2005, data problems may have occurred, which rendered the respective observations invalid to some extent. Omitting the observations from January to May 2005, the number of static factors is reduced to two for both criteria (see Table 1).

Next, we look at the number of dynamic factors or primitive shocks, based on these findings. Obviously, this number could be smaller, as some static factors may just represent linear combinations of the other lagged factors. For this purpose we apply the method of Amengual and Watson (2007), where in a first step the dynamics in the data is eliminated by means of a VAR model. In the second step the number of factors within the residuals is determined by the same criteria as for static factor models. For the first sample, the Bai–Ng criterion suggests three dynamic factors. The Onatski criterion estimates four dynamic factors. For the second sample, we obtain only one dynamic factor based on the Bai–Ng criterion, and two as we use the Onatski method. This result does not change, whether or not we omit the first five observations. So there is some support for the hypothesis of a single dynamic factor driving the labor market and hence a single labor market cycle in Germany in 2005 to 2010 (see Table 2).

### 3.2 Rotations and specific regional properties

The principal components solution yields factors ordered by their explanatory power. The first factor or general factor explains the largest part of the variation in the data and may be interpreted as a nationwide cycle. Figure 1 shows that from 1997 to 2004, in most counties, the first factor is indeed the dominant one, i.e. the factor with the highest loadings. Particularly in the Eastern part of Germany, however, we see deviations from this pattern. The loadings on the first factor are also much lower there. 311 out of the 327 counties in the West have the first factor as the dominant one, compared to only 39 out of the 112 in the East.

This indicates that we might in fact have a different behavior of the labor market cycles in East and West. Hence we obtain a second result, as we apply a rotation technique, seeking to maximize the difference between the explanatory value of a factor in the East and the West, respectively. The applied rotation techniques are explained in Appendix. We choose the first factor to focus on the West and the second factor to focus on the East. Note that the factors are still orthogonal to each other. If East and West were very similar, these factors should not explain much, because there would be almost no mutually orthogonal information in the West and East subsamples. Furthermore, the difference between explanatory power in the East and

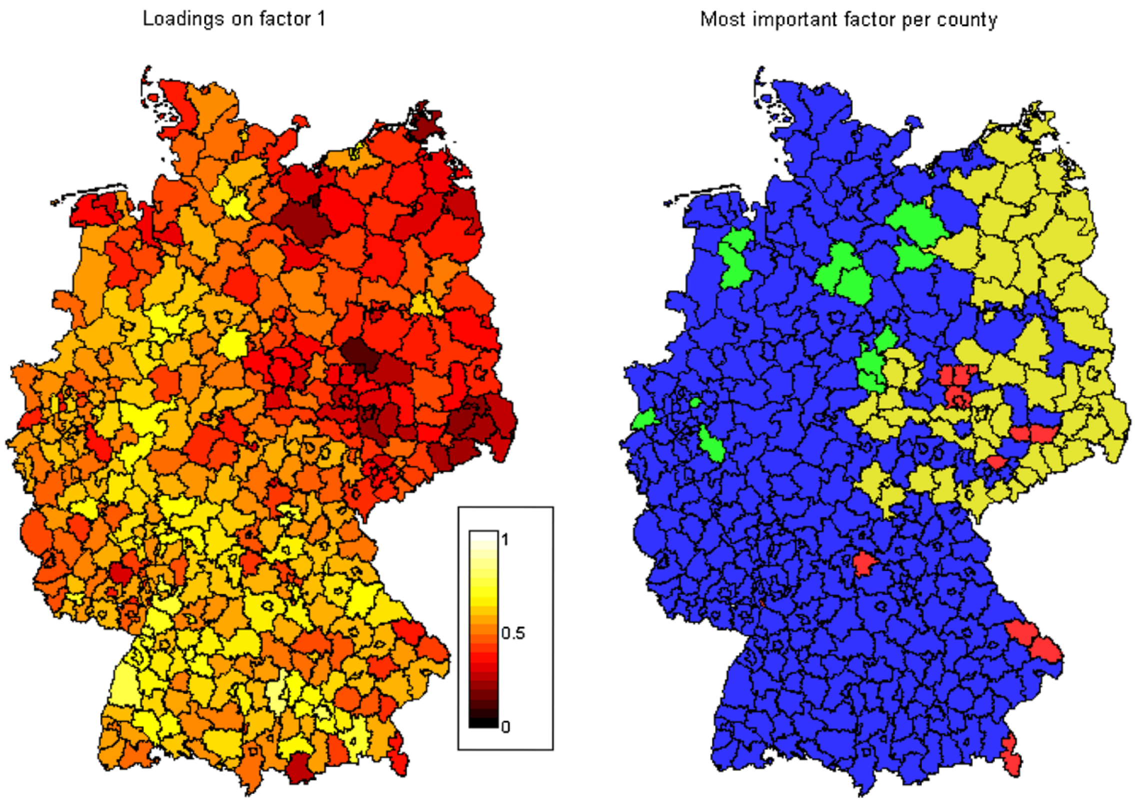


**Fig. 1** Dominant factor in the first subsample and loadings on general factor. *Note*: The *left panel* shows the loadings on the factor that is dominant in the majority of the counties. In the *right panel*, each different color indicates the dominance of a different factor

West subsamples would be very small. Table 3 gives the average explanatory power of each of the four factors for the counties in the East and the West combined and separately. We see that the dominant factor in the West is very weak in the East and vice versa. However, both factors have each high explaining power in their respective region. The two remaining factors have almost negligible importance. Figure 2 shows this very clearly as well. The difference between East and West in average squared loadings for the "East factor" is $|0.3231 - 0.0351| = 0.288$, that of the "West factor" amounts to $|0.0296 - 0.2832| = 0.2536$. To evaluate the significance of this difference, we randomly create partitions of the whole sample into subsamples of 112 and 327 observations, perform the same rotation technique and look at the differences in explanatory value for the respective factors. Out of 10,000 replications, we obtain an empirical distribution that will serve as a guideline for the difference measured by the partition into East and West. Not a single random partition was able to generate the differences obtained from the partition into East and West. We can therefore conclude that between 1997 and 2004, the finding of more than just one labor market cycle in Germany is at least partly due to the differences between East and West.

**Table 3** Average squared loadings per factor for the sample from 1997 to 2004

| | $\overline{\lambda_1^2}$ | $\overline{\lambda_2^2}$ | $\overline{\lambda_3^2}$ | $\overline{\lambda_4^2}$ | Communality |
|---|---|---|---|---|---|
| East | 0.0296 | 0.3231 | 0.025 | 0.0139 | 0.3916 |
| West | 0.2832 | 0.0351 | 0.0486 | 0.0438 | 0.4108 |
| Total | 0.2185 | 0.1086 | 0.0426 | 0.0362 | 0.4059 |

*Note*: The factors and loadings have been rotated to maximize the expression in (A4), creating the highest possible average squared loading for the West German counties for the first factor and the highest possible average squared loading for the East German counties for the second factor. Factors are orthogonal

Alternatively, we conduct an oblique rotation exercise and obtain a third result, where one factor is chosen to maximize the West German loadings and a second one to maximize the East German loadings. The resulting factors are only mildly correlated contemporaneously underlining the results of the former exercise. Looking at the correlations among the oblique factors and their correlations with the general factor according to the first rotation exercise, we find $r_{East,West} = 0.4709$, $r_{Gen.,West} = 0.9803$ and $r_{Gen.,East} = 0.6354$. Hence in the oblique solution, the "West factor" is closer to the general pattern than the "East factor."

Next, we repeat the same with the more recent data set, covering the period between 2005 and 2010. Now, 314 out of the West's 326 counties have the general factor as the

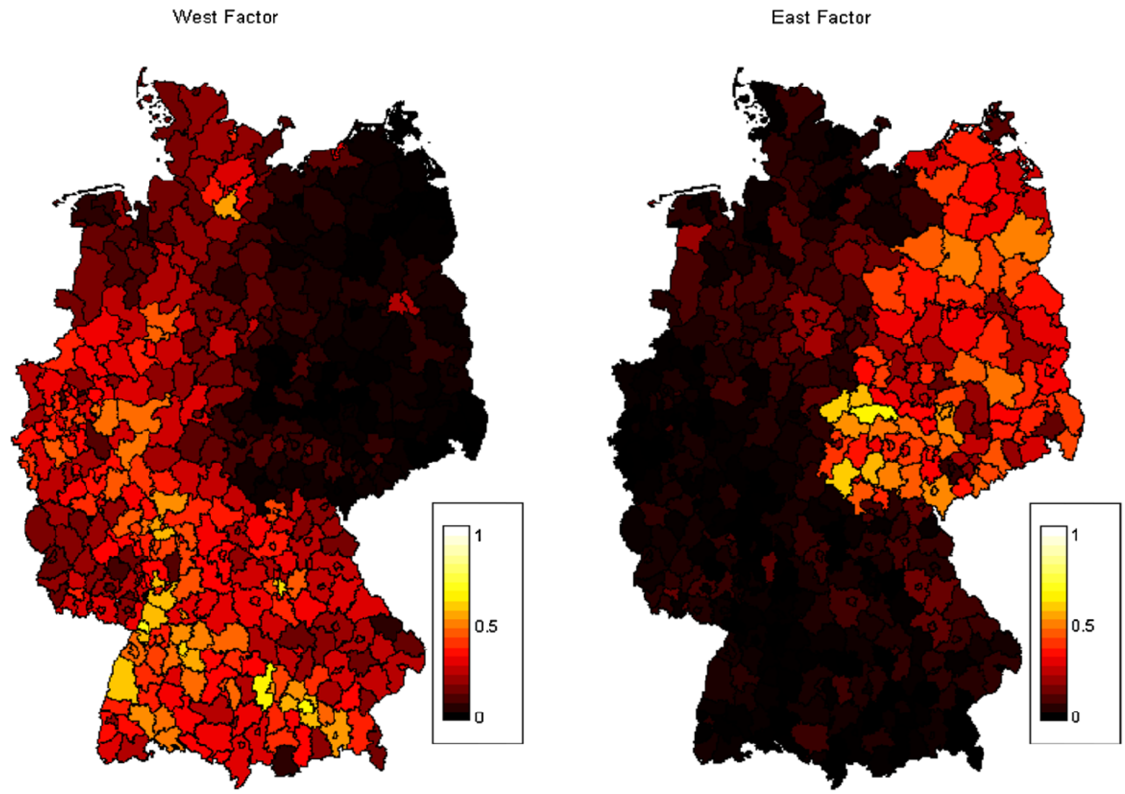


**Fig. 2** Explanatory power of the 'West' and 'East' factors in the data from 1997 to 2004 after rotation

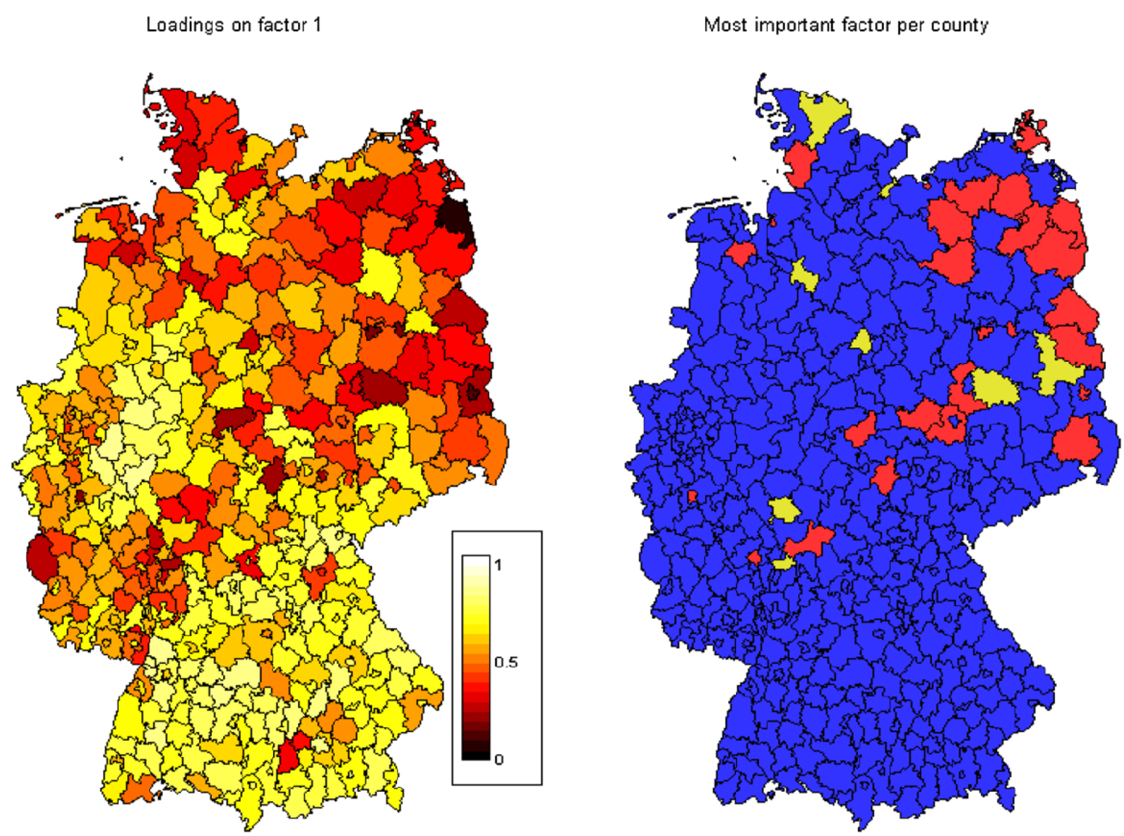


**Fig. 3** Dominant factor in the second subsample and loadings on general factor. *Note*: The *left panel* shows the loadings on the factor that is dominant in the majority of the counties. In the *right panel*, each different color indicates the dominance of a different factor

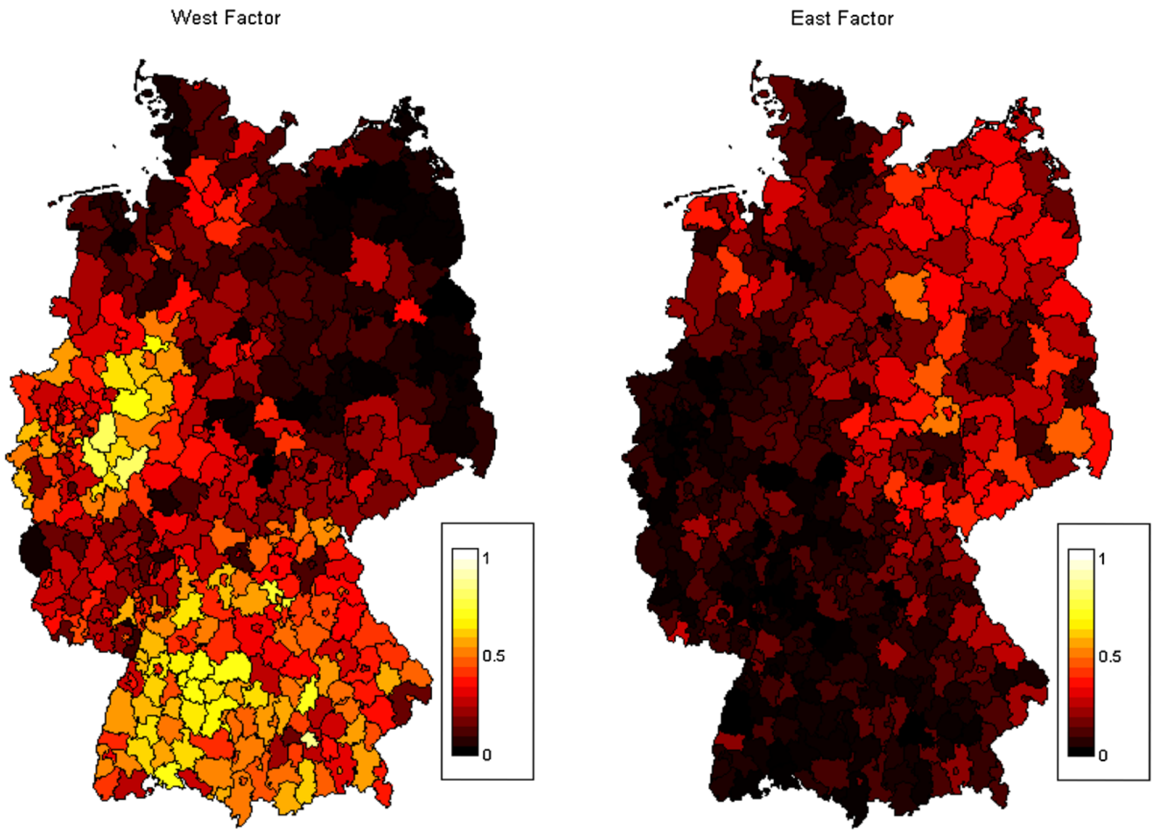


**Fig. 4** Explanatory power of the 'West' and 'East' factors in the data from 2005 to 2010 after rotation

dominant one, but as many as 62 out of the 86 counties in the East do. Especially in Thuringia and Saxony the general factor gained a lot of importance while its impact is diminished in some Northern counties. Figure 3 gives the graphical illustration for this. As the right panel shows, there is much more homogeneity in the full sample than before. Altogether, there is not quite such a clear differentiation between East and West any longer.

We repeat the orthogonal rotation, setting the first as the 'West' and second as the 'East' factor. Table 4 gives the average explanatory value of each of the factors within each subsample. There is still a clear difference, yet not as pronounced any more. The difference for the 'East' factor amounts to 0.1616.

Figure 4 shows that the explanatory power of the 'West' factor is high particularly near Hamburg, in North-Rhine Westphalia and in the South, whereas the 'East' factor is now also prominent in Lower Saxony. Furthermore, we observe many counties whose unemployment is not represented by either of the two factors. Concerning the correlation of the oblique factors with the general factor, we obtain the following results: $r_{East,West} = 0.7921$, $r_{Gen.,West} = 0.9957$ and $r_{Gen.,East} = 0.8452$. Hence, we observe that in the second sample, the differences between the two factors' correlations with the general factor are much smaller.

**Table 4** Average squared loadings per factor for the sample from 2005 to 2010

| | $\overline{\lambda_1^2}$ | $\overline{\lambda_2^2}$ | $\overline{\lambda_3^2}$ | Communality |
|---|---|---|---|---|
| East | 0.1024 | 0.2371 | 0.0168 | 0.3562 |
| West | 0.3457 | 0.0755 | 0.05 | 0.4711 |
| Total | 0.2949 | 0.1092 | 0.043 | 0.4471 |

*Note*: The factors and loadings have been rotated to maximize the expression in (A4), creating the highest possible average squared loading for the West German counties for the first factor and the highest possible average squared loading for the East German counties for the second factor. Factors are orthogonal

Again, we take a look at the empirical distribution of the differences and find that the partition into East and West is still highly significant. We therefore conclude that in the static analysis, the labor market dynamics in West and East Germany were and still are different. However, the higher correlation of the oblique factors points at a substantial degree of convergence between the East and the West cycle.

Figure 5 shows the factors extracted from the first sample. We see that up until 2001, there are clear differences between the factor for East Germany and the one for West Germany, while the general factor resembles the "West factor." As of 2002, the two oblique factors look much more

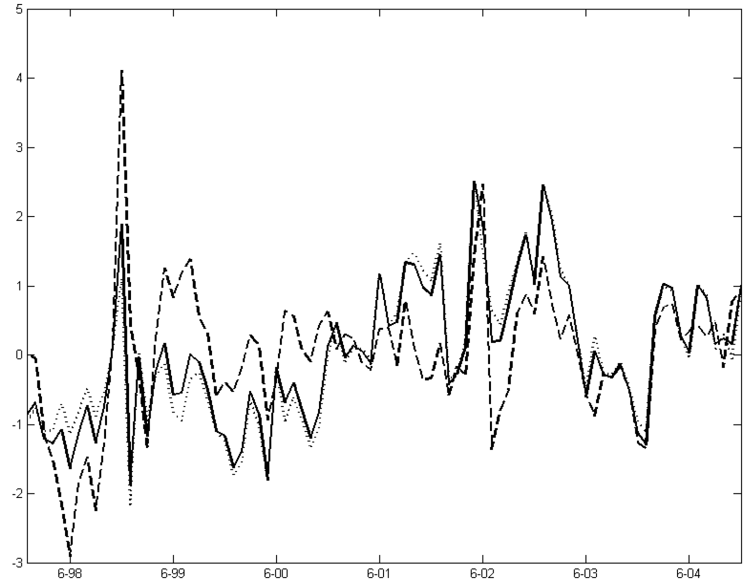


**Fig. 5** Oblique factors for East Germany (*dashed*), West Germany (*dotted*), and the full sample (*solid*) for the first sample (1997–2004)

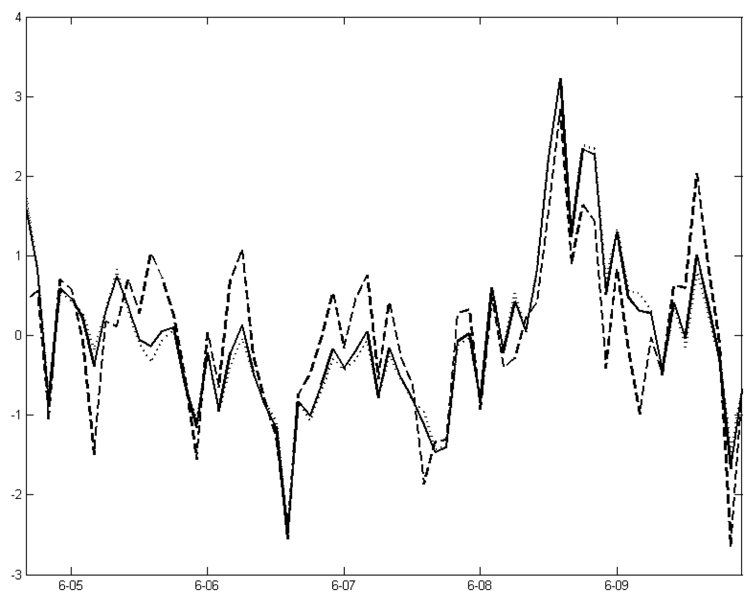


**Fig. 6** Oblique factors for East Germany (*dashed*), West Germany (*dotted*), and the full sample (*solid*) for the second sample (2005–2010)

similar. The same is visible from Fig. 6, covering the subsequent period. There are a few observations with more pronounced gaps between the "East" and the "West factor," yet not long periods, which were observable in the first sample. This visual inspection indicates that some degree of convergence between Eastern and Western labor market dynamics took place until late 2001.

## 4 The driving forces behind the two major factors

Having established the existence of an "East" and a "West" factor in the unemployment dynamics in both data sets, we will next investigate what is behind these factors. As mentioned previously, there should be a connection between the identified labor market cycle and the business cycle. Since our data set contains growth rates of unemployment, it should be a negative one. To measure this connection, we estimate a VAR model that assesses the effect of the ifo business climate index for East and West Germany on the factors that we identified. We apply the ifo indices since GDP, which would be the best suited indicator to measure the business cycle, is not available in monthly frequency.[2] Further, even at quarterly frequency, GDP is not available

[2]We also run VARs at quarterly frequency, where factors are aggregated to the lower frequency. Their results are in line with our findings for the monthly data. The West factor responds to GDP while the East factor neither responds to German GDP nor to Saxonian GDP. However, the number of observations is quite low. Accordingly, we report results for the monthly data with the ifo indices as proxy variables.

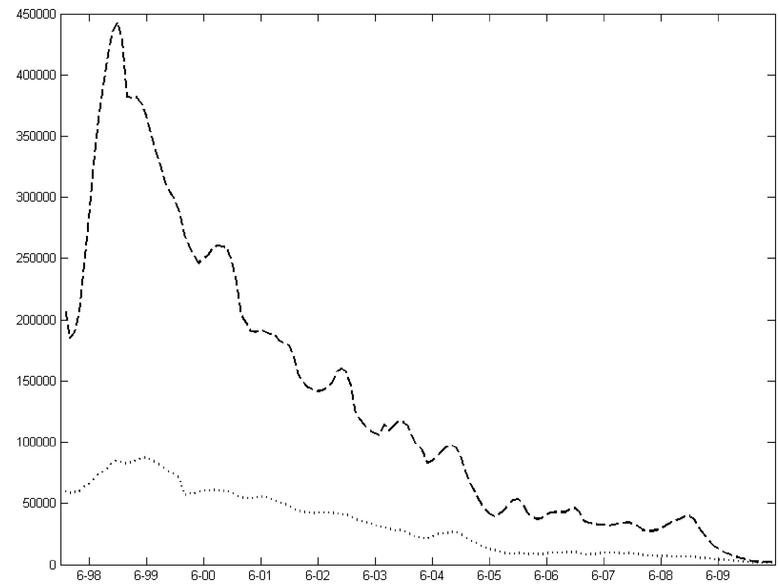


**Fig. 7** Number of people in active labor market policy programs: the *dashed line* denotes figures for East Germany, the *dotted line* denotes figures for West Germany (Source: IAB)

for East Germany separately.[3] An additional variable is introduced to capture the impact of political measures. It reflects how many people are currently supported by job creation schemes. The variable we use is the sum of people in two types of public work schemes, *Arbeitsbeschaffungsmaßnahmen* and *Strukturanpassungsmaßnahmen.* Since we use growth rates for unemployment figures, we are also using growth rates for these figures. The data are available in two monthly series for East and West Germany and are shown in Fig. 7.

Figure 8 shows the responses of the "East" factor in the first data set. Neither the ifo business climate for West Germany nor that for East Germany have a significant effect on the factor. Active labor market policy, however, does. Additionally, the "West" factor generates a response in the "East" factor. Figure 9 shows the responses of the "West" factor in the first data set. It clearly responds to the ifo index for West Germany and to that for East Germany. It does not react to active labor market policy in the West since active labor market policy had only a relative low weight in the West.

Hence in the first sample, we observe that active labor market policy has an effect on the factor prominent in East Germany. We can therefore conclude that the public work schemes that were applied there were a major driving force behind the identified cycle. In West Germany, conversely, the business climate used as a proxy for the business cycle was the main driving force behind the unemployment cycle. These findings combined with the fact that active labor policy for East Germany was substantially reduced in the second half of the first sample may give an explanation for the convergence process observed in the "East" and "West" factors. During the first half of the sample, the "East" factor was mainly driven by active labor policy. When these measures were reduced, the business cycle got relatively more important.

Now as we look at the analogous impulse–response functions for the second sample in Fig. 10, we see that there is a slightly significant reaction of the "East" factor to the ifo index for West Germany, but not to that of East Germany. The response to active labor market policies disappears in the second sample; the response to the West German cycle is stronger than before. Finally, Fig. 11 shows the results of the same exercise for West Germany. The ifo index for West Germany clearly has an effect on the "West" factor. Active labor market policy has a slightly significant effect, which, however, has a negative sign. Instead of assuming that active labor market policy had an adverse effect on unemployment in the West, we may as well consider this result an artifact, due to the very low number of people involved in such programs in West Germany after 2005.

## 5 Conclusion

We analyze the regional labor market dynamics in Germany using a factor model approach for monthly data from December 1997 to May 2010. As the "Hartz" reforms took place within this time period with many effects on the data generating process as well as on the data collection process, structural stability over this sample can be doubted.

Results for the VAR analysis with quarterly data are provided by the authors upon request.

[3] The Federal Statistical Agency stopped reporting East German GDP in 1998. Solely a quarterly interpolation for the Saxonian GDP is available; see Nierhaus (2008).

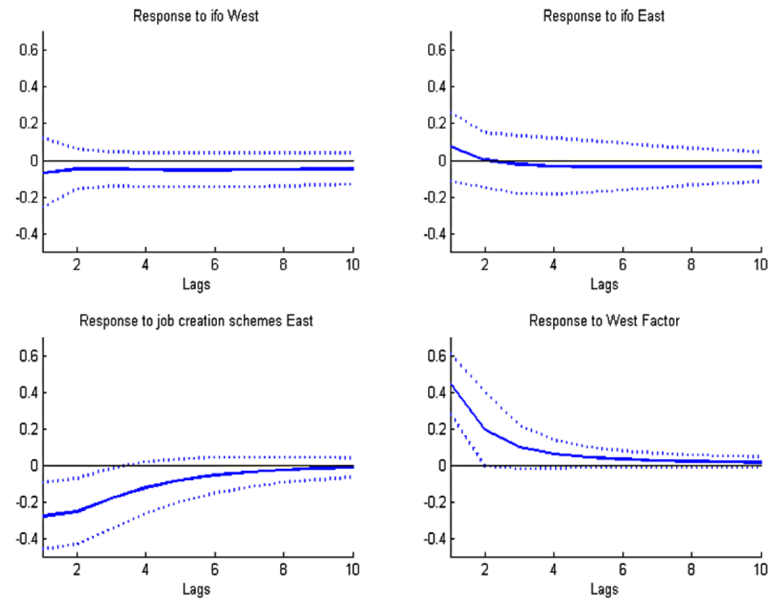


**Fig. 8** Impulse–Response Function showing the "East" factor's response to the ifo index for West Germany, for East Germany, active labor market policies in East Germany and the "West" Factor in the first sample (1997–2004). *Note*: Responses are obtained from a structural VAR(1) model. Shocks are one standard deviation for each series. Orthogonalization of the responses is achieved by Cholesky decomposition. *Dotted lines* denote innovations ±2 standard deviations

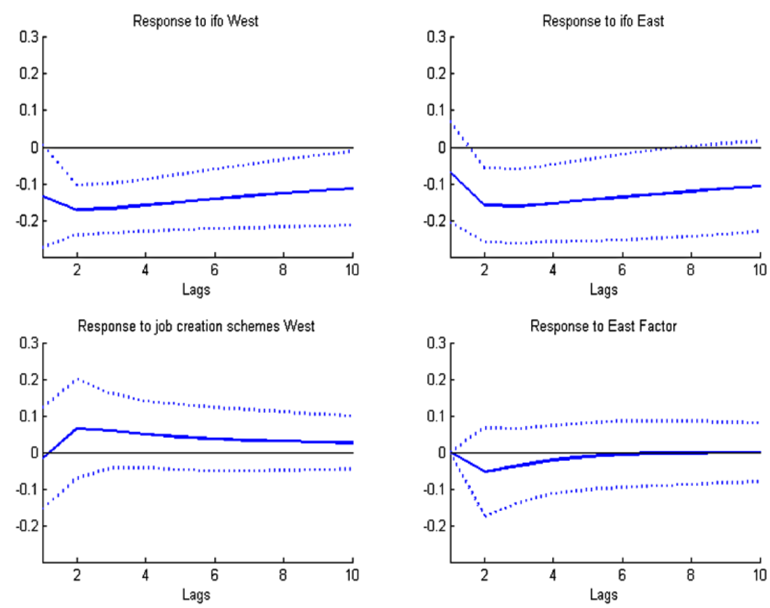


**Fig. 9** Impulse–Response Function showing the "West" factor's response to the ifo index for West Germany, for East Germany, active labor market policies in West Germany and the "East" factor in the first sample (1997–2004). *Note*: Responses are obtained from a structural VAR(1) model. Shocks are one standard deviation for each series. Orthogonalization of the responses is achieved by Cholesky decomposition. *Dotted lines* denote innovations ±2 standard deviations

Indeed, this doubt is proved by a test of structural stability. For the two individually analyzed samples covering the time periods from December 1997 to December 2004 and from January 2005 to May 2010, respectively, structural stability cannot be rejected. Within the first sample, we find evidence for four static and three or four dynamic factors. Thus, the labor market dynamics are not just driven by a single nationwide business cycle factor, but additional sources of shocks play a role. A rotation exercise shows that one of the factors represents a labor market cycle predominant in West Germany, and a second represents one predominant in East Germany. Both factors explain little to nothing of the labor market dynamics in the other part of the country (Fig. 8).

The factor that explains much of the variation of East German labor market dynamics seems to be generally disconnected from the business cycle, as measured by the ifo business climate index. Hence this cycle can be assumed to be a "political cycle" orthogonal to the business cycle. This verdict is strongly supported by the impulse–response analysis which shows a significant response of the cycle to active labor market policy applied in East Germany. Thus, political measures to fight the unemployment phenomenon in East Germany may have induced additional volatility on labor markets and seem to have been far from anti-cyclical.

We perform the same analysis for the second sample, which starts after the structural break related to the "Hartz" reforms. As the time series dimension of this sample is lower

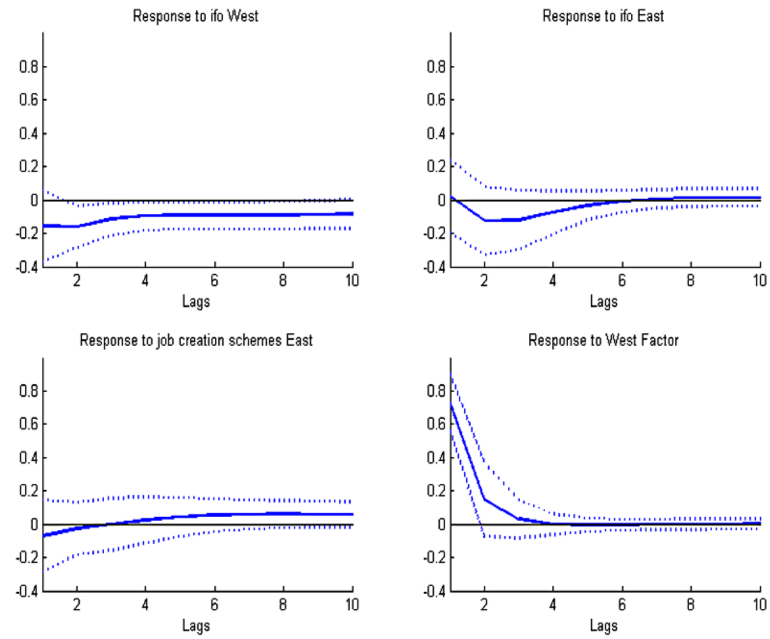


**Fig. 10** Impulse–Response Function showing the "East" factor's response to the ifo index for West Germany, for East Germany, active labor market policies in East Germany and the "West" factor in the second sample (2005–2010). *Note*: Responses are obtained from a structural VAR(1) model. Shocks are one standard deviation for each series. Orthogonalization of the responses is achieved by Cholesky decomposition. *Dotted lines* denote innovations ±2 standard deviations

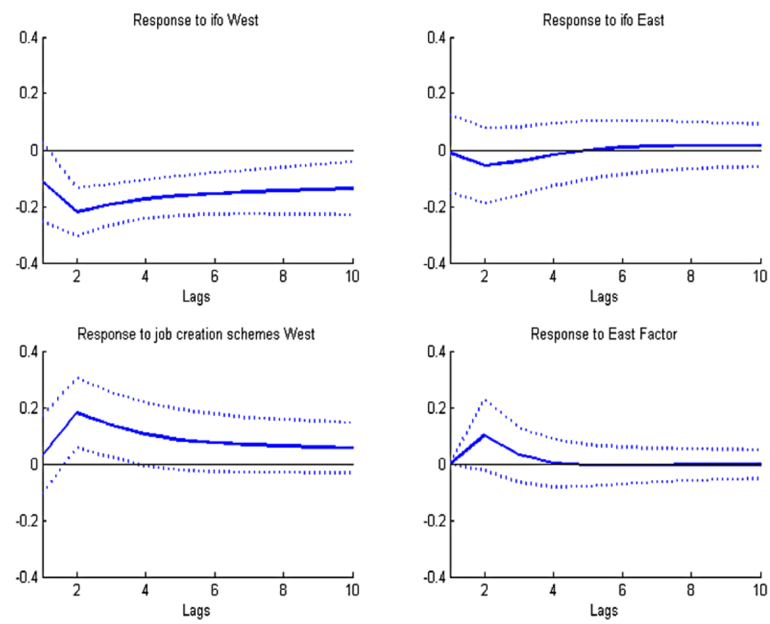


**Fig. 11** Impulse–Response Function showing the "West" factor's response to the ifo index for West Germany, for East Germany, active labor market policies in West Germany and the "East" factor in the second sample (2005–2010). *Note*: Responses are obtained from a structural VAR(1) model. Shocks are one standard deviation for each series. Orthogonalization of the responses is achieved by Cholesky decomposition. *Dotted lines* denote innovations ±2 standard deviations

and quality of the data especially at the early stage of the reform period is questionable, results have to be evaluated with care. We find a lower number of factors, static as well as dynamic. While the rotation exercise still points at particularities in the East German counties, the impact of a potential East German factor is clearly diminished. Visual inspection of the loadings for the first principal component or general factor points at some disparity between North-East (apart from Hamburg) and South-West where the general factor is much more important. Overall, the property of the first data set, in which each county had a high loading either on the East or the West German factor does not hold for the second data set any more. The cycle for East Germany is now no longer driven by active labor market policy, but rather by the business cycle.

Individual factors for East and West run in a quite disconnected manner until late 2001; afterwards, they display only much smaller deviations from each other. The variation between the two factors, however, seems to be induced by active labor market policy. The convergence of the East and West German labor markets would thus have been obstructed by the active labor market policies of the late 1990s. Their reduction after 2005 and virtual abandonment after 2009 can therefore be considered to have a double positive effect, i.e. reducing expenses as well as making the unified labor market more efficient.

## Executive summary

We analyze unemployment dynamics for Germany on a regional basis. The goal of the analysis is to determine the number of factors driving the labor market dynamics, to characterize these factors and to assess whether the patterns changed over time. Therefore we use two data sets. The first of these covers the period from 1998 to 2004, before the introduction of the 'Hartz' labor market reforms; the second one reaches from 2005 to 2010, after the reforms went into effect. Both data sets are converted to growth rates and then adjusted in such a way that only cyclical differences remain. This is achieved by removing seasonal patterns, demeaning and standardizing each series. For the adjusted data, we apply two different criteria to determine the number of factors, or latent systematic components. We find four static and three or four dynamic factors in the first data set. One of these factors is predominantly strong in West Germany, while a second one is predominantly strong in the East.

We transform the factor structure in such a way that we find one factor that focuses on West Germany and one that focuses on East Germany. We analyze the impulse–response functions to find the economic determinants driving the two factors. While the factor for West Germany is significantly responding to measures of the business climate, the factor for East Germany is showing a significant response to the number of people in active labor market policy schemes. We therefore conclude that the second factor represents a "political cycle" induced by active labor market policy.

In the second sample, we find that the number of static and dynamic factors is reduced. Our observation from the first sample cannot be replicated. The factor structure does not suggest an East-West division as clearly as before any longer. A transformation into an East-West factor structure as before and the analysis of the respective of the impulse–response functions shows that now the factor for East Germany is no longer driven by active labor market policy, but by the business cycle, just like the factor for West Germany. We therefore conclude that convergence of the labor market in East and West Germany could have been obstructed by measures of active labor market policy, and the reduction of theses measures as of 2005 helped to improve convergence and efficiency.

## Kurzfassung

Wir analysieren die Dynamik der Arbeitslosigkeit in Deutschland auf regionaler Ebene mit dem Ziel, die Anzahl der treibenden Faktoren zu bestimmen, die Faktoren selbst zu charakterisieren und Veränderungen über die Zeit zu verfolgen. Dazu betrachten wir zwei Datensätze. Der erste Datensatz deckt die Periode von 1998 bis 2004, vor der Einführung der 'Hartz IV'-Arbeitsmarktreformen ab, der zweite reicht von 2005 bis 2010, nach Inkrafttreten der Arbeitsmarktreformen. Beide Datensätze werden zunächst in Wachstumsraten umgerechnet und dann so angepasst, dass nur zyklische Unterschiede erhalten bleiben. Zu diesem Zweck werden die Saisonmuster entfernt und die Datenreihen gemittelt und standardisiert. Für die angepassten Daten verwenden wir zwei Verfahren zur Bestimmung der Anzahl der Faktoren oder latenten systematischen Komponenten. Wir finden im ersten Datensatz vier statische und drei oder vier dynamische Faktoren. Einer der Faktoren tritt besonders stark in Westdeutschland auf, während ein weiterer besonders stark in Ostdeutschland zu beobachten ist.

Wir transformieren nun die Faktorstruktur so, dass wir einen Faktor erhalten, der bestmöglich die westdeutsche Dynamik erklärt und einen, der bestmöglich die ostdeutsche Dynamik erklärt. Wir untersuchen die Impuls-Antwort-Funktionen, um herauszufinden, welche ökonomischen Bestimmungsgrößen die Faktoren beeinflussen. Der westdeutsche Faktor reagiert hierbei signifikant auf Maße des Geschäftsklimas, während der ostdeutsche Faktor eine signifikante Reaktion auf die Anzahl der Teilnehmer an Maßnahmen der aktiven Arbeitsmarktpolitik aufweist. Wir schließen daraus, dass der zweite Faktor einen "politischen Zyklus" repräsentiert, der durch die Maßnahmen der aktiven Arbeitsmarktpolitik hervorgerufen wurde.

In der zweiten Stichprobe finden wir eine geringere Zahl statischer und dynamischer Faktoren. Unsere Beobachtungen aus der ersten Stichprobe lassen sich hier nicht replizieren. Die Faktorstruktur legt keine klare Trennung zwischen Ost- und Westdeutschland nahe, wie sie in der ersten Stichprobe zu beobachten war. Eine Transformation in einen Ost- und einen West-Faktor wie zuvor und die entsprechende Betrachtung der Impuls-Antwort-Funktionen zeigt, dass nun der Faktor für Ostdeutschland nicht mehr von aktiver Arbeitsmarktpolitik getrieben wird, sondern ebenfalls auf den Konjunkturzyklus reagiert. Wir schließen daraus, dass eine Konvergenz der Arbeitsmärkte in Ost- und Westdeutschland durch Maßnahmen der aktiven Arbeitsmarktpolitik beeinträchtigt worden sein könnte und dass die Reduzierung dieser Maßnahmen ab 2005 Konvergenz und Effizienz begünstigt hat.

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## Appendix: Factor rotations

The solution of the factor model is not unique. Instead, we can easily see that

$$Y = F^* L^{*\prime} + U = FAA^{-1}L' + U \tag{A1}$$

also represents a solution, where the so-called rotation matrix $A$ is $(r \times r)$, invertible with $\det(A) = 1$, so as to ensure that $F$ and $L$ do not to lose their original properties. Two-dimensional rotation matrices are explained e.g. in Jobson (1991) or Fahrmeir et al. (1996) and take the form of

$$A = \begin{pmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{pmatrix} \tag{A2}$$

If we have more than two dimensions, we can sequentially rotate the system around the different axes, and hence have a set of $\binom{r}{2}$ matrices to do so. Press et al. (2007) describe an algorithm that can be used to search through the space of orthogonal transformations of the original solution for the $n$-dimensional case. Typically, rotation techniques are used to obtain better interpretable results from factor analysis.

If the factor $j$ we want to find should be particularly strong in one part of the sample $Y_1$ (e.g. East Germany) and particularly weak in another part $Y_2$ (e.g. West Germany), we maximize

$$\Delta\zeta_j = \zeta_j(Y_1) - \zeta_j(Y_2), \tag{A3}$$

where $\zeta_j(Y_1) = \frac{1}{N_1}\sum_{i=1}^{N_1} \lambda_{ij}^2$ represents the average of the squared loadings in region 1, consisting of $N_1$ units (e.g. 112 counties).

The same is possible for a rotation that maximizes explanatory power of $J$ different factors, which are then maintained in an orthogonal fashion. Equation (A3) then changes to

$$\Delta\zeta_J = \sum_{j=1}^{J} \big[\zeta_j(Y_1) - \zeta_j(Y_2)\big] \tag{A4}$$

One question that arises in this context is how large the difference should be to ensure that the partition of the entire sample into $Y_1$ and $Y_2$ be justified the way it is performed. Even though no distribution of $\Delta\zeta_j$ is known beforehand, we can simulate one from random partitions of the sample into subsamples $\tilde{Y}_1$ and $\tilde{Y}_2$ of the same size as $Y_1$ and $Y_2$, for which we calculate the respective $\Delta\zeta_j$. Rotations maximizing (A4) are conducted in the paper to reach orthogonal 'East' and 'West factors.'

Alternatively, if it is assumed that for a certain group of counties $N_k$ out of our $N$ series a specific factor j prevails, we rotate the initial solution to maximize

$$\chi_j(Y_k) = \frac{1}{N_k}\left|\sum_{i=1}^{N_k} \operatorname{sgn}(\lambda_{ij}) \times \lambda_{ij}^2\right|. \tag{A5}$$

The factor thus extracted is then a 'regional' factor that 'specializes' in representing the cycle in that subset of the full sample. If such factors are determined sequentially for different parts of the sample, they will normally not be exactly the same, but also not fully orthogonal. Instead, they will generally be correlated with each other to some extent. Rotations maximizing (A5) are conducted in the paper to reach oblique 'East' and 'West factors.'

## References


Amengual, D., Watson, M.W.: Consistent estimation of the number of dynamic factors in a large N and T panel. J. Bus. Econ. Stat. **25**, 91–96 (2007)

Bade, F.J.: Regionale Beschäftigungsprognose 1995. Mitt. Arb.markt-Berufsforsch. **24**(1), 25–44 (1991)

Bai, J.: Inferential theory for factor models of large dimensions. Econometrica **71**(1), 135–171 (2003)

Bai, J., Ng, S.: Determining the number of factors in approximate factor models. Econometrica **70**, 191–221 (2002)

Bai, J., Ng, S.: Large Dimensional Factor Analysis. Now Publishers, New York (2008)

Blanchard, O.J., Katz, L.F.: Regional evolutions. Brookings Pap. Econ. Act. **23**(1992-1), 1–76 (1992)

Blien, U., Hirschenauer, F., Arendt, M., Braun, H.J., Gunst, D.-M., Kılıçoğlu, S., Kleinschmidt, H., Musati, M., Ross, H., Vollkommer, D.: Typisierung von Bezirken der Agenturen für Arbeit. Z. Arbeitsmarktforsch. **37**(2), 146–175 (2004)

Blien, U., Phan thi Hong, V.: Arbeitslosigkeit regional: Auf verschiedenen Wegen in die Zukunft. IAB-Forum **2**, 43–47 (2008)

Brechling, F.: Trends and cycles in British regional unemployment. Oxf. Econ. Pap. **19**, 1–21 (1967)

Breitung, J., Eickmeier, S.: Testing for structural breaks in dynamic factor models. Discussion Paper Series 1: Economic Studies 2009, 05, Deutsche Bundesbank, Research Centre, Frankfurt (2009)

Dauth, W., Hirschenauer, F., Rüb, F.: Vergleichstypen 2008: Neufassung der SGBIII-Typisierung. Forschungsbericht 8. Institut für Arbeitsmarkt- und Berufsforschung Nürnberg (2008)

Decressin, J., Fatas, A.: Regional labor market dynamics in Europe. Eur. Econ. Rev. **39**(9), 1627–1655 (1995)

Eickmeier, S., Breitung, J.: How synchronized are Central and East European economies with the Euro area? Evidence from a structural factor model. Discussion Paper Series 1: Economic Studies 2005, 20, Deutsche Bundesbank, Research Centre, Frankfurt (2005)

Elhorst, J.P.: The mystery of regional unemployment differentials. Theoretical and empirical explanations. J. Econ. Surv. **17**(5), 709–748 (2003)

Fahrmeir, L., Hamerle, A., Tutz, G.: Multivariate Statistische Verfahren, 2nd edn. de Gruyter, Berlin (1996)

Hamilton, J.D., Owyang, M.T.: The propagation of regional recessions. Working Paper 2009-013, Federal Reserve Bank of St. Louis, St. Louis (2009)

Jobson, J.D.: Applied Multivariate Data Analysis—Volume II: Categorical and Multivariate Methods. Springer, New York (1991)

Kosfeld, R., Dreger, C.: Thresholds for employment and unemployment: a spatial analysis of German regional labour markets, 1992–2000. Pap. Reg. Sci. **85**(4), 523–542 (2006)

Kunz, M.: Unemployment dynamics in West Germany: do districts adjust differently than larger regional units? IAB Discussion Paper 200911. Institut für Arbeitsmarkt- und Berufsforschung, Nürnberg (2009)

Nierhaus, W.: Vierteljährliche Volkswirtschaftliche Gesamtrechnungen für den Freistaat Sachsen mit Hilfe temporaler Disaggregation. Stat. Sachs. **1**, 1–15 (2008)

Onatski, A.: Determining the number of factors from empirical distribution of eigenvalues. Discussion Paper Series 0405-19, Columbia University, Department of Economics, New York (2005)

Press, W.H., Teukolsky, S.A., Vetterling, W.T., Flannery, B.P.: Numerical Recipes: The Art of Scientific Computing, 3rd edn. Cambridge University Press, New York (2007)

Thirlwall, A.P.: Regional unemployment as a cyclical phenomenon. Scott. J. Polit. Econ. **13**, 205–221 (1966)

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