Sources for regional unemployment disparities in Germany: lagged adjustment processes, exogenous shocks or both?

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Contents

Abstract

The paper analyses movements in the unemployment rate of West German districts in the period 1992-2004 by the chain reaction theory of unemployment (CRT). The estimations show that unemployment movements are generated together by lagged adjustment processes and by exogenous shocks.

We find that adjustment processes to labour demand shocks are transient and do not display hysteresis effects. The effect of a labour demand shock to the unemployment rate disappears completely within only 2 years. Approximately half of the shock affects the unemployment rate in the contemporaneous period, the other half is due to temporal persistence in future periods, i.e. lagged adjustment effects. These results hold for low, middle and high unemployment regions and are in line with other studies in this field.

The effects of exogenous national variables are much higher than those of exogenous regional variables during both, boom as well as recession years. The differentiation between low, middle and high unemployment regions shows that the development of regional factors would generate a regional convergence process, while national factors tend to impede this development.

Zusammenfassung

Die Studie untersucht Veränderungen der Arbeitslosenquote in westdeutschen Kreisen im Zeitraum 1992-2004 mit Hilfe der Chain Reaction Theory of unemployment (CRT). Die Schätzungen zeigen, dass sowohl Anpassungsprozesse als auch exogene Schocks für die Veränderungen verantwortlich waren.

Anpassungsprozesse nach Arbeitsnachfrageschocks sind vorübergehend und zeigen keine Hysteresiseffekte. Der Effekt eines Arbeitsnachfrageschocks verschwindet innerhalb von nur zwei Jahren. Ungefähr die Hälfte des Schocks schlägt sich dabei bereits in der Periode des Schocks in der Arbeitslosenquote nieder, die andere Hälfte wirkt sich über zeitliche Persistenz, d. h. über verzögerte Anpassungseffekte aus. Diese Ergebnisse gelten sowohl für Regionen mit niedriger, mittlerer und hoher Arbeitslosenquote und sind mit denen aus anderen Studien auf diesem Gebiet vergleichbar.

Die Effekte nationaler exogener Variablen sind sowohl in Boom- als auch in Rezessionsjahren deutlich höher als die Effekte regionaler exogener Variablen. Die Unterscheidung in Regionen mit niedriger, mittlerer und hoher Arbeitslosenquote zeigt, dass regionale Faktoren einen regionalen Konvergenzprozess bewirken würden, nationale Faktoren aber dazu tendieren, dieser Entwicklung entgegensteuern.

JEL classification: C22, C23, O18, R11, R12

Keywords: unemployment, disparities, adjustment, persistence, hysteresis, convergence

1 Introduction

The development of the national as well as the regional labour market is influenced by a variety of factors more or less closely related to the typical outcome variables like employment or unemployment figures. Moreover, these variables interact with each other in the same period or – more probably – with a specific time lag. Thus, observed reactions in the labour market at present are caused by different variables at different points of time. Especially for a regional economy, things become even more complex: it can be treated as small open economy reacting on shocks within the region but also on exogenous changes of the economic situation, e.g. in the national economy. Therefore, a region is likely to respond to both, regional as well as national shocks.

One of the most important labour market outcome variables is the unemployment rate. In many European countries and as well in Germany, the range of the regional unemployment rates within the country is enormous and even greater than between countries. In Germany, the unemployment rate at district level in the year 2004 had a range between 3.7 and 31.8 percent. Additionally, regional disparities maintain over long periods of time. Therefore, the question that arises addresses to the possible sources of these persistent disparities. Most of the common regional labour market literature considers only two alternative explanations for the existence of regional unemployment differentials: equilibrium approaches interpret the interplay of labour market (related) variables as long-run relationship, where the variation of each variable directly changes the long-run equilibrium in the observed region. Hysteresis approaches instead consider the variation of variables as transient. They also impose a long-run relationship between the variables, but, in contrast to equilibrium models, changes do not influence the long-run equilibrium. They suppose that the deviation from the equilibrium is only transient and that adjustment mechanisms force the labour market back towards this relationship.

The chain reaction theory of unemployment (CRT) developed by Karanassou/ Snower (2000) can instead be seen as a combination of these extremes as it allows for both, changes in the long-run relationship between the variables and lagged adjustment processes. It explicitly considers, first, national as well as regional and second, contemporary as well as lagged values of endogenous and exogenous variables. Furthermore, the CRT applies a system approach which has clear advantages compared to a single-equation model used in most equilibrium based studies, see Elhorst (2003) for further discussion. The major advantage of the CRT is that it allows to distinguish between equilibrium and hysteresis effects as it enables the researcher to measure the quantities to which the variation of the regional unemployment rate is driven by the change of exogenous variables on the one hand and persistent adjustment behaviour on the other hand. Of course, variations may also be due to both effects, which is also captured by the CRT.

The aim of this paper is therefore to gain a detailed view on the different mechanisms affecting the unemployment rate. Especially, the following crucial questions can be addressed by the CRT: Is it the steady variation of variables or slow working adjustment that leads to stable unemployment differentials observed in Germany at district level? Are adjustment mechanisms present in the labour market? If there are any, how long is the adjustment period of regional unemployment rates after the occurrence of a labour demand shock? Which variables have the strongest influence on the unemployment rate? How much contributed regional and national exogenous factors to the development of the unemployment rate during the observation period? Do high, middle and low unemployment regions react similarly or do they show differences in the adjustment paths and in the reaction to exogenous shocks? These questions are answered in the empirical part or the paper.

The rest of the paper is organized as follows: In Section 2 the theoretical background of the chain reaction theory is presented. In Section 3 follows a brief description of the dataset used in this paper. Section 4 empirically investigates stationarity of the variables at district level in Germany. The potential sources of unemployment variations, i.e. the persistence of shocks and the effects of exogenous variables are the focus of Section 5. Finally, Section 6 gives some concluding remarks.

2 The chain reaction theory of unemployment

As described in the introduction, the CRT can be seen as a mixture of equilibrium and hysteresis models. Thus, it combines important features of both approaches and accounts for possible shifts in the levels of variables over time and their lagged adjustment processes. Furthermore the total variation of the different variables can be decomposed into the share of variation due to equilibrium explanations and variation due to hysteresis phenomena. Both shares can be explicitly calculated as the CRT interprets changes in the variables by the concept of “chain reactions”: A single shock in one variable leads to changes in all other (endogenous) variables. Various feedback effects captured by the coefficients of lagged variables then determine how strong the effects are felt in the system, how fast the variables return to their steady state and how much of the shock remains in the system. In the following part, the theoretical concept of the CRT developed by Karanassou/Snower (2000) is briefly described.

As in many studies, the labour market model in the CRT consists of three equations – labour demand, labour supply and a wage setting mechanism. The aggregate labour demand equation is derived from a monopolistic competition approach, where identical firms with monopoly power in the market are confronted with the same production function and product demand of their product. Product supply is modelled as Cobb-Douglas function and depends positively on employment and the capital stock of the firm. The product demand of each firm is calculated as total product demand over the number of firms in the market, weighted with the price level of firm i relative to the price level in the market. The relative price level itself is exponentially weighted with a negative price elasticity of product demand. The labour demand is then derived by setting the marginal revenue equal to the marginal cost of each firm. The resulting aggregate labour demand equation then equals

$$E_t = \alpha + \alpha_E E_{t-1} - \alpha_w w_t + \alpha_K K_t + \varepsilon_t , \qquad (1)$$

where E_t represents labor demand, w_t the real wage and K_t the capital stock at time t.

The wage equation is generated from the reservation wage of each worker in the population, where the wage is equal to the reservaration wage of the marginal empoyee. The reservation wage is different for each worker. Then, if aggregate employment rises, the reservation wage of the marginal employee rises as well. This relation is assumed to be linear and equals

$$w_t = \beta + \beta_E E_t . \tag{2}$$

Last, the aggregate labour supply is derived by the labour force participation decision of each person in the working-age: a person will take up work if the marginal return from being in the labour force at least equals the marginal cost of being in the labour force. The marginal return is positively related to the employment probability and the wage and negatively to the inactivity rate, i.e. all persons from the working-age-population who are currently not in the labour force. The marginal cost depends positively on the ratio of new entrants into the labour market to incumbent members. Setting the marginal return equal to the marginal cost, the labour force participation equation becomes:

$$L_t = \gamma + \gamma_L L_{t-1} + \gamma_w w_t + \gamma_E E_t + \gamma_Z Z_t , \tag{3}$$

with L_t as labor supply and Z_t as working age population at time t.

Equations (1) – (3) describe the labour market in the CRT. As all variables are in logs, the unemployment rate u_t can easily be calculated out of the relationship

$$u_t = L_t - E_t . \tag{4}$$

In Section 5, a more elaborate version of the model presented in equations (1)-(4) is specified. The empirical model is estimated as structural vector autoregressive (SVAR) model of the form

$$A_0 y_{it} = A_1 y_{it-1} + A_2 y_{it-2} + B_0 x_{it} + B_1 x_{it-1} + C_0 z_t + C_1 z_{t-1} + \varepsilon_{it} \tag{5}$$

where y_{it} is a vector of regional endogenous variables, x_{it} a vector of regional exogenous variables and z_t is a vector of national exogenous variables. A, B and C are the corresponding coefficient matrices and ε_{it} is a vector of identically independently distributed (iid) error terms. In contrast to the regional model of Blanchard/Katz (1992), who focuses exclusively on regional shocks, the above labour market system considers regional as well as national variables. Therefore, this framework allows to differentiate between the effects of national and regional variation in the data. Different to e.g. Decressin/Fatás (1995) or Kunz (2009), one can then directly use the national and regional values for the estimation. The advantage is that construction and measurement of region-specific (relative) variables is not necessary. As – according to Martin (1997) – the results may seriously depend on how these relative variables are measured, misleading conclusions due to measurement issues are eliminated. Furthermore one is able to discriminate between regional and national effects. Moreover, the framework allows to calculate the extent of changes in the unemployment rate that is due to national and regional variation and enables to show which of the two has a stronger influence on the unemployment rate.

The next Section describes the dataset and explains why different combinations of regional units as well as different lengths of the time series are necessary for the estimations in Sections 4 and 5.

3 National and regional data

The data set used in this paper is provided by the German Federal Employment Agency, the German Statistical Office and the International Monetary Fund. Variables obtained from the Federal Employment Agency are employment and unemployment figures as well as wages. Data from the German Statistical Office contain population data, figures on the gross domestic product (gdp), gross investment figures, the consumer price index, the manufacturer's price index for oil and the gdp-deflator. Oil prices, interest rates and the growth rate of the public consumption expenditures were obtained from the International Monetary Fund. All series are on an annual basis. Table 1 gives an overview of the regional and national variables used for the estimation of the empirical model outlined in Section 2:

Table 1
Regional and National variables in the dataset

Regional variables			**National variables**		
n_{it}	Employment	1987-2004	oil_t	Real oil prices	1976-2004
l_{it}	Labour force	1987-2004	inv_t	Real investment	1970-2004
u_{it}	Unemployment rate	1987-2004	int_t	Real interest rate	1991-2004
pop_{it}	Population	1985-2004	$cons_t$	Real public consumption	1992-2004
w_{it}	Real wage	1992-2004			
gdp_{it}	Real gdp	1991-2004			
$Prod_{it}$	Real productivity	1991-2004			
All variables except the unemployment rate u_{it}, the interest rate int_t and the growth rate of public consumption expenditures $cons_t$ are in logs. Employment, wages, gdp and productivity are measured at the place of work, all other variables are measured at the place of residence, see Section 5.1 for further discussion.					

The employment level contains only people covered by the social security system ("sozialversicherungspflichtig Beschäftigte"). The labour force is calculated as sum of employed and unemployed persons. The unemployment rate is calculated as difference between the labour force and employment. For the population variable only the labour market relevant population in an age of 15-64 years are considered. Wages stem from a two percent random sample of all employed covered by the social security system (IABS). Productivity is calculated as gdp per employed. As the active units in the labour market focus on real rather than nominal values, all nominal variables are deflated by a corresponding price index. The nominal oil prices were deflated with the manufacturer's price index for oil. Wages were deflated with the consumer price index. Gdp, productivity and investment were deflated via the gdp-deflator.

The national and regional variables have different lengths which can be seen in Table 1. This raises the question, which estimations should be carried out with which variables in the following Sections. For the tests on stationarity in Section 4, always the maximum length of the time series is used. In the estimations in Section 5, only data from 1992-2004 are included as real public consumption limits the data set.

4 Stationarity of national and regional variables

For the stability of the labour market system outlined in Section 2 it is necessary that all variables are stationary, i.e. all lagged coefficients lie outside the unit circle. Therefore, the national and regional variables have to be tested for stationarity. The standard procedures to test times series for stationarity are the Augmented-Dickey-Fuller-Test (ADF) or the Phillips-Perron-Test to mention only the most important. A disadvantage of all these tests is that they have only low power. Therefore, panel-unit-root tests have been developed to improve the power of the tests. In the recent years, a growing body of literature has developed a variety of approaches. For an overview see Breitung/Pesaran (2006). In the following, we test all variables introduced in Section 3 for stationarity. For national variables (ordinary time-series data) we use the ADF-Test and for regional variables (panel data) we employ the two common first generation panel unit root tests of Levin/Lin/Chu (2002) and Im/Pesaran/Shin (2003).

We start with the nationwide variables and use the ADF-Test allowing for a maximum of two lags in the testing structure. The equation to estimate for each national variable is

$$\Delta y_t = \mu_t + \rho y_{t-1} + \sum_{k=1}^{K} \phi_k \Delta y_{t-k} + \varepsilon_t \qquad (6)$$

where μ_t is a constant term and the lagged differences of y_t, Δy_{t-k}, control for serial correlation among the ε_t. The null hypothesis of the test is that the variable under consideration follows a non stationary process. Each variable is tested including a maximum of two lagged differences, i.e. $K = 2$. The p-value of the test for each variable is shown in Table 2:

Table 2
ADF-Test for (trend) stationarity of national variables

Test	Lags	oil_t	Δoil_t	inv_t	int_t	Δint_t	$cons_t$
ADF	0	0.595	0.000***	0.000***	0.409	0.010***	0.000***
ADF	1	0.570	0.002***	0.009***	0.531	0.006***	0.988
ADF	2	0.658	0.044**	0.000***	0.852	0.141	0.985

*, **, *** significant at the 10, 5 and 1 percent level

As can be seen from the estimations, only investment and the growth rate of public consumption expenditures can be considered as stationary whereas the real oil price and the interest rate follow a non stationary process. Therefore, the latter two variables were also tested in first differences. The transformed variables (Δoil_t and Δint_t) are then found to be stationary.

As mentioned already above, panel-unit root test are applied for regional variables. Here, the common first generation tests of Levin/Lin/Chu (2002) and Im/Pesaran/ Shin (2003) are used. The basic regression used in both tests (LLC and IPS), is

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{k=1}^{K} \phi_{ik} \Delta y_{i,t-k} + z'_{it} \gamma_i + \varepsilon_{it} . \qquad (7)$$

As in the ADF-test, the lagged differences of y_{it}, $\Delta y_{i,t-k}$, control for serial correlation among the ε_{it}. Furthermore, z'_{it} may be empty or include a constant term, fixed effects or a time trend into the regression. Also the null hypothesis, that $\rho_i = 0$ for all i, i.e. all time series are independent random walks, is the same in the LLC and the IPS test. Thus, both tests use the same basic regression and the same null hypothesis. They differ only in the underlying alternative hypothesis specification. LLC specify a homogenous alternative, where all ρ_i are equal and significantly lower than *0*, i.e. all time series are stationary, whereas IPS tests the less restrictive heterogenous alternative, where ρ_i may differ across regions and only a significant fraction of all time series is stationary. The results of both tests can be found in Table 3:

Table 3
IPS- and LLC-Test for stationarity of regional variables

Test	**Lags**	n_{it}	Δn_{it}	l_{it}	Δl_{it}	w_{it}	Δw_{it}
IPS	0	1.000	0.000***	1.000	0.000***	1.000	0.000***
IPS	1	1.000	0.000***	1.000	0.000***	1.000	0.000***
IPS	2	1.000	0.000***	1.000	0.000***	1.000	0.000***
LLC	0	0.000***	0.000***	0.000***	0.000***	1.000	0.000***
LLC	1	0.000***	0.000***	0.000***	0.000***	1.000	0.000***
LLC	2	0.000***	0.000***	0.000***	0.000***	0.998	0.000***
Test	**Lags**	pop_{it}	Δpop_{it}	$urate_{it}$	gdp_{it}	$prod_{it}$	
IPS	0	1.000	0.000***	0.245	0.320	0.014**	
IPS	1	1.000	0.000***	0.218	0.260	0.011**	
IPS	2	1.000	0.000***	0.009***	0.004***	0.000***	
LLC	0	0.004***	0.000***	0.000***	0.000***	0.000***	
LLC	1	0.001***	0.000***	0.000***	0.000***	0.000***	
LLC	2	0.000***	0.000***	0.000***	0.000***	0.000***	

*, **, *** significant at the 10, 5 and 1 percent level

The LLC-test clearly rejects the null of non-stationarity for all variables except real wages. According to the results of the IPS-test only the unemployment rate, gdp and productivity can be considered as stationary whereas regional employment, labour force, real wages and population series are non-stationary. Again, the first differences of these variables turn out to be stationary in both tests. For the estimations in Section 5, only variables that display stationarity in both tests are included.

5 Results

In this section the estimation procedure and the main results of the labour market model outlined in Section 2 are presented. Subsection 5.1 discusses the econometric specification and the results of the estimations. The following subsection then introduces the measure of unemployment persistence, provides results for strength and speed of the unemployment adjustment process in the aftermath a of a labour demand shock and quantifies the effects of the employment variations during the sample period. Last, Subsection 5.3 deals with the effects of national and regional exogenous variables on the unemployment rate.

5.1 Econometric specification and estimation results

The time series in Table 1 cover 13 observations for West German districts (1992-2004). As in other studies on regional adjustment, two lags are allowed for each endogenous variable to capture non-monotone adjustment paths (see Blanchard/Katz (1992), Decressin/Fatás (1995), Frederiksson (1999)). Due to the differentiation in order of non-stationary variables and the inclusion of two lags of each endogenous variable, three observations are lost. The specification of the model is based on the following theoretical considerations:

Different to Karanassou/Snower (2000) or Bande/Karanassou (2007), who estimate the CRT on national/provincial level, our estimations are carried out for a much smaller regional level (districts). Here, migration and commuting activities display significantly higher values than on a larger regional level, see Kunz (2009). As our focus is to simulate effects of labour demand shocks, e.g. the closure of a major employer, we use the employment level at the place of work. The consequence is that the unemployment rate can no more be approximated by log-differences of labour supply and labour demand (both measured at the place of residence). Therefore, the unemployment rate is also determined within the model. Because of the close relationship of the unemployment rate on the on hand and labour demand and labour supply on the other hand, we only use simultaneous and one-period lagged labour demand (at the place of work) and labour supply (at the place of residence) development to determine the unemployment rate, but not wages or other exogenous variables.

Furthermore, we only allow labour demand to affect all other variables simultaneously to make sure that we indeed capture labour demand shocks. Labour supply instead does not affect labour demand and wages, but the unemployment rate. Wages are allowed to affect both, labour supply and labour demand, but not the unemployment rate.

For exogenous variables, simultaneous and one-period lagged values are allowed. Real oil prices, gdp and investment figures influence labour demand. Real wages are affected by real productivity, investment and the interest rate and labour demand is influenced by population effects, public consumption behaviour and the interest rate. Additionally, dummy-variables for each district are added in each equation to capture region-specific fixed effects. The lag selection of the resulting specification is based on the AIC- and BIC- information criteria.

With regard to the estimation technique, a fixed effects estimator in a dynamic panel model as described above is inconsistent for fixed *t*, see Nickell (1981) or Kiviet (1995 and 1999). Pesaran/Smith/Im (1995) suggest a mean-group estimator, i.e. the mean of separate regressions obtained for each group, which yields consistent estimates of the average effects as the number of time periods increases to infinity. Frederiksson (1999) argues that the Seemingly Unrelated Regression (SURE) produces similar, but more precise results, as it is more efficient and considers the regional correlation between each variable in the SVAR. Therefore, the system of equations above is estimated by three-stage-least squares (3-SLS) where all right hand side variables are assumed to be exogenous. This estimation procedure is equivalent to a SURE and has the advantage that it is still comparable to studies using a SVAR-model estimated by OLS. Therefore, the system of equations outlined in Section 2 is estimated by the following econometric specification:

$$A_0 y_{it} = A_1 y_{i,t-1} + A_2 y_{i,t-2} + B_0 x_{it} + B_1 x_{i,t-1} + C_0 z_{it} + C_1 z_{i,t-1} + e_{it} \tag{8}$$

$$e_{it} = \mu_i + \upsilon_{it} \tag{9}$$

with $i = 1,...,N$ and $t = 1,...,T$. The vectors y_{it}, x_{it} and z_t as well as the coefficient matrices A, B and C are defined as in equation (5). The vector e_i represents the error term and follows a one-way error component model where μ_i captures the regional fixed effect and υ_{it} is identically and independently distributed and not serially correlated.

The estimation results of equation (8) are reported in Table 4[1].

Each equation is estimated with 3,260 observations and is highly significant. As can be seen from the R^2 of the equations, the fit of the model is high. The estimations again show the complexity of the labour market structure and the signs of the variables are prevailingly compatible to the expectations:

Labour demand (the employment growth rate) depends negatively on the growth rate of real wages. Higher wages thereby reflect higher costs for enterprises and lead to a decrease in the demand of human labour. Gdp as well as the growth rate of real oil prices show a positive impact on the employment growth rate during the

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[1] The values for the region-specific effects are not presented.

same observation period but a negative one for the lagged value. Rising gdp represents the general economic situation: in boom periods with economic growth employment is positively affected. A rising oil price raises the costs for enterprises and should therefore have a negative impact on labour demand, but only the lagged growth rate of oil prices is compatible to the expectations. Investment figures influence labour demand positively in contemporaneous as well as in lagged periods. Rising investment goes along with a rising demand for labour as the additional capital stock also affords additional workers.

Table 4
Estimation Results for all districts

Labour demand: Δn_{it}		**Wage setting: Δw_{it}**		**Labour supply: Δl_{it}**		**Unemployment rate: $urate_{it}$**	
Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.
$L\Delta w_{it}$	-0.119***	$L\Delta w_{it}$	-0.508***	$L\Delta l_{it}$	-0.141***	Δl_{it}	-0.349***
gdp_{it}	0.115***	$L2\Delta w_{it}$	-0.085***	$L2\Delta l_{it}$	0.143***	$L\Delta l_{it}$	-0.089***
$Lgdp_{it}$	-0.071*	Δn_{it}	0.054***	$L\Delta w_{it}$	-0.043***	Δn_{it}	-0.191***
Δoil_t	0.006***	$L\Delta n_{it}$	0.038**	Δn_{it}	0.086***	$L\Delta n_{it}$	-0.177***
$L\Delta oil_t$	-0.005***	$urate_t$	0.280***	$L\Delta n_{it}$	0.082***		
inv_t	0.086***	$Lurate_t$	-0.414***	Δpop_{it}	0.170***		
$Linv_t$	0.102***	$Lprod_t$	-0.034***	$L\Delta pop_{it}$	0.285***		
		Δint_t	0.749***	Δint_t	0.660***		
		$L\Delta int_t$	0.347***	$L\Delta int_t$	0.121***		
		inv_t	0.124***	$cons_t$	0.249***		
		$Linv_t$	-0.222***	$Lcons_t$	0.248***		
Obs.	3,260	Obs.	3,260	Obs.	3,260	Obs.	3,260
R²	0.528	R²	0.404	R²	0.633	R²	0.992
p-val.	0.000***	p-val.	0.000***	p-val.	0.000***	p-val.	0.000***

*, **, *** significant at the 10, 5 and 1 percent level

The growth rate of real wages is positively related to the contemporaneous and the lagged employment growth rate as well as to changes in the aggregate interest rate. A rising employment growth rate signifies a strong labour market where workers are able to push through higher wage claims. Interest rates go along with the economic cycle and are therefore positively correlated with wages. The unemployment rate as well as investment shows a positive influence only in the same period. Their lagged values have instead a negative effect. The coefficient of the unemployment rate measures the Phillips curve introduced by Phillips (1958): the sign of the coefficient is positive and therefore in contrast to the postulated negative effect of unemployment on the (nominal) wage growth rate. Only the lagged unemployment rate shows the expected sign. Thus a Phillips Curve cannot be found in West German district data. New investments usually afford higher skills among the workers which then go along with rising wages. As already argued for the employment growth rate, higher investment figures go along with rising employment and therefore also with rising wages. The lagged value of real productivity displays a negative sign, i.e. real productivity depresses the wage growth rate. This negative effect might reflect a convergence process for real wages across regions. As the real wage is the monetary outcome of the productivity level, regions with high productivity have lower wage growth rates as low productivity regions which implies a catch up process in real wages of low productivity regions.

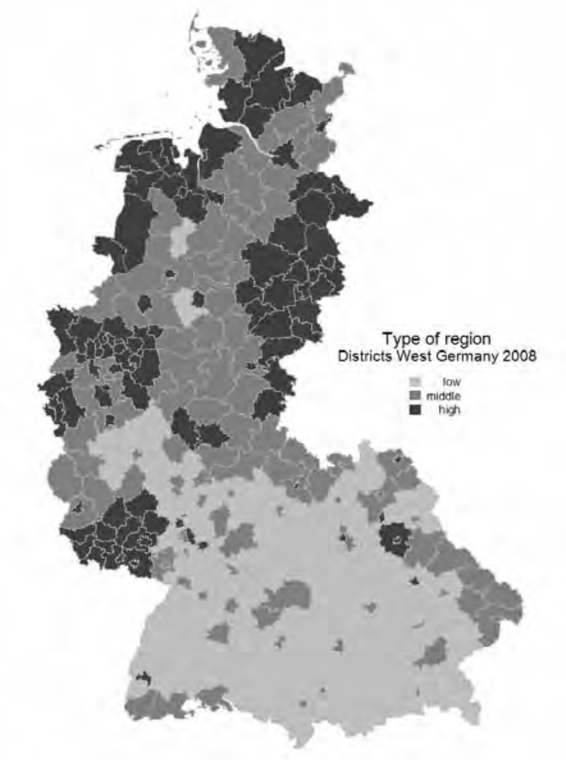
The regional labour force is negatively driven by the regional wage growth rate. This is in contrast to the expectations as rising wages should make more people out of the labour force willing to work. All other variables (employment growth rate, population growth rate, the growth rate of the nationwide public consumption expenditures, changes in the interest rate) show positive signs. The positive effect of the employment growth rate implies that new jobs in a region also increase the regional labour supply. Rising population is a natural source for a rising labour force itself. The positive coefficient of the public consumption expenditure growth rate might reflect labour market programs subsidized by the public hand pushing additional people into the labour force. Rising interest rates causes people to work more because they can expect higher capital returns if they save their wages. Additionally, if people are indepted, they have to work more to be able to pay their rising interest payments. Thus, both explanations justify the observed positive coefficient.

The unemployment rate is negatively affected by both, the growth rate of labour supply and labour demand in the contemporaneous and the lagged period. While a positive employment growth rate means rising employment and therefore directly affects the unemployment rate negatively, the negative sign for the coefficients of the growth rate of labour supply is in contrast to the expectations. The negative sign probably reflects migration trends towards economically prosperous districts with low unemployment rates.

As an important aim of the paper is to analyse regional disparities in the unemployment rate and the mechanisms at work that generate them, we additionally grouped the 326 districts into 3 equally sized categories with respect to the unemployment rate in 1992: low, middle and high unemployment regions. Low unemployment regions are districts with an unemployment rate below 5.19% (109 districts), middle unemployment regions had an unemployment rate between 5.19% and 7.50% (109 districts) and high unemployment regions are districts with an unemployment rate higher than 7.50% (108 districts). The spatial distribution of low, middle and high unemployment regions in can be seen in Figure 1.

The figure shows that the distribution of low, middle and high unemployment regions in the year 1992 clearly forms clusters: low unemployment regions can be found primarily in southern Germany, middle unemployment regions in the central northern part and high unemployment regions on the boarders to East Germany, France, Denmark and the Netherlands.

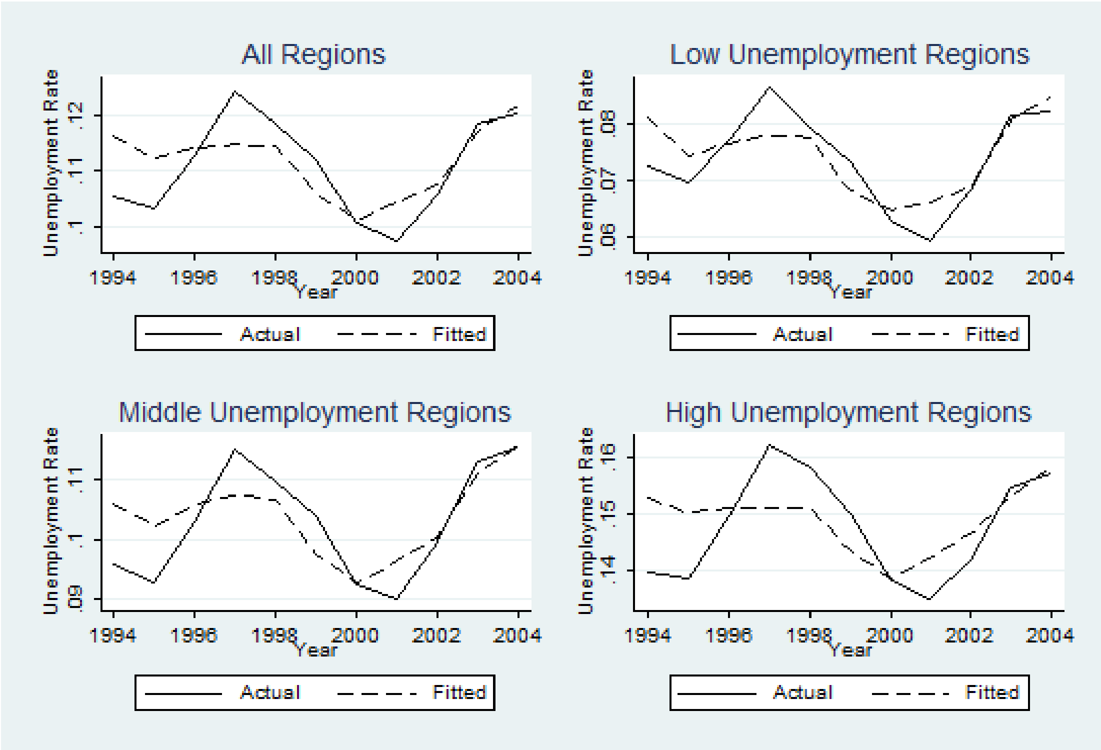
Figure 1
Distribution of low, middle and high unemployment districts



The estimation of equation (8) and all further calculations were also carried out separately for high, middle and low unemployment regions. The estimation results of equation (8) for these subsets can be found in the Appendix. Actual and fitted values of the unemployment rate according to the estimated models for all, low, middle and high unemployment regions in the period 1994-2004 can be seen in Figure 2.

Generally, the development of the unemployment rate was very similar for all districts and the different subsets during the observation period. The unemployment rate in West German districts increased from 1995-1997, decreased afterwards until 2001 and rose again in the period 2001- 2004. Thus, the observation period covers one economic cycle with a boom period from 1997-2001 and a recession period from 2001-2004. The levels for the different subsets were instead different. Low unemployment regions fluctuated around a mean of about 7%, middle unemployment regions around 10% and high unemployment regions around 15%. As can be seen in Figure 2, all estimated models are able to capture the specific time path that the unemployment rate underwent during this period.

Figure 2
Original and fitted unemployment rate of all, low, middle and high unemployment regions in the period 1994-2004



In the following section, the estimation results are used to derive adjustment dynamics of the unemployment rate in the aftermath of a labour demand shock. For the dependent variables we calculate the adjustment paths after a one-off unit shock in labour demand, i.e. the employment growth rate. We measure the effect that changes in each exogenous variable had on the unemployment rate separately for the boom years 1997-2001 and the recession period of 2001-2004.

5.2 Labour demand shocks

In Section 2 we argued, that labor market shocks are felt through time. This means that the effect of a shock in one single year is transported through different lagged adjustment mechanisms and is therefore also present in the following years. The question then is, how large the effect of a labour demand shock is first, in the aftermath of the shock and second, in total. In the CRT, the adjustment process after the occurrence of a shock in period t is called unemployment persistence. It is defined as

$$\sigma \equiv \sum_{j=1}^{\infty} R_{t+j} \, . \tag{10}$$

where σ measures the effect of unemployment persistence for all periods $t+j,\ j \geq 1$ following the shock. Then, the series R_{t+j} denotes the impulse response function (IRF) of unemployment. In other words, unemployment persistence is simply the sum of all deviations from the initial unemployment rate at time t that are due to the shock. It covers the reactions in the system after the occurrence of a shock in period t. Economically, σ can be thought as additional unemployed in the labour market after a shock, trying to find a new job. The duration until these unemployed are back in employment may last several years. If equation (10) is dynamically stable[2], the shock dies out gradually and converges towards its initial level. Then, unemployment persistence equals a finite quantity. If unemployment instead remains on a higher (lower) than the initial value, unemployment displays hysteresis and $\sigma = \infty$. In this case the shock leaves a permanent effect in the unemployment rate, meaning that not all unemployed get a new job again.

The total effect of the shock can then be characterized by the sum of the initial response R_t (the shock itself) and the unemployment persistence σ. The immediate response of unemployment can be interpreted as short-run elasticity, see Bande/ Karanassou (2007). Then, the total effect equals

$$R_t + \sigma = \sum_{j=0}^{\infty} R_{t+j} \tag{11}$$

and can be characterized as long-run elasticity of unemployment with respect to the shock.

Mathematically, our measure of unemployment persistence can be calculated from the above estimation results by solving the system of equations represented in equation (8) for the unemployment rate as outlined in Bande/Karanassou (2007). The reduced form unemployment rate then equals a polynomial equation of the form

$$\rho(L)u_{it} = b(L)x_{it} + c(L)z_t + \theta_d(L)\varepsilon_{it}^n + \theta_w(L)\varepsilon_{it}^w + \theta_s(L)\varepsilon_{it}^l \tag{12}$$

where u_{it} is the regional unemployment rate, x_{it} is a 3x1 vector of regional exogenous variables and the 4x1 vector z_{it} contains the national variables. ε_{it}^n, ε_{it}^w, and ε_{it}^l are the error terms (residuals) and can be calculated from the labour demand / supply, wage setting and unemployment equations. $\rho(L)$, $b(L)$, $c(L)$, $\theta_d(L)$, $\theta_w(L)$ and $\theta_l(L)$ are functions of the estimated coefficients given in Table 4.

To visualize the effect of a labour demand shock on the unemployment rate, we calculate the according impulse response function for all as well as for low, middle and high unemployment regions separately. According to Bande/Karanassou (2007) and Decressin/Fatás (1995) we construct the shock as one-off unit shock in labour demand. The impulse response functions for the shocks are displayed in Figure 3:

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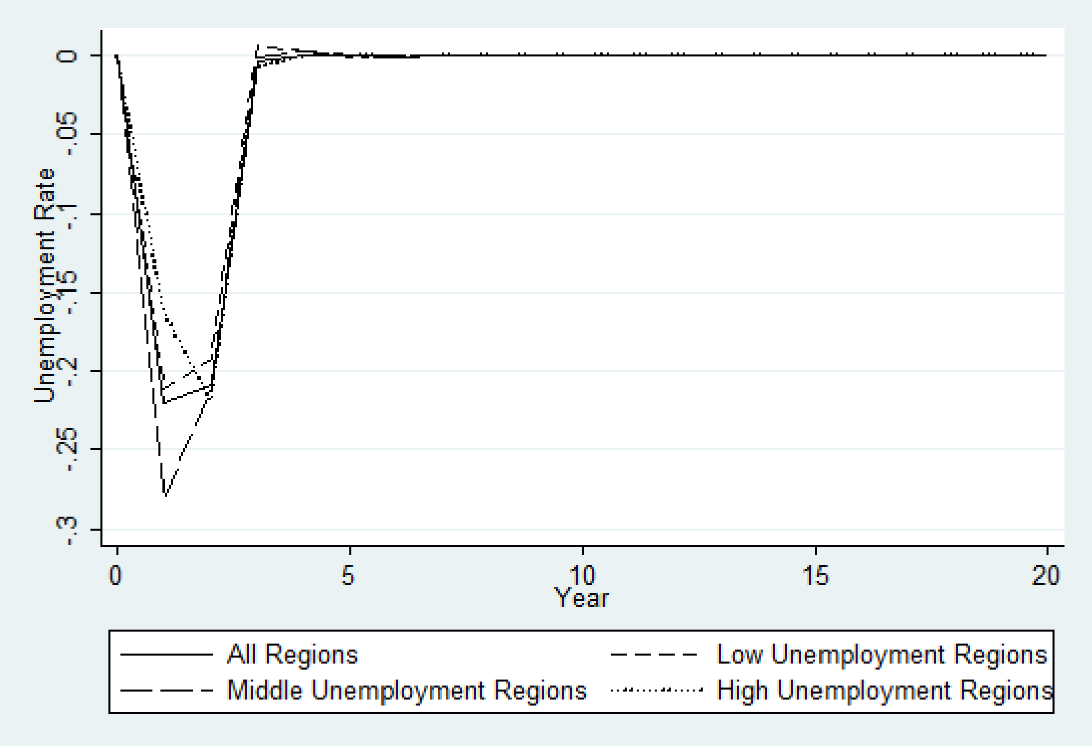
[2] The coefficients of the lagged unemployment rate are lower than unity.

Figure 3
Unemployment responses of all, low, middle and high unemployment regions to a shock in labour demand



The response of the unemployment rate to a shock in labour demand is very similar in all different settings: the shocks do not lead to a permanent increase of the unemployment rate. They decrease rapidly after the occurrence of the shock and are completely absorbed by the system within only two years. In the year of the shock, the effect varies between 16 percentage points (low unemployment regions) and 27 percentage points (middle unemployment regions). In the estimation with all districts, the effect amounts to 22 percentage points. These values are comparable to the estimation results of Kunz (2009), who estimates a model in the line of Blanchard/Katz (1992) for West German districts in the period 1989-2004. He finds that the unemployment rate returns to its initial value already in the period after a labour demand shock and decreases the unemployment rate by 13% in the year of the shock. Thus, a labour demand shock does not leave permanent effects on the unemployment rate and converges rapidly towards its initial level.

Next, we calculate short-run elasticity, persistence and long-run elasticity of a positive labour demand shock with respect to the unemployment rate according to equations (10) and (11). The results are displayed in Table 5:

Table 5
Persistence of a labour demand shock in all, low, middle and high unemployment regions

Regions	All	Low	Middle	High
Short-run elasticity (R_0)	-0.22	-0.21	-0.28	-0.16
Persistence (σ)	-0.21	-0.18	-0.21	-0.23
Long-run-elasticity (R_t)	-0.43	-0.40	-0.49	-0.39

According to the estimations, a labour demand shock displays a long-run elasticity lower than unity in all combinations. This result shows that the unemployment rate is “underresponsive” in the sense that the initial labour demand shock is not fully reflected in the unemployment rate – also in the long-run. Approximately half of the shock is felt in the initial period, whereas the rest is felt in future periods – mainly in the period after the shock. Thus, labour demand shocks are not characterised by substantial unemployment persistence. The differences between low, middle and high unemployment regions are only little. The strongest long-run elasticity is not estimated for high, but for middle unemployment regions. As expected, high unemployment regions show the lowest reaction to a positive labour demand shock. As they additionally show the highest persistence, a positive labour demand shock displays lower effects in the initial but stronger effects in future periods compared to low and middle unemployment regions. Thus, high unemployment regions are not hit as severe as low and middle unemployment regions initially, but the shock is more persistent in future periods.

The most important findings from sections 5.1 and 5.2 are the following:

The simultaneous labour market model estimated for all West German districts as well as for low, middle and high unemployment districts separately shows a good fit of the movements in the unemployment rate for the period 1992-2004. The coefficients of the exogenous variables in the models are prevailingly compatible to the expected signs and the results are quite similar across the different settings. The unemployment rate is “underresponsive” to a labour demand shock in the long-run as not the full size of the shock is reflected in the unemployment rate. The shock does not leave permanent effects on the unemployment rate, i.e. the unemployment rate does not exhibit hysteresis effects and disappears completely within only 2 years. Approximately half of the total unemployment response is felt in the contemporaneous period, the rest of the effect in future periods – mainly in the period after the shock. The long-run elasticity of the shock is quite similar across low, middle and high unemployment regions. As expected, high unemployment regions are not hit as severe as low and middle unemployment regions initially, but the shock is more persistent in future periods.

5.3 Exogenous shocks

In the previous section the focus was to explore the adjustment of the unemployment rate after the occurrence of a labour demand shock, i.e the shock in an endogenous variable of the system. In this section instead, the focus is on shocks in the exogenous variables. More precisely, we measure the impact of each exogenous variable in the absence of all other shocks by the direct and indirect effects on the unemployment rate over time.

To observe this, a concept to measure the total effect of actual exogenous shocks has to be applied to be able to separate the effects of shocks from different variables. This concept is developed similar to the concept already demonstrated for the measurement of unemployment persistence and is applied for each exogenous variable in each period. The total effect of all shocks of the respective variable, $\sum_{t=1}^{T} \tilde{R}_t$, can be measured by the sum over all its shocks in each period and is then given by[3]

$$\sum_{t=1}^{T} \tilde{R}_t = \sum_{t=1}^{T} \sum_{j=1}^{t} R_{tj} \tag{13}$$

where R_{tj} denotes the response of unemployment in period *t* to the *j*th shock. Thus, $\sum_{t=1}^{T} \tilde{R}_t$ is just the sum of all direct and indirect effects that each shock of the respective variable has on the unemployment rate. If $\sum_{t=1}^{T} \tilde{R}_t$ equals zero then the respective variable has no influence on the unemployment rate.

As the influence of the exogenous variables might be different in boom and recession periods, we calculate the impact on the unemployment rate for each variable separately for the boom period 1997-2001 and for the recession period 2001-2004. Additionally, figures are again calculated for all as well as for low, middle and high unemployment regions. The results for each exogenous variable and the summarized effect of regional (reg_t), national (nat_t) and all (all_t) exogenous variables can be seen in Table 6:

Table 6
Effects of exogenous shocks for boom and recession years

Region	**inv_t**	**int_t**	**oil_t**	**$cons_t$**	**gdp_t**	**$prod_t$**	**pop_t**	**reg_t**	**nat_t**	**all_t**
Boom period 1997-2001										
All	-0.58	-0.15	0.06	0.19	-0.10	-0.01	0.04	-0.07	-0.48	-0.56
Low	-0.56	-0.17	0.02	0.09	-0.07	-0.02	0.13	0.04	-0.62	-0.57
Middle	-0.64	-0.18	0.06	0.19	-0.06	-0.02	0.08	0.00	-0.57	-0.57
High	-0.52	-0.13	0.08	0.26	-0.14	-0.01	0.00	-0.15	-0.31	-0.46
Recession period 2001-2004										
All	1.06	0.18	0.07	-0.01	0.02	0.00	-0.01	0.01	1.30	1.31
Low	1.02	0.20	0.03	-0.01	0.07	0.00	0.09	0.15	1.23	1.39
Middle	1.17	0.21	0.15	-0.02	0.04	-0.01	-0.01	0.03	1.50	1.53
High	0.96	0.15	0.06	-0.01	-0.03	0.00	-0.04	-0.07	1.16	1.09

In the boom period 1997-2001, the exogenous variables under consideration lowered the unemployment rate by 0.56 percentage points. As the actual (fitted) unemployment rate decreased by 2.66 (1.04) percentage points during this period, this

[3] For a detailed description of the measure for the total effects of the shocks confer Bande/ Karanassou (2007)

means that the exogenous variables capture roughly 21% (54%) of the unemployment development. In the recession period of 2001-2004 the exogenous variables raised the unemployment level by 1.31 percentage points, although the actual (fitted) unemployment rate increased only by 2.29 (1.75) percentage points. This means that the exogenous variables account for an even higher share of 57% (75%) in the actual (fitted) unemployment development during the recession period. The different regional settings show only little differences: high unemployment regions have not profited as much as low and middle unemployment regions during the boom period, but they also have not suffered as much during the recession period.

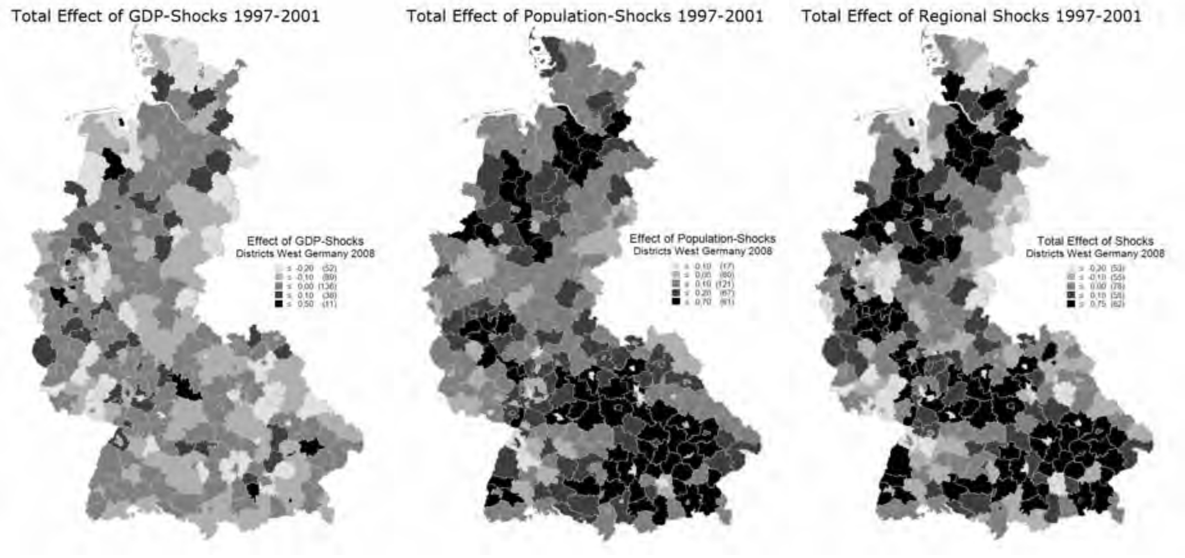
The differentiation between regional and national exogenous variables clearly shows that the effects of national variables were much higher than those of regional variables during both, the boom as well as the recession years. This is a possible explanation for the fact that regions tend to parallel the national unemployment rate, see Figure 3, which is also statistically stated in the strong cyclical sensitivity of regions and districts in Kunz (2009). In the boom period, the unemployment rate of low unemployment regions decreased by 0.62 percentage points through the development of national exogenous factors which is twice the effect estimated for high unemployment regions. In the recession period, high unemployment regions again denoted the lowest upward shift of 1.16 percentage points, but the effect on low unemployment regions was only little higher (1.23). By contrast, the development of regional exogenous factors was commutated for boom and recession years: they caused an upward shift in the unemployment rate of low unemployment regions and lowered the unemployment rate of high unemployment regions. These observations suggest the following conclusion: in contrast to high unemployment regions, low unemployment regions profited disproportional of national developments in the boom period but were hit only approximately to the same extent during recession periods. Regional factors instead always lead to an upward pressure in the unemployment rate of low unemployment regions and to a reduction in the unemployment rate of high unemployment regions. Put differently: while the development of regional factors would generate a regional convergence process, national factors tend to impede this development. As the influence of national factors is much stronger, a regional convergence process does not occur, see also Kunz (2009).

The strongest influence on the unemployment rate had the level of investment. On average, its development lowered the unemployment rate by 0.58 percentage points during the boom period and raised the unemployment rate by exactly twice this amount (1.06 percentage points) during the recession years. The interest rate also caused a decrease of the unemployment rate of 0.15 percentage points on average during the boom years and caused an upward pressure of 0.18 in the recession period. For both variables, the effects for the different regional settings (i.e. low, middle and high unemployment regions) were not too distinct, but especially in the boom period, low unemployment regions always performed better than high unemployment regions. The development of the public consumption expenditures instead had considerable upward effects on the unemployment rate from 1997-2001 but almost no effects from 2001-2004. Additionally, these pushing effects were only weak for low unemployment regions (0.09 percentage points) but amounted to 0.26 percentage points for high unemployment regions. Changes in the oil prices also displayed moderate positive effects in boom and recession years. Principally, oil prices pushed the unemployment rate stronger in high unemployment regions compared to low unemployment regions, but the differences between were not as distinct as for pubic consumption expenditures. To sum up, during the years 1997-2001, all effects of the national variables contributed to a better unemployment development in low than in high unemployment regions. This means that the development of all national variables – especially the public consumption expenditure behaviour – were responsible for raising spatial differences between low and high unemployment rates in the boom period 1997-2001.

Among the regional variables, gdp and the population development had moderate effects on the unemployment rate. The effects of changes in real productivity instead were almost zero. On average, gdp movements lowered the unemployment rate by 0.10 percentage points during the boom period and lead to an increase of 0.02 percentage points from 2001-2004. The corresponding effects of the population development amounted to 0.04 in boom and -0.01 percentage points in recession years. Interestingly – and in contrast to aggregate variables – both regional variables contributed to a better unemployment development in high than in low unemployment regions. This implies that the development of the considered regional variables steadily leads to decreasing spatial differences between low and high unemployment rates.

As seen above, regional variables did not have as large effects as national variables on the aggregate unemployment rate. But, as the development of these variables differs among each regional unit, the total effects are different for each district. As we have estimated equation (8) separately for low, middle and high unemployment regions, the coefficients also vary depending on the affiliation to the respective unemployment group. Therefore, the regional effects vary because of the different development of the respective exogenous variable as well as because of different coefficients and show considerable variation across districts. The total effect of actual shocks of regional variables are visualised in maps separately for the boom and recession years. As the effects of productivity shocks vary only within a span of -0.05 to 0.03, we do not show a separate map for productivity. The effects of gdp and population shocks as well as for all regional shocks during the period 1997-2001 are displayed in Figure 4.

Figure 4
Total effect of regional variables at district level (1997-2001)



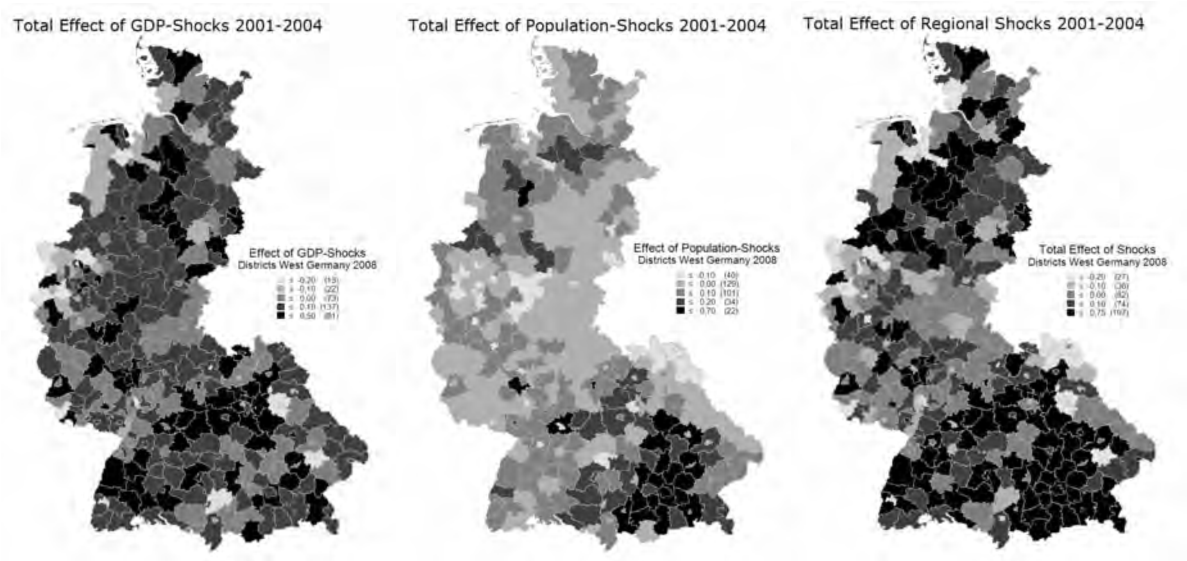
In many districts, the boom period 1997-2001 was characterized by negative gdp shocks, i.e. districts could profit of a positive gdp development lowering their unemployment rate. But, in most of them (225 districts), the effect was in a range between 0 and -0.2 percentage points. Only 52 districts could denote a decrease of more than 0.2 percentage points. Districts with the highest negative effects were mainly former high unemployment areas situated in Bavaria and Lower-Saxony. By far the strongest negative effect on the unemployment rate was measured in the city district Wolfsburg (Lower-Saxony), where an increase in real gdp by 52.8% lowered the unemployment rate by 1.49 percentage points. Despite a marginal increase of the gdp of 0.17%, the city district Leverkusen (North-Rhine-Westphalia) had to denote the highest rise of the unemployment rate by 0.41 percentage points.

Changes in the population growth rate had positive effects in nearly ¾ of all districts. The range of the total effect varied between –0.30 in Rastatt (Baden-Württemberg) to 0.57 percentage points in Erding (Bavaria). Most central and southern Bavarian districts as well as districts situated in Lower-Saxony had to manage with an upward pressure through population gains. In many city districts as well as in the region of the densely populated Ruhr-Area (North-Rhine-Westphalia) the unemployment rate was instead relieved by population losses.

The regional distribution of the total effect of all regional variables (including the effects of real productivity) obviously follows the pattern already found for the population development. The overall loser and the overall winner districts thereby often show effects with the same sign for all exogenous variables. Winner districts are predominantly districts that denoted high unemployment in 1992, loser districts had predominantly low unemployment rates. This result confirms the observation that regional variables tend to support a convergence process. Again, the city district of Wolfsburg (Lower-Saxony) had the strongest negative effect of –1.63 percentage points. As already seen above, the negative effect in Wolfsburg is driven by more than 91% through the extraordinary development of gdp and only by 9% through population (7%) and productivity effects (2%). The strongest positive effect was measured in Dachau (Bavaria), where the unemployment rate raised by 0.67 percentage points through the development of all regional variables. Approximately 20% were caused by the gdp development and around 80% by population gains. The effect of productivity was negligible.

The according effects for the recession period 2001-2004 can be seen in Figure 5:

Figure 5
Total effect of regional variables at district level (2001-2004)



In contrast to the boom period 1997-2001, the recession period 2001-2004 was characterized by rising unemployment caused through gdp shocks. In 218 districts, the unemployment rate increased due to the bad gdp development during this period. Despite this development, 13 districts – predominantly those with a high unemployment rate in 1992 – could denote a negative effect below -0.20 percentage points. The strongest negative effect on the unemployment rate was measured in Freiburg im Breisgau (Baden-Württemberg), where the unemployment rate decreased by 0.38 percentage points. Positive unemployment effects, i.e. a rise in unemployment, can be found primarily in the south of Germany (Bavaria and Baden-Württemberg) and in Lower-Saxony. The city district Wilhelmshaven (Lower-Saxony) had to denote the highest rise of all districts. The unemployment rate increased by 0.49 percentage points through a decrease of real gdp by nearly 5% during the recession period.

In the recession period 2001-2004, the effects of the population growth rate were negative in approximately half of all districts (169), while the other 158 districts denoted a rising unemployment rate. The range of the total effect varied between –0.32 in the city district of Frankenthal (Rhineland-Palatinate) to 0.62 percentage points in Erding (Bavaria). Thus, Erding – the district with the lowest unemployment rate of only 2.23% in 1992 – had to manage with the highest positive unemployment effect caused by population gains in both periods, the boom years as well as the recession years. Apparently and similar to the district Erding, most of the low unemployment districts around the Bavarian capital city Munich had to manage with an upward pressure through population gains from 1997-2001 and from 2001-2004. Accumulations of districts with negative effects could be only found in northern Bavaria and North Rhine-Westphalia.

The total effect of regional shocks in the recession years 2001-2004 looks very similar to the distribution in the boom period as described above. Thus, as already detected above, the effects at district level are commutated in boom and recession years. If these distributions are compared with Figure 1, obviously high unemployment regions profited and low unemployment regions lost through the development of regional exogenous variables. This confirms that regional exogenous variables tend to generate a regional convergence process. The strongest negative effect on the unemployment rate of -0.49 can be found in the city district of Schweinfurt (Bavaria), the district with the highest increase through regional factors is Erding (Bavaria) with a total regional effect of 0.74 percentage points.

The most important results from section 5.3 are the following:

The effects of national variables were much higher than those of regional variables during both, the boom as well as the recession years. This is a possible explanation for the fact that regions tend to parallel the national unemployment rate. Investment figures had the strongest influence among all variables. The effect of productivity was instead negligible. All other variables displayed moderate to weak effects. The differentiation between low, middle and high unemployment regions shows that low and middle unemployment regions profited overproportionally from national developments in the boom period but are also hit stronger than high unemployment regions during recession periods. Regional factors instead always lead to an upward pressure in the unemployment rate of low unemployment regions and to a reduction in the unemployment rate of high unemployment regions. Put differently: while the development of regional factors would generate a regional convergence process, national factors tend to impede this development. As the influence of national factors is much stronger, a regional convergence process does not occur, see also Kunz (2009)

The results of the districts-specific calculations confirm the observation that regional variables tend to support a convergence process. Districts with the strongest negative (winner) and positive (loser) effects of regional variables thereby often show effects with the same sign for all exogenous variables. Winner districts are predominantly districts that denoted high unemployment in 1992, loser districts had predominantly low unemployment rates. The composition of the total regional effects shows that districts are very differently affected by each single regional variables, but that the same variable often has the same effect independent of the period (boom or recession).

6 Conclusion

The simultaneous labour market model for West German districts gives some valuable insights for the explanation of movements in the unemployment rate during the period 1992-2004: unemployment movements are generated together by lagged adjustment processes and by exogenous shocks.

Adjustment processes to labour market shocks are transient and do not display hysteresis effects. The unemployment rate is “underresponsive” to a labour demand shock in the long-run as not the full size of the shock is reflected in the unemployment rate. The effects of a labour demand shock to the unemployment rate disappear completely within only 2 years. Approximately half of the shock affects the unemployment rate in the contemporaneous period, the other half is due to temporal persistence in future periods, i.e. lagged adjustment effects. The long-run elasticity of the shock is quite similar across low, middle and high unemployment regions. As expected, high unemployment regions are not hit as severe as low and middle unemployment regions initially, but the shock is more persistent in future periods.

The effects of national exogenous variables are much higher than those of regional exogenous variables during both, the boom as well as the recession years. This is a possible explanation for the fact that regions tend to parallel the national unemployment rate. Investment figures have the strongest influence among all variables. The differentiation between low, middle and high unemployment regions shows that the development of regional factors would generate a regional convergence process, while national factors tend to impede this development. As the influence of national factors is much stronger, a regional convergence process does not occur, see also Kunz (2009)

The observation that regional variables tend to support a convergence process is confirmed in their region-specific effects: districts with a decreasing unemployment rate are predominantly high unemployment districts, those with an increasing unemployment rate are predominantly low unemployment districts. This result is due to the fact that districts with strong positive or negative effects of a single regional variable often show effects with the same sign for all exogenous variables. Additionally, the same variable often has the same effect independent of the period (boom or recession).

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Appendix

Estimation Results for low unemployment districts

Labour demand: Δn_{it}		**Wage setting: Δw_{it}**		**Labour supply: Δl_{it}**		**Unemployment rate: $urate_{it}$**	
Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.
$L\Delta w_{it}$	-0.105^{***}	$L\Delta w_{it}$	-0.498^{***}	$L\Delta l_{it}$	-0.101^{***}	Δl_{it}	-0.405^{***}
gdp_{it}	0.127^{***}	$L2\Delta w_{it}$	-0.146^{***}	$L2\Delta l_{it}$	0.055^{**}	$L\Delta l_{it}$	0.002
$Lgdp_{it}$	-0.091^{***}	Δn_{it}	0.054^{*}	$L\Delta w_{it}$	-0.054^{***}	Δn_{it}	-0.200^{***}
Δoil_t	0.002	$L\Delta n_{it}$	0.012	Δn_{it}	0.029^{**}	$L\Delta n_{it}$	-0.161^{***}
$L\Delta oil_t$	-0.001	$urate_t$	0.224^{***}	$L\Delta n_{it}$	0.080^{***}		
inv_t	0.090^{***}	$Lurate_t$	-0.548^{***}	Δpop_{it}	0.304^{***}		
$Linv_t$	0.098^{***}	$Lprod_t$	-0.053^{***}	$L\Delta pop_{it}$	0.448^{***}		
		Δint_t	0.711^{***}	Δint_t	0.614^{***}		
		$L\Delta int_t$	0.386^{***}	$L\Delta int_t$	0.300^{***}		
		inv_t	0.118^{***}	$cons_t$	0.167^{***}		
		$Linv_t$	-0.255^{***}	$Lcons_t$	0.106^{***}		
Obs.	1,090	Obs.	1,090	Obs.	1,090	Obs.	1,090
R^2	0.581	R^2	0.463	R^2	0.710	R^2	0.989
p-val.	0.000^{***}	p-val.	0.000^{***}	p-val.	0.000^{***}	p-val.	0.000^{***}

*, **, *** significant at the 10, 5 and 1 percent level

Estimation Results for middle unemployment districts

Labour demand: Δn_{it}		**Wage setting: Δw_{it}**		**Labour supply: Δl_{it}**		**Unemployment rate: $urate_{it}$**	
Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.
$L\Delta w_{it}$	-0.152^{***}	$L\Delta w_{it}$	-0.533^{***}	$L\Delta l_{it}$	-0.220^{***}	Δl_{it}	-0.361^{***}
gdp_{it}	0.094^{***}	$L2\Delta w_{it}$	-0.041	$L2\Delta l_{it}$	0.133^{***}	$L\Delta l_{it}$	-0.131^{***}
$Lgdp_{it}$	-0.058^{***}	Δn_{it}	-0.004	$L\Delta w_{it}$	-0.051^{**}	Δn_{it}	-0.262^{***}
Δoil_t	0.008^{***}	$L\Delta n_{it}$	0.014	Δn_{it}	0.051^{***}	$L\Delta n_{it}$	-0.167^{***}
$L\Delta oil_t$	-0.001	$urate_t$	0.297^{***}	$L\Delta n_{it}$	0.100^{***}		
inv_t	0.081^{***}	$Lurate_t$	-0.497^{***}	Δpop_{it}	0.289^{***}		
$Linv_t$	0.100^{***}	$Lprod_t$	-0.029^{***}	$L\Delta pop_{it}$	0.274^{***}		
		Δint_t	0.946^{***}	Δint_t	0.738^{***}		
		$L\Delta int_t$	0.389^{***}	$L\Delta int_t$	0.192^{***}		
		inv_t	0.149^{***}	$cons_t$	0.261^{***}		
		$Linv_t$	-0.242^{***}	$Lcons_t$	0.230^{***}		
Obs.	1,090	Obs.	1,090	Obs.	1,090	Obs.	1,090
R^2	0.525	R^2	0.457	R^2	0.572	R^2	0.992
p-val.	0.000^{***}	p-val.	0.000^{***}	p-val.	0.000^{***}	p-val.	0.000^{***}

*, **, *** significant at the 10, 5 and 1 percent level

Estimation Results for high unemployment districts

Labour demand: Δn_{it}		**Wage setting: Δw_{it}**		**Labour supply: Δl_{it}**		**Unemployment rate: $urate_{it}$**	
Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.
$L\Delta w_{it}$	-0.121***	$L\Delta w_{it}$	-0.532***	$L\Delta l_{it}$	-0.149***	Δl_{it}	-0.291***
gdp_{it}	0.134***	$L2\Delta w_{it}$	-0.068	$L2\Delta l_{it}$	0.150***	$L\Delta l_{it}$	-0.122***
$Lgdp_{it}$	-0.054***	Δn_{it}	0.087***	$L\Delta w_{it}$	-0.037**	Δn_{it}	-0.126***
Δoil_t	0.007***	$L\Delta n_{it}$	0.059**	Δn_{it}	0.126***	$L\Delta n_{it}$	-0.191***
$L\Delta oil_t$	-0.008	$urate_t$	0.280***	$L\Delta n_{it}$	0.067***		
inv_t	0.103***	$Lurate_t$	-0.343***	Δpop_{it}	0.115**		
$Linv_t$	0.089***	$Lprod_t$	-0.023**	$L\Delta pop_{it}$	0.220***		
		Δint_t	0.585***	Δint_t	0.664***		
		$L\Delta int_t$	0.252**	$L\Delta int_t$	-0.081		
		inv_t	0.120***	$cons_t$	0.286***		
		$Linv_t$	-0.194***	$Lcons_t$	0.390***		
Obs.	1,080	Obs.	1,080	Obs.	1,080	Obs.	1,080
R^2	0.517	R^2	0.342	R^2	0.664	R^2	0.993
p-val.	0.000***	p-val.	0.000***	p-val.	0.000***	p-val.	0.000***

*, **, *** significant at the 10, 5 and 1 percent level

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