

# **Spatial Interaction and Regional Unemployment in Europe**

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**Abstract.** The findings of recent studies on adjustment processes suggest that regional labour markets in the EU and the US differ significantly. Low wage flexibility and limited labour mobility in European countries involve persistent unemployment differentials across regions. However, the spatial dimension of regional labour market problems is largely neglected in the corresponding analyses. In contrast, the present paper focuses on the spatial structure of regional unemployment disparities. Regions are tightly linked by migration, commuting and interregional trade. These types of spatial interaction are exposed to the frictional effects of distance, possibly causing the spatial dependence of regional labour market conditions. The spatial association of regional unemployment is analysed for a sample of European countries between 1986 and 2000 by measures of spatial autocorrelation and spatial econometric methods. The results indicate that there is a significant degree of spatial dependence among regional labour markets in Europe. Regions marked by high unemployment as well as areas characterised by low unemployment tend to cluster in space. The findings suggest that different forms of spatial interaction affect the evolution of regional unemployment in Europe.

JEL classification: C21, E24, R12

**Keywords:** Regional unemployment, spatial interaction, spatial econometrics, Europe.

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## 1. Introduction

The adjustment of labour markets after region-specific shocks has been a central issue of recent research on regional labour markets. A number of studies have analysed the implications of the establishment of European Monetary Union (EMU) for regional labour markets in Europe. As EMU implies a loss of policy options at the national level, the functioning of the remaining adjustment mechanisms has become a central topic. With functioning adjustment mechanisms, a negative shock affecting regional labour markets should result in lower wages and declining labour supply via migration. Blanchard and Katz (1992) observe for the US that wages and unemployment account for adjustment in roughly equal parts. In contrast, in European labour markets, labour force participation and unemployment absorb shocks, whereas wage response is slight and migration is generally low. Evidence provided by Eichengreen (1993) and Obstfeld and Peri (1998) indicates that the responsiveness of migration to regional wage and unemployment differentials is much greater in the US than in Europe. Compressed wage differentials tend to reduce the incentives to leave high-unemployment regions in the European Union (EU). Bertola (2000) concludes that the large and persistent unemployment differentials across European regions are caused by inflexible wages and low labour mobility. Thus, stylised facts on regional unemployment suggest that equilibrating mechanisms are seriously impaired. Labour market regulations and institutional features of European labour markets seem to compress regional wage differentials and limit labour mobility.

Bertola (1999), as well as Blau and Kahn (1999), analyse the impact of different institutions and regulations on labour market outcomes. According to their results, wage adjustment and labour mobility are affected by minimum-wage provisions unemployment benefits and welfare payments. Epifani and Gancia (2001) have formulated a core-periphery model with unemployment benefits and equilibrium unemployment. Their analysis shows that friction in the job-matching process leads to equilibrium unemployment, and search costs generate a positive externality of agglomeration on the labour market. The model can explain the empirical puzzle of declining labour mobility despite increasing labour market disparities experienced by European regions. According to Bertola (1999) relatively high non-employment income reduces the incentive of job seekers to accept comparatively low wages, thereby truncating the lower end of wage distributions. Centralised bargaining also tends to compress wages. However, the empirical evidence provided by Nickell and Layard (1999) relativises some of the negative labour market effects assigned to regulations and institutions. Their results imply that strict labour market regulations, employment protection and minimum wages should not be the main target areas of policies aiming at a significant decline of unemployment. Instead they advise reform of social security systems combined with active labour market policies.

A common feature of most of the above mentioned studies is that they investigate the functioning of labour market adjustments and the effects of labour market regulations without considering the spatial dimension of regional labour market disparities. The research on adjustment processes focuses mainly on more or less isolated regions. The spatial aspects of labour market problems are largely neglected, although, by analysing migration, interaction between regions is considered to some extent. The methodology of most studies, however, implies that migration takes place in a non-spatial world, since the location of the origin and destination of migration flows is of

minor importance. The frictional effects of distance are ignored. However, empirical evidence points to the strong effects of distance as an obstacle to migration. The probability of migration varies inversely with the geographical distance between origin and destination, as the direct costs of moving rise and benefits from migration become increasingly unknown (Helliwell 1998, Tassinopoulos and Werner 1999). Burda and Profit (1996) discuss the significance of distance with respect to job matching across regions, i.e. the job-search activities of workers and the recruiting activities of firms across the borders of local labour markets. An important element of the matching approach is the significance of trading frictions and, according to Burgess and Profit, in labour markets the frictional impact of distance is a crucial one. Up to now, only a few studies have explicitly considered the spatial dimension of regional labour markets. Some studies investigate the wage curve taking spatial effects into account. Manning (1994) and Buettner (1999) analyse the relationship between earnings and unemployment for British counties and German regions, respectively. The empirical evidence points to a negative effect of local unemployment on local earnings, supporting the wage-curve hypothesis. However, the results also indicate that linkages between local labour markets have to be considered, since there are significant effects across the borders of labour market areas. Burridge and Gordon (1981) analyse spatial effects between British labour market areas and focus on the relationship between migration and regional unemployment. They provide evidence for an equilibrating effect of migration on regional unemployment differentials. This effect arises largely from migration induced by variations of regional employment growth. Moreover, their results suggest that, in more accessible labour markets, larger changes in employment growth are required to induce changes in unemployment. An analysis by Molho (1995) confirms that there is significant spatial interaction among regional labour markets in the UK. According to the results, local employment growth has significant effects on local unemployment. But this effect is not confined to the local labour market. Unemployment in neighbouring areas is affected as well. This spillover is marked by relatively low distance decay, consistent with migration behaviour. Furthermore, the study also identifies highly localised effects, pointing to spatial dependence caused by commuting. Finally, Overman and Puga (2002) analyse unemployment clusters across European regions. The results of their nonparametric approach indicate that unemployment rates are much more homogenous across neighbouring areas than across regions in the same EU country. The common characteristics of adjacent regions, such as sectoral composition or skill structure, do not account for the spatial association of unemployment. This neighbour effect also marks the change in regional unemployment and transcends national borders.

To sum up, empirical evidence emphasises the importance of spatial effects. As a result, analyses of regional labour markets have to pay attention to the fact that regions are not isolated entities. The present paper is an attempt to provide additional information on the spatial dimension of unemployment and labour markets in Europe, focusing on the frictional effects of distance and different forms of spatial interaction. In contrast to studies that analyse the functioning of different adjustment mechanisms in a non-spatial setting, we stress the significance of interregional spillover effects and equilibrating mechanisms effective between regional labour markets. Regions are tightly linked by migration, commuting and interregional trade. The central issue of the empirical analysis is whether this interaction results in a spatial dependence of regional labour market conditions. The analysis aims to investigate the role of spatial

distance costs as a reason for insufficient equilibrating forces and persistent disparities between regional labour markets in Europe.

The point of departure of the analysis undertaken here is the accounting identity of regional unemployment, which relates changes in regional unemployment to changes in the various components of labour supply and demand. Burridge and Gordon (1981) applied this approach to investigate the relationship between regional unemployment, labour force participation, migration, and commuting and employment growth. The present analysis focuses on employment growth and labour mobility as determinants of regional unemployment and spatial dependence. The significance of spatial dependence with respect to regional unemployment in Europe is investigated for a sample of European countries between 1986 and 2000. The spatial association of regional unemployment, i.e. the significance of spatial clusters of high or low unemployment is analysed using measures of spatial autocorrelation. The regression analysis concentrates on the relationship between the change in regional unemployment, employment growth and spillover between regional labour markets. Spatial econometric methods are applied in order to determine whether regional unemployment is affected by employment growth in neighbouring regions.

The rest of the paper is organised as follows. In section 2 the empirical methodology is presented. The data and empirical results are described in section 3. Section 4 concludes the paper.

## 2. Method

The present analysis aims at investigating the significance of spatial interaction for regional unemployment disparities in Europe. However, a direct analysis of various forms of spatial interaction between regional labour markets is not possible due to a lack of data. Comparable data on commuting and interregional trade are not available. Data on interregional migration in Europe is restricted to rather large regions and intra-national flows. The scarcity of data therefore requires us to apply a method that allows us to analyse the effects of spatial interaction without quantitative information on the different linkages between labour markets. In this paper the spatial dimension of European labour markets is investigated by measures of spatial autocorrelation and spatial regression models.

### 2.1 Specification of spatial weights

Significant spatial interaction between neighbouring labour markets implies that cross sectional data is marked by a positive spatial autocorrelation. In this case, similar values, either high or low, are more spatially clustered than could be caused by chance. In contrast to the clearly defined autocorrelation in time-series, the dependence is multidirectional in the spatial case. Measures of spatial autocorrelation take into account the various directions of dependence by a spatial weights matrix  $\mathbf{W}$ . For a set of  $R$  observations, the matrix  $\mathbf{W}$  is an  $R \times R$  matrix the diagonal elements of which are set to zero. The matrix specifies the structure and intensity of spatial effects. Hence, the element  $w_{ij}$  represents the intensity of effects between two regions  $i$  and  $j$  (see Anselin and Bera 1998). A frequently applied weight specification is a binary spatial weight matrix such that  $w_{ij} = 1$  if the regions  $i$  and  $j$  share a border and  $w_{ij} = 0$  otherwise. Instead of using the concept of binary contiguity, in this study the

elements of  $\mathbf{W}$  are based on a distance decay function. To generate different structures of spatial interaction, a negative exponential function is employed:

$$w_{ij} = \exp(-\beta_E \cdot d_{ij}) \quad (0 < \beta_E < \infty) \quad (1)$$

with  $d_{ij}$  as distance between the centres of regions  $i$  and  $j$  and  $\beta_E$  as the distance decay parameter. A transformed distance decay parameter  $\gamma_E$  ( $0 \leq \gamma_E \leq 1$ ) measures the percentage decrease of spatial effects if distance expands by a given unit (see Bröcker 1989, Stetzer 1982).<sup>1</sup> To facilitate the interpretation and computation of spatial autocorrelation, spatial weights matrices are row-standardised, i.e. the weights  $w_{ij}$  are divided by the corresponding row sum.

It is assumed that spatial interaction such as commuting, migration or interregional trade is exposed to the frictional effects of geographical distance. With increasing  $\gamma_E$  these geographical impediments gain in strength, so that the decline of spatial effects becomes more pronounced with increasing distance from region  $i$ . The results of tests for spatial dependence are influenced by both the choice of the regional unit of analysis and the choice of spatial weights (Anselin 1988). In order to check the sensitivity of results with respect to a variation of  $\mathbf{W}$ , the whole range of  $\gamma_E$  is considered throughout the analysis. Concerning the effects across national borders, three different regimes are considered. Firstly, it is assumed that national borders do not matter. In this case, the calculation of cross border and intra-national weights does not differ. Thus, spatial interaction between neighbouring regions belonging to different countries is only affected by the frictional effects of distance. There are no additional impediments resulting from crossing a national border. Secondly, it is assumed that national borders prevent linkages between neighbouring labour markets. Significant cross border effects are excluded. All corresponding weights are set to zero.

However, the correct cross border weights are probably somewhere between these extreme specifications. Studies on interregional trade flows point to the significant trade impeding effects of national borders even for well integrated countries. The estimates of Bröcker (1998), McCallum (1995) and Helliwell (1998) imply a reduction of international trade, as compared to intra-national trade, by a factor of around 20 (for EU countries and the Canada-US border respectively).<sup>2</sup> Therefore, the third weight specification allows for border-specific impediments, i.e. a particular border effect for every pair of countries. The corresponding weights are calculated by reducing the purely distance-based weights by a border-specific factor. These factors are based on the trade impediments estimated by Bröcker (1998).<sup>3</sup>

## 2.2 Estimation of spatial effects

Common approaches applied to investigate unemployment differentials and adjustment mechanisms in European labour markets largely neglect linkages between neighbouring regions. Studies that focus on the adjustment of labour markets to shocks usually estimate vector auto-regression systems in order to analyse adjustment mechanisms such as changes in wages and labour force participation. Linkages between regions are considered to some extent since migration is taken into account. However, corresponding models do not explicitly incorporate a spatial dimension. It is often ignored that migration and other forms of spatial interaction are exposed to the frictional effects of distance.

In contrast, the present analysis emphasises the spatial aspects of labour markets using small units of observation. Data availability for the corresponding regional system entails restrictions with respect to the methodology. Panel specifications or vector auto-regressions are not applicable as time series for the analysed regions are rather short. Therefore, the point of departure is a traditional cross-sectional regression. Using matrix notation, the non-spatial model applied to analyse the evolution of regional unemployment in Europe is given by:

$$\Delta \mathbf{u} = \alpha_0 \mathbf{1} + \alpha_1 \Delta \mathbf{e} + \sum_{k=2}^N \alpha_k \mathbf{C}_k + \boldsymbol{\varepsilon} \quad (2)$$

where  $\Delta \mathbf{u}$  is the change in the regional unemployment rate,  $\mathbf{1}$  is a column vector of  $R$  ones,  $\Delta \mathbf{e}$  is regional employment growth and  $\boldsymbol{\varepsilon}$  is a vector of residuals. The analysis focuses on the effects of employment growth and the corresponding spillover on regional unemployment. Apart from regional employment growth, control variables  $\mathbf{C}_k$  are considered to avoid misspecifications due to omitted systematic variables. These comprise population density, indicators for sectoral composition and country dummies. As employment growth is included in order to capture the labour demand effects on regional unemployment, the control variables and country dummies should reflect the labour supply effects, country-specific labour market regulations or the differences regarding the efficiency of matching workers to jobs.<sup>4</sup>

The population density can be applied as an indicator for large and dense urban labour markets. These regions can be marked by a higher efficiency of the matching process because more job-seekers and job offers might lead to faster matching and lower unemployment (Elhorst 2000). However, the population density can also reflect amenities of large European agglomerations, which might cause strong immigration and higher unemployment. Indicators for the industrial composition can be used as approximations of the skill structure of the regional labour force. Structural change is characterised by an expanding service sector and declining employment in manufacturing and agriculture. Thus, matching jobs and job seekers is possibly more difficult in regions marked by a labour supply specialised in agriculture or manufacturing (Elhorst 2000, Taylor and Bradley 1997). Finally, country-specific labour market regulations and policies, allowed for by the inclusion of country dummies, can affect the matching process or labour supply.

Spatial dependence resulting from factor mobility or interregional trade is not explicitly considered in the standard model given by equation (2). Nevertheless, the approach might include spillover effects, operating through interregional trade. The corresponding effects imply that employment growth in region  $i$  generates employment growth in region  $j$ , which again affects unemployment in region  $j$ . This mechanism of transmission causes a spatial auto-correlation of employment growth (see Molho 1995). If interregional trade is the only, or by far the most, important source of spillover affecting the spatial structure of unemployment, the model given by (2) might already capture the entire spatial dependence. However, other forms of interaction can also result in a spatial auto-correlation of unemployment. Ignoring any significant spatial effects leads to serious econometric problems. If regional unemployment is marked by a spatial autocorrelation not captured by the explanatory variables, the model given by equation (2) will be incorrectly specified. Different spatial regression models can be applied to solve the problem.<sup>5</sup>

We focus on regression models that incorporate substantive spatial effects due to significant economic linkages between neighbouring regional labour markets. If spatial effects of the substantive form are ignored, the OLS regression of equation (2) will result in biased estimates and incorrect inference. To achieve proper estimates, the dependence can be incorporated through a spatial lag of the dependent variable:

$$\Delta \mathbf{u} = \rho \mathbf{W} \Delta \mathbf{u} + \alpha_0 \mathbf{1} + \alpha_1 \Delta \mathbf{e} + \sum_{k=2}^N \alpha_k \mathbf{C}_k + \varepsilon \quad (3)$$

where  $\rho$  is the spatial autoregressive parameter of the spatially lagged dependent variable. Molho (1995) offers an interpretation of the spatial lag model for an application focusing on the regional unemployment rate. According to Molho, the spatial lag specification implies that, starting from a steady state pattern of regional unemployment, a region-specific shock will not only affect the respective labour market, but instead spillover to neighbouring regions. The induced changes of unemployment in neighbouring areas again spillover to adjacent labour markets, including the location where the shock originated. This process of spatial adjustments continues until a new steady-state pattern of regional unemployment is reached. However, the spatial lag model does not allow us to draw precise conclusions regarding the different mechanisms that may cause a spatial association of regional unemployment. The spatially lagged dependent variable probably captures various spillover effects leading to spatial dependence.

A substantive dependence characterising regional unemployment can also be incorporated by the spatial lags of explanatory variables. As in the case of the spatially lagged dependent variable, the consequences of a corresponding specification error are serious: biased coefficient estimates and invalid inference procedures. The corresponding spatial cross-regressive model is given by:

$$\Delta \mathbf{u} = \alpha_0 \mathbf{1} + \alpha_1 \Delta \mathbf{e} + \sum_{k=2}^N \alpha_k \mathbf{C}_k + \tau \mathbf{W} \Delta \mathbf{e} + \varepsilon \quad (4)$$

In the following regression analysis a spatial lag of employment growth  $\mathbf{W} \Delta \mathbf{e}$  is included to capture spillover between regional labour markets. Whereas the spatially lagged dependent variable might cover all forms of spillover, the spatial lag of employment growth is restricted to those spatial effects that function via regional employment. Florax and Folmer (1992) emphasise the specific meaning of cross-regressive spatial dependence by considering the example of a regional production function. In this case, spatial dependence in general implies that the production in region  $i$  is also influenced by production in adjacent areas. In contrast, cross-correlation represented by spatially lagged explanatory variables indicates that production in region  $i$  is also affected by the availability of inputs in adjacent areas. In the present context, the former implies that regional unemployment is influenced by the evolution of unemployment in neighbouring areas. The latter implies that a change in unemployment in region  $i$  is influenced by employment growth in adjacent regions. Thus, the cross-regressive model is restricted to certain mechanisms of transmission but, thereby, allows more precise conclusions. Different types of spatial causation can also be considered simultaneously by including a spatial lag of employment growth in the spatial lag model.

With respect to the interpretation of different spatial effects, a second issue has to be considered. The cross-regressive model including employment growth and the spatially lagged employment change can provide us with evidence of the significance



of different forms of spatial interaction. Whereas employment growth, marked by a positive spatial auto-correlation may be interpreted as capturing the effects of inter-regional trade, the spatially lagged employment change can point to spillover caused by commuting and migration. As mentioned above, the spatial effects associated with regional employment growth imply that growth in region  $i$  induces growth in region  $j$  which affects unemployment in region  $j$ . In contrast, spatially lagged employment growth can indicate spatial interaction based on labour mobility as the variable implies that employment changes in region  $i$  influence unemployment in region  $j$  even if employment in region  $j$  remains constant. Thus, rising regional labour demand is associated with increasing job opportunities in neighbouring areas as well.

### 3. Empirical results

#### 3.1 Data

The analysed cross-section includes 359 European regions (Belgium (9), Denmark (12), Germany (71), Spain (46), France (88), Ireland (7), Italy (65), Luxembourg (1), Netherlands (12), Portugal (5), United Kingdom (43)). The sample contains NUTS2 and NUTS3 regions as well as functional regions that comprise several NUTS units. The selection of regions aimed at a spatial system with areas of comparable size and, as far as possible, the application of functional regions. Due to data restrictions the sample covers only those countries that have been EU members since 1986. Greece is not considered because of a lack of regional data. A detailed description of the sample is given in the Appendix. Regional data on unemployment, working population, employment, population and area were collected from the Eurostat Regio database. For some regions the missing observations were taken from the Cambridge Econometrics' European regional databank.

The Eurostat definition of unemployment is in line with the recommendations of the International Labour Office (ILO). According to the ILO recommendations the definition of unemployment is linked to the following conditions: An unemployed person has to be without work during the survey reference week, is able to take up employment within two weeks and has actively sought work over the past four weeks. The unemployment rate is defined as the percentage of unemployed persons in the total economically active population (the total of unemployed and employed persons). The harmonized regional data on unemployment is based on estimates taken from the Community Labour Force Survey that are combined with the regional structures of registered unemployed persons or regionally representative results of labour force surveys. A similar procedure is applied in order to generate harmonized employment data.<sup>6</sup>

The spatial dependence of regional unemployment in Europe is analysed over the 1986-2000 period. Thus, the change in the regional unemployment rate between 1986 and 2000 is the dependent variable in the regression analysis. Since data on regional employment is available only until 1995, the explanatory variable employment growth refers to the 1986-1995 period. The spatially lagged employment change was calculated for weight matrices that cover the whole range of distance decay parameters. To avoid errors, control variables are considered, including sectoral specialisation and population density in 1987. All variables are expressed in logarithms. The indicators for the sectoral composition of the regions base on employment data are taken from NACE-CLIO R3 classification, (B01: Agricultural,

forestry and fishery products, B02: Manufactured products, B03: Market services). The corresponding employment shares, i.e. percentages of regional employment in manufacturing respectively market services, are used as control variables. Moreover, country dummies are included. As outlined in section 2, these variables are considered in order to capture the labour supply effects, country-specific labour market conditions or differences regarding the efficiency of the matching process.

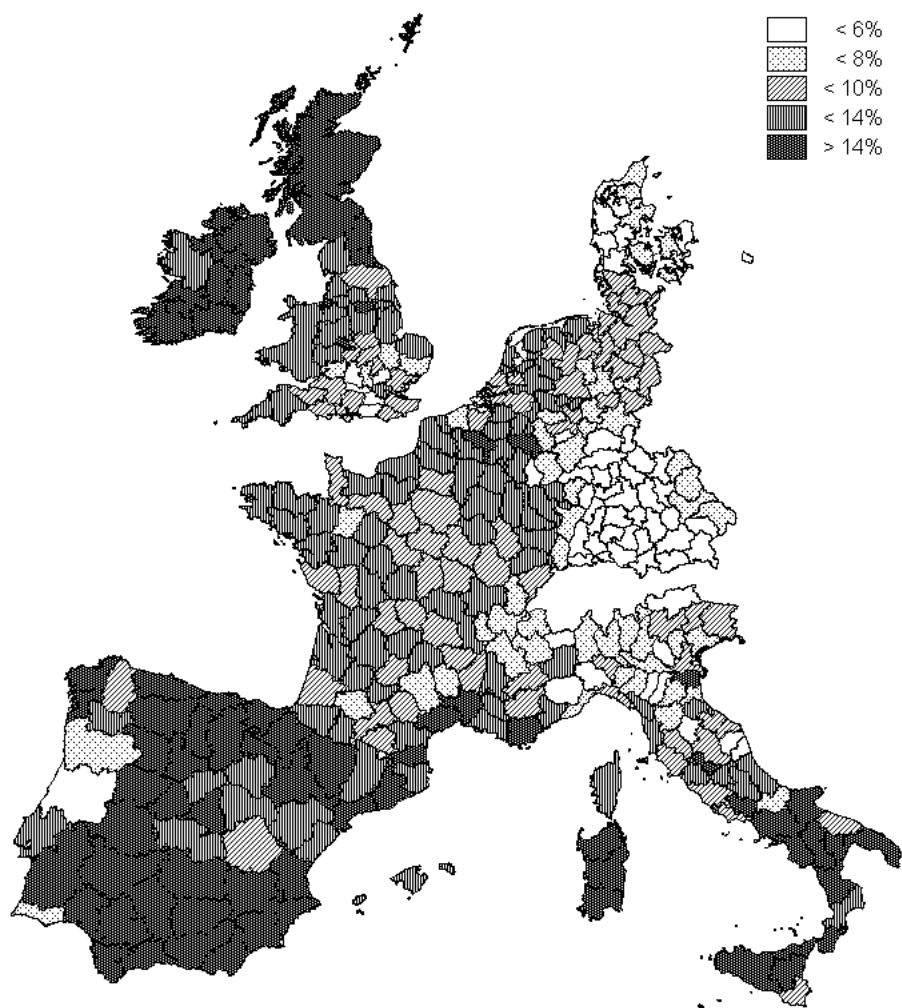
### **3.2 Unemployment clusters across European regions**

Between 1986 and 2000 the average unemployment rate in the EU (EU12) decreased from 10.7% to 8.5%. However, this average change masks significant national and regional differences. While some countries have seen a distinct reduction in unemployment since the mid 1980s, others have experienced deteriorating labour market conditions. For instance, the unemployment rate of the Netherlands fell from 10% to less than 3% and the decline in Ireland was even more pronounced (18.1% in 1986, 4.4% in 2000). In contrast, unemployment in Germany increased from 6.6% to 8.1% and in Italy from 10.5% to 10,8%.

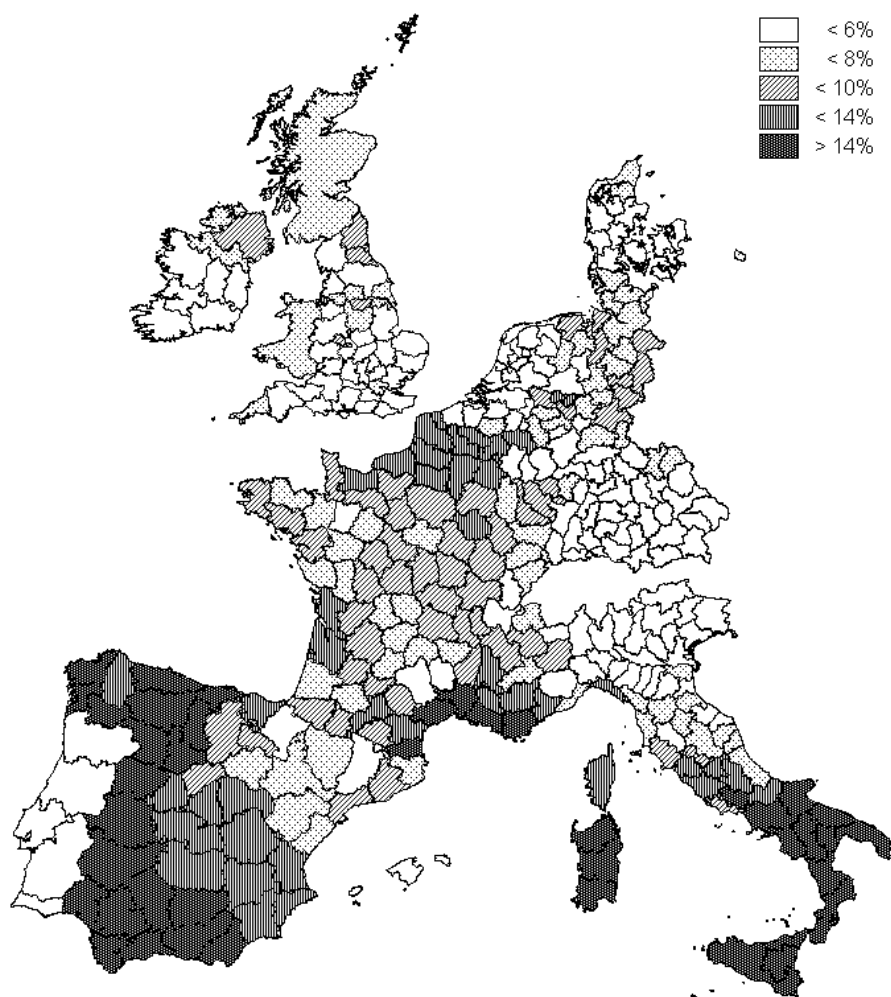
As Figures 1 and 2 illustrate for the sample of European regions, some features of regional unemployment in the EU remained more or less unchanged since the middle of the 1980s, whereas others have changed dramatically.<sup>7</sup> In 1986 as well as in 2000 several regions in Spain and the southern part of Italy suffered from severe labour market problems, with unemployment rates of more than 25% in some areas. In contrast, Denmark and the northern part of Italy achieved modest unemployment rates of around 5% in the middle of the 1980s and at the end of the 1990s. However, simultaneously significant changes in the spatial structure of unemployment are obvious. Most regions in Ireland, the UK and the Netherlands saw a distinct reduction in unemployment. At the same time, the disparities between the northern and southern part of Italy became even more pronounced and a cross border cluster of high unemployment evolved in the Franco-Belgian border area.

These changes were accompanied by an increase in regional unemployment disparities. The dispersion of regional unemployment rates, measured by the coefficient of variation, rose from 0.5 in 1986 to 0.65 in 2000 (see Figure 3). This increase is based on both a rising dispersion between member states and a higher regional variation within most of the analysed countries (see also Mauro et al. 1999). A similar trend characterises the concentration of regional unemployment in Europe. During the period under consideration, the concentration of unemployment, measured by the Theil coefficient<sup>8</sup> rose from 0.05 (1986) to 0.08 (2000). And again, this change is based on concentration processes effective between and within the countries.

Altogether, the geographical distribution of unemployment suggests that the spatial dimension, i.e. spatial dependence is an important aspect of regional labour markets in Europe. Moreover, regional unemployment disparities as for example in Italy or Germany and cross border unemployment clusters such as the area on the Franco-Belgian border indicate that unemployment clusters are not exclusively based on national differences.



*Fig. 1. Regional unemployment rates 1986*



*Fig. 2. Regional unemployment rates 2000*

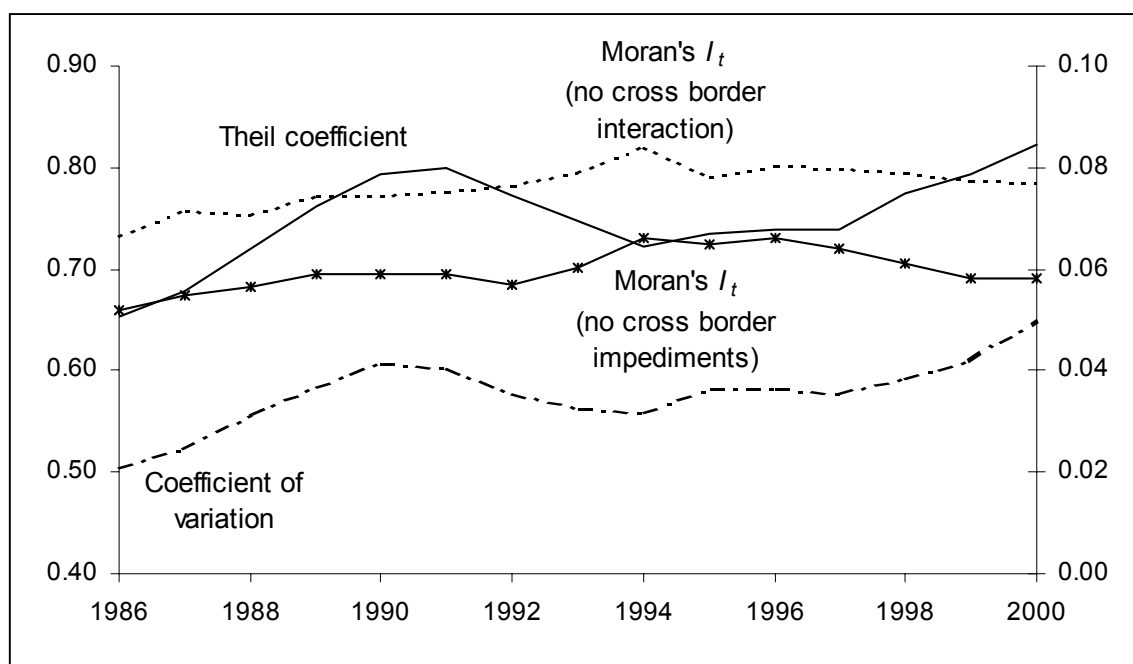


Fig. 3. Concentration, dispersion and spatial autocorrelation of regional unemployment in Europe

These presumptions, derived from visual examination, are confirmed by the results of Moran's  $I_t$  (see Table 1). The Moran coefficient is applied in order to measure the spatial association of regional unemployment. The correlation analysis points to a strong positive auto-correlation of both regional unemployment ( $u_{i,t}$ ) and the change in regional unemployment during the period under consideration ( $\Delta u_{i,1986-2000}$ ). This result is rather robust since a significant spatial autocorrelation is detected for all applied spatial weights, in other words for the whole range of distance decay parameters. Adjacent regions that form clusters of high and low unemployment seem to be a central feature of disparities in Europe. Furthermore, spatial dependence is not solely the consequence of national differences since a significant auto-correlation also characterises relative unemployment rates, i.e. the ratio of the regional unemployment rate to the nation-wide unemployment rate ( $u_{i,t}/u_{n,t}$ ). Unemployment clusters are not exclusively national clusters, covering all regions that belong to the same EU member state. Disparities below the national level, as for example in Spain, Italy or Germany, are as well marked by clusters that add to the overall spatial dependence of unemployment. These intra-national clusters and national differences seemingly account for most of the spatial auto-correlation because Moran's  $I_t$  tends to be higher for the national weight specifications (no cross border interaction) than for weight matrices including unrestricted or restricted cross border interaction (no border impediments respectively border-specific impediments). Thus, cross border clusters, such as the area on both sides of the Franco-Belgian border, are more likely to be the exception than the rule.<sup>9</sup>

Table 1: Spatial autocorrelation of regional unemployment in Europe

Variable	Moran's $I_t$ (standardised z-value)				
	Distance decay parameter $\gamma_E$				
	0.1	0.3	0.5	0.7	0.9
$u_{i,1986}$					
- no cross border interaction	0.54 (42.8)**	0.65 (41.3)**	0.73 (34.1)**	0.78 (26.5)**	0.81 (19.3)**
- no border impediments	0.21 (68.7)**	0.53 (49.9)**	0.66 (36.4)**	0.73 (27.4)**	0.78 (19.5)**
- border-specific impediments	0.50 (50.6)**	0.64 (43.6)**	0.73 (34.8)**	0.77 (26.9)**	0.80 (19.5)**
$u_{i,2000}$					
- no cross border interaction	0.43 (34.1)**	0.66 (41.7)**	0.78 (36.5)**	0.84 (28.8)**	0.89 (21.2)**
- no border impediments	0.19 (61.8)**	0.54 (50.8)**	0.69 (38.1)**	0.77 (29.0)**	0.84 (21.1)**
- border-specific impediments	0.39 (40.3)**	0.64 (43.7)**	0.77 (37.1)**	0.83 (29.0)**	0.87 (21.2)**
$u_{i,1986} / u_{n,1986}$					
- no cross border interaction	0.12 (9.4)**	0.34 (21.4)**	0.48 (22.3)**	0.55 (18.7)**	0.60 (14.4)**
- no border impediments	0.05 (17.7)**	0.29 (27.4)**	0.45 (25.0)**	0.53 (19.9)**	0.59 (14.7)**
- border-specific impediments	0.11 (11.5)**	0.33 (22.7)**	0.48 (22.8)**	0.55 (19.0)**	0.60 (14.5)**
$u_{i,2000} / u_{n,2000}$					
- no cross border interaction	0.14 (11.2)**	0.34 (21.6)**	0.48 (22.2)**	0.57 (19.3)**	0.64 (15.4)**
- no border impediments	0.06 (18.5)**	0.28 (26.3)**	0.43 (23.8)**	0.53 (20.0)**	0.62 (15.7)**
- border-specific impediments	0.13 (13.5)**	0.34 (23.0)**	0.47 (22.8)**	0.56 (19.7)**	0.64 (15.6)**
$\Delta u_{i,1986-2000}$					
- no cross border interaction	0.61 (48.4)**	0.69 (43.8)**	0.73 (34.1)**	0.75 (25.8)**	0.76 (18.3)**
- no border impediments	0.14 (45.2)**	0.54 (50.8)**	0.56 (31.0)**	0.65 (24.1)**	0.69 (17.3)**
- border-specific impediments	0.49 (49.7)**	0.64 (43.7)**	0.71 (33.8)**	0.73 (25.6)**	0.74 (18.1)**

Notes: \*\* significant at the 0.01 level.

Comparing the results for unemployment rates in 1986 and 2000 suggests that the intensity of spatial dependence has slightly increased during the period under consideration. Figure 3 displays the evolution of spatial auto-correlation for regional unemployment rates over the 1986-2000 period. Apart from Moran's  $I_t$  (for  $\gamma_E = 0.5$ ), the coefficient of variation and the Theil coefficient are mapped in order to examine the relationship between the dispersion, concentration and spatial dependence of regional unemployment. As shown in Figure 3, all measures are characterised by a more or less pronounced increase, though, the statistics do not develop in a perfectly synchronized manner. The results for Moran's  $I_t$  indicate that the increase in spatial association was a relatively continuous process until the middle of the 1990s. Between

1996 and 2000 Moran's  $I_i$  decreased a little but remained above the level of 1986. The evolution of dispersion and concentration is marked by stronger fluctuations. Both the Theil coefficient and the coefficient of variation rapidly increased between 1986 and 1990, then declined until the middle of the 1990s and subsequently rose again thereafter. This suggests that the evolution of dispersion and concentration of regional unemployment is affected by the overall change in unemployment. The decline of unemployment in the EU12 between 1986 and 1990 was associated with increasing dispersion and concentration. Both measures were decreasing when the average unemployment rate in the EU12 was rising again from 1990 to 1994.

The evolution of the measures suggests that unemployment has become more concentrated and that this process of concentration was accompanied by an increasing spatial dependence. Consequently, the rising concentration of labour market problems probably corresponds to a concentration of unemployment in spatial clusters. Such a process of spatial concentration is consistent with the polarisation of unemployment detected by Overman and Puga (2002) for EU regions and by López-Bazo et al. (2001) for Spanish regions.

To sum up, the results point to a significant spatial dependence, i.e. both regions marked by high unemployment rates and areas characterised by rather favourable labour market conditions tend to cluster in space.<sup>10</sup> These clusters are not exclusively caused by national differences. Intra-national disparities are characterised by a spatial clustering as well. Moreover, the empirical evidence suggests that the change in regional unemployment is also marked by significant spatial effects. The following regression analysis focuses on the latter.

### 3.3 Estimation results

Table 2 shows regression results for different specifications applied to analyse spatial effects that characterise the change in regional unemployment rates between 1986 and 2000. Estimates of the non-spatial model, given by equation (2), are presented in column (1). Feasible Generalized Least Squares (FGLS) estimation of a model with groupwise heteroscedasticity had to be applied because of heteroscedastic error terms.<sup>11</sup> All explanatory variables are significant at the 5% level. The coefficient of the share of market services in total employment ( $\text{serv}_{t_0}$ ) indicates that a relatively high fraction of service employment in 1987 is associated with a decrease, or a relatively small increase, in regional unemployment. In other words, regions characterised by a specialisation in services tended to experience a rather favourable development as regards unemployment since the middle of the 1980s. The negative coefficient of the share of manufacturing in total employment ( $\text{manu}_{t_0}$ ) implies that regions specialised in manufacturing achieved, on average, a decline (or again relatively small increases) in unemployment as well.<sup>12</sup> In contrast, the evolution of unemployment tended to be rather unfavourable in highly agglomerated European regions, as indicated by the positive coefficient of the population density ( $\text{dens}_{t_0}$ ).

The latter result is not in line with the highly efficient matching process found in large and dense urban labour markets, as discussed in section 2. The estimate points rather to the opposite, i.e. a slower matching process because it takes more time to gather all relevant information in such large labour markets. Another explanation might be an above average increase in the labour supply in these areas. If the highly agglomerated

regions of Europe are the preferred destinations of migration flows, the corresponding increase in labour supply might result in a smaller reduction of unemployment for every given expansion of employment. Furthermore, the coefficients of employment shares of manufacturing and services indicate that a corresponding specialisation of regions will probably not reduce the efficiency of the matching process. At the same time, this finding suggests that the skill structure in regions specialised in agriculture tends to exacerbate the regional matching process. The effect of regional employment growth ( $\Delta e$ ) on unemployment is negative, as one would expect. Beyond that, the variable incorporates another interesting effect. Moreover, as regional employment growth is marked by a significant spatial auto-correlation, this explanatory variable also includes spillover effects. According to the discussion of different regression models in section 2, this result might be interpreted as spatial interaction caused by inter-regional trade. Thus, although spatial effects are not explicitly modelled in this approach, the inclusion of the spatially auto-correlated employment growth already entails the consideration of inter-regional spillover occurring. However, spatial interaction base on inter-regional trade is obviously not the only source of spatial dependence characterising the evolution of regional unemployment. Tests for spatial auto-correlation in the regression residuals ( $LM_{ERR}$ ,  $LM_{LAG}$ ) provide strong evidence of a misspecification due to omitted spatial effects.<sup>13</sup>

Furthermore, results concerning the included country dummies suggest that there are more country-specific effects beyond national differences in employment growth. Negative coefficients point to the favourable decline of unemployment in countries such as Ireland and the Netherlands, both pursuing wide-ranging structural reforms from the second half of the 1980s onwards. In contrast, positive and significant coefficients emerged for countries marked by less comprehensive reforms, as e.g. Germany or France.<sup>14</sup>

Regression results for models that explicitly include spatial effects are given in columns (2) and (3). The selection of spatial models is based on a variation of the distance decay parameter (weight matrix) of the integrated spatial effects. All assumptions concerning cross border effects (no cross border interaction, restricted and unrestricted cross border interaction) are taken into account regarding the calculation of spatial variables. The fit of the model and tests for spatial auto-correlation are used to identify appropriate spatial weights. Thus, the chosen model, i.e. distance decay, provides the best fit simultaneously capturing, if possible, the overall spatial interaction that characterises the change in regional unemployment.



Table 2: Regression results for the change in regional unemployment 1986-2000

Explanatory variables	FGLS		Maximum Likelihood (ML)
	(1)	(2)	
<b>manu</b> <sub>t<sub>0</sub></sub>	-0.43** (6.03)	-0.37** (4.97)	-0.21** (3.17)
<b>serv</b> <sub>t<sub>0</sub></sub>	-0.45** (3.05)	-0.33* (2.18)	-0.26* (1.99)
<b>dens</b> <sub>t<sub>0</sub></sub>	0.05* (2.50)	0.04* (2.07)	0.03 (1.92)
<b>Δe</b>	-1.04** (4.86)	-0.89** (4.11)	-0.83** (4.38)
<b>WΔe</b> ( $\gamma_E = 0.3$ ) border-specific impediments		-2.78** (3.57)	-0.13 (0.18)
<b>WΔu</b> ( $\gamma_E = 0.6$ ) no cross border interaction			0.64** (11.37)
<b>Country Dummies</b>			
<i>Belgium</i>	0.17	-0.11	0.03
<i>Denmark</i>	0.56**	0.08	0.21
<i>Germany</i>	0.80**	0.53**	0.21
<i>Spain</i>	0.39**	0.15	0.07
<i>France</i>	0.64**	0.28	0.15
<i>Ireland</i>	-0.50**	-0.61**	-0.22
<i>Italy</i>	0.49**	0.03	0.06
<i>Netherlands</i>	-0.31*	-0.27*	-0.12
<i>United Kingdom</i>	-0.01	-0.21	-0.05
$R^2$	0.65	0.66	0.71
LM <sub>ERR</sub>	118.0** (0.5) <sup>1)</sup> [0.1-0.9] <sup>2)</sup>	114.9** (0.5) [0.1-0.9]	
LM <sub>LAG</sub>	111.0** (0.5) [0.1-0.9]	98.8** (0.5) [0.1-0.9]	

Notes: \*\* significant at the 0.01 level,  
\* significant at the 0.05 level,  
1) corresponding distance decay  $\gamma_E$ ,  
2) range of  $\gamma_E$  with significant spatial autocorrelation of the error term at the 0.05 level.

In column (2) the estimates of the spatial cross-regressive model (equation (4)) are presented. The regression yields a negative and significant coefficient for the spatial lag of regional employment growth. Coefficients of the other explanatory variables are more or less unaffected by the inclusion of the spatial lag. The coefficients slightly

decrease but remain significant. The result for the spatial lag of employment growth suggests that the generation of jobs not only reduces the unemployment rate of the corresponding region but also unemployment in neighbouring areas, thus, presumably spatial dependence caused by labour mobility. Weight specifications including border specific impediments achieve a slightly better fit than matrices with no, or unrestricted, cross border interaction. However, the differences between the various specifications regarding cross border interaction as well as the differences between distance decays are not very pronounced. Thus, the result with respect to the range of the spatial effects  $\mathbf{W}\Delta\mathbf{e}$  should be interpreted carefully. The model presented here is associated with a relatively low distance decay of  $\gamma_E = 0.3$ . According to this distance decay, the intensity of spatial effects based on labour mobility declines very slowly, by 50% over a range of roughly 100 kilometres. This estimate is clearly not consistent with conventional commuting behaviour. Moreover, compared with the empirical evidence provided by Molho (1995), the distance decay also appears to be quite low with respect to migration. The corresponding estimates for regional labour markets in the UK point to a reduction of spatial effects by more than 90% over a range of 100 miles. However, as mentioned previously, the fit of models with relatively low distance decays (0.1 to 0.5) varies only marginally, while the range of spatial effects differs significantly. For example, the half-life distance declines from 360 kilometres to 55 kilometres if the distance decay is increased from 0.1 to 0.5. Some unusual forms of labour mobility might be relevant in this context as well. Temporary migration or long distance commuting (weekly or monthly) gain in importance and might contribute to relatively low distance decay.<sup>15</sup> Although labour mobility in Europe is too low in order to offset regional unemployment disparities, it is apparently one of the factors that generate the significant spatial dependence of regional labour market conditions.<sup>16</sup> However, tests for spatial auto-correlation still indicate a misspecification, even though the degree of residual auto-correlation is reduced by the inclusion of the spatially lagged explanatory variable.

The results of the spatial lag model are presented in column (3). Concerning the spatially lagged dependent variable the weight specification reflecting no cross border interaction yields a slightly better fit than do specifications with border-specific impediments. Only the specifications with unrestricted cross border interaction achieve clearly inferior results. This applies to the whole range of distance decay parameters. Thus, assuming no impeding effects of borders at all is apparently not adequate regarding spatial interaction between regional labour markets in Europe.

The fit of the model is maximised for a rather high distance decay ( $\gamma_E = 0.6$ ). The significant coefficient of the spatially lagged dependent variable points to strong spillover effects that decline rather quickly with increasing distance. Thus the neighbourhood of regions marked by an unfavourable development of unemployment tended to worsen regional labour market conditions (and vice versa for the neighbourhood of regions characterised by a decrease in unemployment). The distance decay implies that the intensity of spatial interaction decreases by 50% over a range of roughly 40 kilometres. These spatial weights are more in line with highly localised interaction, such as daily commuting.<sup>17</sup> But the declining coefficients of  $\Delta\mathbf{e}$  and  $\mathbf{W}\Delta\mathbf{e}$  suggest that the spatially lagged change in unemployment also picks up other forms of spatial interaction with a rather limited scope. The coefficient of  $\mathbf{W}\Delta\mathbf{e}$  is even reduced to insignificance. Therefore it is difficult to distinguish between

different spatial effects. Moreover, spatial variables seem to absorb some country-specific effects since their inclusion results in clearly reduced coefficients of all country dummies.

#### 4. Conclusions

The results of this paper emphasise the importance of spatial interaction with respect to regional labour markets in Europe. The findings confirm the empirical evidence provided by several studies, pointing to significant spillover among regional labour markets. In particular this applies to the analysis of Overman and Puga (2002). They conclude that the unemployment rates of European regions are much closer to the rates of adjacent regions than to the average rate of other regions within the same EU country. The spatial concentrations of areas with similar skill composition or sectoral specialisation are not the primary cause of this spatial association. The present analysis also points to a significant spatial dependence, i.e. both regions marked by high unemployment rates and areas characterised by rather favourable labour market conditions tend to cluster in space. Spatial dependence is a central feature of the large and persistent unemployment differentials that characterise EU regions. Moreover, the evolution of regional unemployment is also marked by spatial effects. The results suggest that the change in regional unemployment between 1986 and 2000 was associated with an increasing concentration of labour market problems in spatial clusters. This geographical concentration probably corresponds with the polarisation processes detected by Overman and Puga (2002) or López-Bazo et al.(2001).

Furthermore, the findings point to different forms of spatial interaction that affect the change in regional unemployment. However, it turned out to be rather difficult to distinguish explicitly between effects resulting from commuting, migration or interregional trade. The detected spillover associated with a high distance decay and no significant cross border interaction might point to spatial dependence caused by commuting and migration. The high distance decay indicates significant frictional effects of distance. Thus the spatial distance costs are apparently one reason for insufficient equilibrating forces between regional labour markets. However, to achieve more precise conclusions in this respect will necessitate a method based on consistent data on labour mobility and trade among European regions. Finally, assuming different spatial regimes, e.g. country-specific intensities and distance decays of spatial effects, might also be an appropriate approach. Thus, a number of issues remain to be investigated concerning the spatial interaction of regional labour markets in Europe.

Findings concerning spatial effects among European labour markets have implications for regional policy. The existence of unemployment clusters, i.e. similar labour market conditions in neighbouring regions, suggests that policies that promote labour mobility across *longer* distances and national borders might be appropriate to reducing differences in regional unemployment. Regional disparities marked unemployment clusters cannot be reduced by short distance mobility within the borders of these clusters. As far as these clusters coincide with national clusters, in other words with international disparities, measures leading to more consistent labour market regulations in Europe constitute adequate policies as well. However, the clustering of unemployment in Europe also consists of intra-national disparities. The harmonisation of national regulations and policies is not an appropriate instrument to dissolve corresponding spatial structures within Germany, Italy or Spain.

Furthermore, as Burgess and Profit (2001) note, significant spillover effects between neighbouring regions imply the existence of wider consequences of local unemployment shocks. Massive layoffs in a certain region will tend to depress adjacent labour markets as well. Likewise, every measure that reduces local unemployment will also have positive effects in neighbouring labour markets. This calls for close cooperation and common measures between regions in order to diminish severe labour market problems.

## Notes

<sup>1</sup> The transformed parameter is given by:  $\gamma_E = 1 - e^{-\beta_E \cdot D_{MIN}}$ , where  $D_{MIN}$  denotes the average distance between the centres of immediately neighbouring regions over the whole cross-section, in the present case 55 kilometres.

<sup>2</sup> Helliwell (1998) also provides evidence of significant border effects on migration.

<sup>3</sup> Only the study of Bröcker (1998) provides, to our knowledge, estimates of border-specific impediments. There are no estimates for Spain, Portugal and Ireland. For these countries the average border effect is assumed or the estimates for a neighbouring country are used (estimates for UK applied to Ireland).

<sup>4</sup> A comprehensive consideration of all corresponding effects, e.g. regarding regional differences in participation, qualification of the work force or occupational structure of the working population, is not possible due to severe data restrictions.

<sup>5</sup> See Anselin (1988) for a detailed description of test statistics and spatial regression models. The spatial error model is not considered in the present analysis since we focus on spatial dependence caused by interaction between regional labour markets. The spatial error model is an appropriate approach if spatial association is caused by measurement problems or inadequate units of observation.

<sup>6</sup> See European Communities (2001): Regio database – Reference guide, Luxembourg.

<sup>7</sup> Mauro et al. (1999), Bertola (2000) or Overman and Puga (2002) provide comprehensive analyses of regional labour market disparities in Europe.

<sup>8</sup> The Theil coefficient is given by:  $TC_t = \sum_i U_{it} \cdot \log\left(\frac{U_{it}}{WP_{it}}\right)$ , where  $U_{it}$  and  $WP_{it}$  are regional shares of unemployment and working population in year t respectively.

<sup>9</sup> See Overman and Puga (2002) for an interesting analysis of this cross border cluster. They discuss in detail the circumstances that led to the emergence of the unemployment cluster.

<sup>10</sup> The result of significant spatial dependence effective between regional labour markets in Europe is robust with respect to the size of the regions. Overman and Puga (2002) detect a significant spatial auto-correlation for a cross section of NUTS2 regions. On average the areas investigated in the present analysis are smaller than NUTS2 regions.

<sup>11</sup> The different regimes of the groupwise heteroscedasticity approach were defined according to the general development of unemployment in the countries, i.e. increasing, declining and unchanged unemployment.

<sup>12</sup> This result confirms evidence provided by Overman and Puga (2002). They argue that this negative effect on unemployment is caused by the development of Northern and Central European regions specialised in heavy industry. Since the worst part of their adjustment process was over by the middle of the 1980s, many of these areas attained a reduction in unemployment.

<sup>13</sup> The tests for spatial auto-correlation apply the unrestricted cross border weight specification (for the whole range of distance decay parameters) because these weights may offer a more stringent method of testing.

<sup>14</sup> For a detailed description of structural reforms in the OECD countries, see OECD (1997).

<sup>15</sup> I am grateful to a referee for pointing to the potential effects of these unusual types of labour mobility. See also Papapanagos and Vickerman (2000) as well as Straubhaar (2000). The conspicuously low distance decay might also partly be caused by national effects that are captured by the spatial lag as well. The inclusion of the spatially lagged of employment growth reduces the coefficients of most country dummies.

<sup>16</sup> In the last two decades labour mobility in Europe has declined markedly. The low mobility is frequently ascribed to cultural and linguistic differences. However, these factors should have been effective in periods of larger migration flows as well. Moreover, they cannot explain the low mobility within European countries. Recent studies emphasise inefficiencies in the regional matching process and high mobility costs, especially high house prices, as possible causes of low intra-national mobility (see Faini et al. 1997, McCormick 1997).

<sup>17</sup> The results are robust with respect to the functional form of the distance decay. Applying a weight matrix based on a power function ( $1/d_{ij}$ ) does not change the general results that significant spatial effects are effective between regional labour markets. However, coefficients slightly change and the model applying the power function is inferior compared with the models that include weights based on the negative exponential function. This outcome is in line with empirical evidence provided e.g. by Fotheringham, O'Kelly (1989). They conclude that the exponential function is more appropriate for depicting short distance interaction such as commuting. The additional regression results are available upon request.

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## APPENDIX

The regional system was based on different administrative units: Belgium - NUTS2 (Brussels and adjacent regions merged), Denmark – NUTS3 (København and adjacent regions merged), Germany – Raumordnungsregionen (functional regions comprising several NUTS3 units), Spain – NUTS2 and NUTS3, France – NUTS2 and NUTS3, Ireland – NUTS3 (Dublin and the surrounding area merged), Italy – NUTS3 and units comprising several NUTS3 regions, Luxembourg, Netherlands – NUTS2, Portugal – NUTS2, United Kingdom – NUTS2, NUTS3 and units comprising several NUTS3 regions (data for Wales, Scotland and Northern Ireland was only available on the NUTS1 level). The following regions are not considered because of data restrictions: Berlin and all regions that were part of East Germany before 1990, Islas Baleares, Ceuta y Melilla (Spain), Départements d'outre-Mer (France), Açores, Madeira (Portugal). The 359 European regions used in the sample are:

- Belgium (9): Brussels, Antwerpen, Limburg, Oost-Vlaanderen, West-Vlaanderen, Hainaut, Liège, Luxembourg, Namur
- Denmark (12): København, Vestsjællands amt, Storstrøms amt, Bornholms amt, Fyns amt, Sønderjyllands amt, Ribe amt, Vejle amt, Ringkøbing amt, Århus amt, Viborg amt, Nordjyllands amt
- Germany (71): Schleswig-Holstein Nord, Schleswig-Holstein Süd-West, Schleswig-Holstein Mitte, Schleswig-Holstein Ost, Hamburg, Bremen, Ostfriesland, Bremerhaven, Oldenburg, Emsland, Osnabrück, Hannover, Südheide, Lüneburg, Braunschweig, Hildesheim, Göttingen, Münster, Bielefeld, Paderborn, Arnsberg, Dortmund, Emscher-Lippe, Duisburg/Essen, Düsseldorf, Bochum/Hagen, Köln, Aachen, Bonn, Siegen, Nordhessen, Mittelhessen, Osthessen, Rhein Main, Starkenburg, Mittelrhein-Westerwald, Trier, Rheinhessen-Nahe, Westpfalz, Rheinpfalz, Saar, Unterer Neckar, Franken, Mittlerer Oberrhein, Nordschwarzwald, Stuttgart, Ostwürttemberg, Donau Iller (BW), Neckar Alb, Schwarzwald-Baar, Südlicher Oberrhein, Hochrhein-Bodensee, Bodensee-Oberschwaben, Bayrischer Untermain, Würzburg, Main-Rhön, Oberfranken West, Oberfranken Ost, Oberpfalz Nord, Mittelfranken, Westmittelfranken, Augsburg, Ingolstadt, Regensburg, Donau Wald, Landshut, München, Donau Iller (BY), Allgäu, Oberland, Südostoberbayern
- Spain (46): La Coruña, Lugo, Orense, Pontevedra, Principado de Asturias, Cantabria, Pais Vasco, Comunidad Foral de Navarra, La Rioja, Huesca, Teruel, Zaragoza, Comunidad de Madrid, Avila, Burgos, León, Palencia, Salamanca, Segovia, Soria, Valladolid, Zamora, Albacete, Ciudad Real, Cuenca, Guadalajara, Toledo, Badajoz, Cáceres, Barcelona, Gerona, Lérida, Tarragona, Alicante, Castellón de la Plana, Valencia, Islas Baleares, Almería, Cadiz, Córdoba, Granada, Huelva, Jaén, Málaga, Sevilla, Murcia
- France (88): Île de France, Ardennes, Aube, Marne, Haute Marne, Aisne, Oise, Somme, Eure, Seine Maritime, Cher, Eure et Loir, Indre, Indre et Loire, Loir et Cher, Loiret, Calvados, Manche, Orne, Côte d'Or, Nièvre, Saône et Loire, Yonne, Nord, Pas de Calais, Meurthe et Moselle, Meuse, Moselle, Vosges, Bas Rhin, Haut Rhin, Doubs, Jura, Haute Saône, Territoire de Belfort, Loire Atlantique, Maine et Loire, Mayenne, Sarthe, Vendée, Côte du Nord, Finistère, Ille et

- Vilaine, Morbihan, Charente, Charente Maritime, Deux Sèvres, Vienne, Dordogne, Gironde, Landes, Lot et Garonne, Pyrénées Atlantiques, Ariège, Aveyron, Haute Garonne, Gers, Lot, Hautes Pyrénées, Tarn, Tarn et Garonne, Corrèze, Creuse, Haute Vienne, Ain, Ardèche, Drôme, Isère, Loire, Rhône, Savoie, Haute Savoie, Allier, Cantal, Haute Loire, Puy de Dôme, Aude, Gard, Hérault, Lozère, Pyrénées Orientales, Alpes de Haute Provence, Hautes Alpes, Alpes Maritimes, Bouches du Rhône, Var, Vaucluse, Corse
- Ireland (7): Border, Dublin, Midland, Mid-West, South-East, South-West, West
- Italy (65): Torino, Novara, Alessandria, Cuneo, Valle d'Aosta, Imperia/Savona, Genova, Milano, Bergamo, Cremona/Mantova, Brescia, Pavia, Bolzano-Bozen, Trento, Verona, Vicenza, Belluno, Venezia, Padova, Friuli-Venezia Giulia, Piacenza, Parma, Reggio nell'Emilia, Modena, Bologna, Ferrara, Ravenna, Forli, Massa-Carrara/Lucca, Florenz, Livorno/Pisa, Arezzo, Siena, Grosseto, Perugia, Terni, Pesaro e Urbino, Ancona, Macerata, Ascoli Piceno, Viterbo, Rieti, Roma, Latina, Frosinone, L'Aquila, Pescara, Molise, Napoli, Salerno, Foggia, Bari, Taranto, Potenza, Matera, Cosenza, Catanzaro, Reggio di Calabria, Palermo, Messina, Catania, Siracusa, Sassari, Nuoro/Oristano, Cagliari
- Luxembourg (1)
- Netherlands (12): Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, Noord-Holland, Zuid-Holland, Zeeland, Noord-Brabant, Limburg (NL)
- Portugal (5): Norte, Centro, Lisboa e Vale do Tejo, Alentejo, Algarve
- United Kingdom (43): Tees Valley and Durham, Northumberland/Tyne and Wear, Cumbria, Cheshire, Greater Manchester, Lancashire, Merseyside, East Riding and North Lincolnshire, North Yorkshire, South Yorkshire, West Yorkshire, Derbyshire and Nottinghamshire, Leicester/Rutland, Northamptonshire, Lincolnshire, Herefordshire/Worcestershire, Warwickshire, Shropshire and Staffordshire, West Midlands, Peterborough/Cambridgeshire, Norfolk, Suffolk, Luton/Bedfordshire, Hertfordshire, Essex, London, Berkshire, Milton Keynes/Buckinghamshire, Oxfordshire, Brighton, Hove/East Sussex, Surrey, West Sussex, Hampshire and Isle of Wight, Kent, Bristol/North and North East Somerset/Swindon/Wiltshire, Gloucestershire, Bournemouth, Poole/Dorset, Somerset, Cornwall and Isles of Scilly, Devon, Wales, Scotland, Northern Ireland

Regional unemployment rates and data on working populations was taken from the Eurostat Regio database and are based on the results of the Community Labour Force Survey.

Data on regional employment was taken from the Eurostat Regio database and from the Cambridge Econometrics' European regional databank. The indicators for the sectoral composition base on employment data by NACE-CLIO R3 sector (B01: Agricultural, forestry and fishery products, B02: Manufactured products, B03: Market services).

Data on population and area was collected from the Eurostat Regio database