Nonlinear Stochastic Convergence Analysis of Regional Unemployment Rates in Poland

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Abstract

This paper analyzes convergence of unemployment rates in Poland at NUTS4 level by testing nonlinear convergence, applying the modified KSS-CHLL for each pair of territorial units. The results suggest that actually the convergence is a rare phenomenon and occurs only in 1916 cases out of potential over 70 000 combinations. This paper inquires what systematic reasons contribute to this phenomenon.

There are some circumstances under which unemployment convergence should be more awaited than in the others. These include sharing a higher level territorial authority, experiencing similar labour market hardship or sharing the same structural characteristics. For each of these three criteria we analyse the frequency of the differential nonstationarity within groups (as evidence of convergence) and across groups (as evidence of "catching up").

1 Introduction

Eastern European transition economies frequently witnessed dramatically high unemployment rates throughout the 1990s. Currently, national average rates seem to have dropped to moderate levels, providing some evidence in support of the hypotheses of increasing EU-wide cohesion. However, natural restructuring processes affected local labour markets asymmetrically, leaving some regions with still rates approaching 40%. As demonstrated by Tyrowicz and Wójcik (2009b) regional unemployment rates distributions demonstrate not only unprecedented stability as measured by σ convergence, but also strong β divergence.

As widely believed, these phenomena may be explained by diversified structure with respect to industry composition and economic outlooks at the eve of transition. Such an approach, on the other hand, neglects the potential impact of cohesion policies as well as spatial factors. In this paper we inquire whether one can confirm that some - so to say - purposeful stochastic convergence patterns emerge among Polish regions at NUTS4 level in as far as registered unemployment rate is concerned.

We provide an analysis of stochastic convergence for each pair of the 379 NUTS4 level units from three perspectives. First, we we analyse whether within some NUTS2 regions stochastic convergence is more common than within some others. This research question is motivated by the fact that although active labour market policies (ALMPs) are implemented at NUTS4 level, at least in principle they are coordinated by NUTS2 level authorities, while the latter differ both in the institutional design and in the strategic agenda. Secondly, we test whether there is more occurrence of the stochastic convergence within some decimal groups of the initial unemployment rates distribution. Tyrowicz and Wójcik (2009a) find using kernel density estimates that mobility between the middle groups is more frequent than within the high and the low end ones. Does the mobility imply more or less stochastic convergence? Finally, we use clustering techniques to provide reliable grouping of NUTS4 units based in the structure of unemployment. Structural variables comprised the shares of long-term unemployed, youth, living in the rural areas and unemployed with none or negligible experience. Indeed, NUTS4 units differ in these characteristics, forming clusters

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strongly homogenous within and heterogenous between . Again, the frequency of stochastic convergence is analysed in this context.

The paper is organised as follows. In section 2 we briefly discuss the literature in the field, demonstrating how this study contributes to the understanding of local unemployment levels dynamics. We further move to describing methodology in section 3 and data in section 4. Results are discussed in section 5. The concluding remarks provide some policy implications of the findings and suggest some directions for future research.

2 Literature review

From a time-series perspective one can analyze the so-called stochastic convergence. Applied to GDP *per capita* it examines whether permanent movements in income of one country (or region) are associated with also permanent movements in income of another countries (regions). Therefore, stochastic convergence implies that differences in incomes between countries or regions cannot contain unit roots. Consequently, the differences need to be stationary.

Early empirical studies on testing stochastic convergence for GDP *per capita* include Campbell and Mankiw (1989) and Cogley (1990). However, the concept was in-depth elaborated only few years later by Carlino and Mills (1993), who focus on US states GDP performance. Subsequent works comprise Bernard and Durlauf (1995), Greasley and Oxley (1997), St. Aubyn (1999) and Cellini and Scorcu (2000). On the other hand, this method has been argued to potentially classify as non-converging regions which consistently experience more of the asymmetric external shocks. Armstrong and Taylor (2000) suggest that if the speed of adjustment is slow while external shocks strong, divergence may emerge as a statistical artefact in spite of effective convergence exhibited by the processes. Therefore, cointegration tests should encompass considerations for possible structural breaks, which may make the interpretation of the findings relatively troublesome.

The method of stochastic convergence has also been applied to analysing unemployment. This last approach is applied by Bayer and Juessen (2006) for Germany and Gomes and da Silva (2006) for the case of Brazil. Bayer and Juessen (2006) perform a unit-root test on regional unemployment rate differentials using Mikrozensus data for West Germany over the 1960-2002 time span. They find moderate evidence in support of the convergence hypothesis, namely when controlling for structural breaks unit-root is rejected for the majority of regions. Similarly, Gomes and da Silva (2006) for the six metropolitan regions of Brazil find strong evidence of hysteresis and unemployment regional differential persistence, especially strong for the case of Rio de Janeiro.

In the context of transition, basing on the findings of Tyrowicz and Wójcik (2009b), one can state that for the majority of NUTS4 regions in Czech Republic, Poland and Slovakia little evidence in support of the convergence hypothesis may be found. In the case of Czech Republic the null was consistently rejected, while in the case of Slovakia and Poland data suggest strong persistence of regional unemployment rate differentials despite inclusion of trend and allowing for structural breaks. Summarising, these findings suggests that the NUTS4 regions follow different patterns of evolution with respect to the national average. The question is if these patterns resemble each other.

Incorporating the spatial context is more an more present in the literature in both macro-level and micro-level studies. On a micro-level Wasmer and Zenou (2006) construct a theoretical search model in which, when transportation costs are introduced, a zone exists where both the employed and the unemployed co-exist and are not mobile, while the size of this zone depends positively on the magnitude of the transportation costs. On the empirical side Rogers (1997) develops a precise measure of commuting costs in municipal employment growth dynamics. Martin (2004) includes a spatial mismatch index in estimating the effectiveness of unemployment-to-employment flows for Black communities in American cities, finding that metropolitan employment shifts increased the Black unemployment rates by considerable amounts and these negative effects were not fully compensated by labour mobility.

For the former level of analysis, Great Britain, Germany, Italy and the Netherlands seem to be the most analysed cases (*cfr.* Manning (1994) , Molho (1995) and Buettner (1999) among others). Some attention has also been devoted to the EU-wide regional analyses. Overman and Puga (2002) suggest that unemployment rates are much more homogenous across neighbouring areas than across regions in the same EU country, while common characteristics of adjacent regions - like sectoral structure or unemployment composition - do not account for the whole of this spatial effect. Niebuhr (2003) and, subsequently, Niebuhr and Stiller (2004) and Bräuninger and Niebuhr (2005) elaborate further this issue explicitly accounting for spatial weights matrices. Findings suggest clustering of the high/low unemployment regions with some cross-border clustering.

There has been considerably less research on transition economies. Ferragina and Pastore (2008) suggest that unemployment levels in CEECs exhibit patterns rare among the so-called mature economies. Varied theoretical and empirical approaches attempting to link transition and economic integration suggest that labour market phenomena seem to be a indispensable element to understand the dynamics of these processes. Südekum (2003) uses an augmented wage curve incorporating increasing returns to scale and agglomeration factors in order to address the observed phenomena of polarisation between a low unemployment developed core and a high unemployment depressed periphery. At the same time, Overman and Puga (2002) argue that international trade and inflow of capital from abroad tend to - if anything - reinforce and not to weaken the existing patterns of unemployment.

There seems to be a consensus in the literature that *via* labour mobility and trade flows contribute to the spillover effects of the local employment growth/decreases to other regions. The spread of this effect depends on the labour mobility (relocation costs), with relatively low distance decay consistent with everyday commuting. In Molho (1995), spillovers are strongest after a lag, which he interprets as corroboration of migration underpinnings of the findings, while localized spatial interactions are interpreted to support the hypotheses of commuting adjustments in response to shocks. Furthermore, the spillover - by the phenomena of migration, commuting and interregional trade - may well have a reversal nature in the form of a "returning wave".

What seems to be missing in the literature literature so far is the understanding, that authorities of the macro-regions analysed may have insufficient tools to intervene in the most deprived regions. For example, consider a case of a local labour market characterised by excess of labour supply. Among the equidistant other local labour markets, some are characterised by similar conditions, while other experience labour shortages (at least in some segments of the market). Consider now, that except for the local labour market administrative borders, there exist also supra-administrative borders in some form - for some of the local labour markets for example information about the vacancies are available at lower cost than for the others. In such a setting, persisting regional unemployment rate differentials may be a consequence not that much of the relocation costs, but effectively result from differentiated costs of informational access. This is exactly the area of further analyses.

More explicitly, all of the above mentioned approaches seek stochastic convergence with reference to a national average benchmark. Namely, they try to test whether relative local unemployment rate converges to a national average - in principle an "artificial" number computed based on a number of the realisations of potentially independent processes. In this paper we take a different approach. Namely, instead of using an "artificial" national average unemployment rate as a benchmark, we test the cointegration hypothesis for every pair of NUTS4 units (*poviats*). In doing so, we have adopted three main grouping criteria: belonging to the same NUTS2 region, belonging to the same decimal group of the initial unemployment rate distribution and belonging to the same cluster based on structural characteristics of the local labour markets. The details of the analytical strategy are discussed in the next section.

3 Methodology

Formally stochastic convergence for a number of countries or regions means that the long-term forecasts of a variable of interest for all countries or regions ($i = 1, \ldots, n$) equalize at some fixed time t, (Bernard and Durlauf 1995):

$$E(y_{1,t+k} - y_{i,t+k} | I_t) = 0, \qquad \forall i > 1, for \quad k \longrightarrow \infty \tag{1}$$

where $y_{i,t+k}$ is the logarithm of variable of interest for region i at time $t + k$, and I_t is all the information available at time t. Using the concepts of unit roots and cointegration, the convergence test implies examinination whether the difference $y_{1,t+k} - y_{i,t+k}$ in equation (1) is a zero mean stationary process, thus implying cointegration between all geographical units considered. Convergence in unemployment rates for two countries or regions, i and j, implies that their GDPs *per capita* must have a cointegrating vector [1, -1]. However, this concept of convergence has been criticized as rather strict, since for this kind of strong convergence to exist it is necessary that the long-run forecast of difference between the two regions is equal to zero.

There is an alternative time-series definition of convergence, also known as catching-up. This definition means that the differences decrease over time, (Bernard and Durlauf 1996), and can be written as:

$$E(y_{1,T} - y_{j,T}|I_t) < (y_{1,0} - y_{j,0}) \tag{2}$$

where 0 refers to the present and T to some time in the future. The difference between the two time series should also be stationary, but now the time trend can be deterministic. Again, the only cointegrating vector between the two regions can be [1, -1]. Intuitively, convergence will appear if in the long run values of two time series equalize, while catching-up would mean reducing the distance in the long run.

Following Bernard and Durlauf (1995), stochastic convergence occurs if relative logarithm of a variable under scrutiny, y_{ijt}, follows a stationary process, where $y_{ijt} = \log Y_{it} - \log Y_{jt}$, and Y_{it} is the real value for unit i, and Y_{jt} is the real value for unit j. Both series have to be integrated of the same order (non-stationarity in most cases means being integrated of order one). If the difference is stationary, it means convergence between countries (or regions) i and j. The non-stationarity can be tested using the conventional augmented Dickey-Fuller (ADF) regression in the following form:

$$\Delta y_{ijt} = \alpha_i + \gamma_i t + \beta_i y_{ijt-1} + \sum_{k=1}^{p} \theta_{ijk} \Delta y_{ijt-k} + \epsilon_{ijt}, \qquad t = 1, \ldots, T \tag{3}$$

where $i = 1, \ldots N, j = i+1, \ldots, N$ constitute all possible pairs of regions, and $k = 1, \ldots, p$ ADF lags.

The distinction between long-run convergence and convergence as catching-up, (Oxley and Greasley 1995), can be derived from estimating the equation (3). First, if y_{ijt} contains a unit root (i.e. $\beta_i = 0$), levels of unemployment for regions i and j diverge over time. Second, when y_{ijt} is stationary (i.e. $\beta_i < 0$, which means no stochastic trend) and (a) the absence of the deterministic trend (i.e. $\gamma_i = 0$) indicates long-run convergence between regions i and j; (b) existence of the deterministic trend (i.e. $\gamma_i \neq 0$) indicates catching-up (or narrowing of the differentials) between regions i and j.

However, the equation (3) may not be able to detect convergence if y_{ijt} is nonlinear. Kapetanios, Shin and Snell (2003) extend the augmented Dickey-Fuller unit root test to incorporate nonlinearity as characterized by the Smooth Transition Autoregressive (STAR) process:

$$\Delta x_t = \sum_{j=1}^{p} \rho_j \Delta x_{t-j} + \delta x_{t-1}^3 + \upsilon_t \tag{4}$$

where

$$x_t = y_t - \hat{\alpha} - \hat{\beta} t \tag{5}$$

is the de-meaned and de-trended series with $\hat{\alpha}$ and $\hat{\beta}$ being the least squares estimators obtained from regressing y_t on a constant and a trend terms. The null hypothesis of $H_0 : \delta = 0$ (nonstationary) against the alternative $H_0 : \delta < 0$ (stationary) can be tested.

Although this test is useful in the study of nonlinear convergence, it cannot tell the significance of the deterministic trend. Therefore, there is no possibility within this framework to distinguish between long-run converging and catching up, even if nonlinear stationarity is found. Subsequently, Chong, Hinich, Liew and Lim (2008) modify the Kapetanios et al. (2003) unit root test and Oxley and Greasley (1995) time series test of income convergence. They incorporate an additive intercept (μ) term and the trend component [$G(trend)$] into equation (4) which yields:

$$\Delta y_t = \mu + \sum_{j=1}^{p} \rho_j \Delta y_{t-j} + \delta x_{t-1}^3 + \phi G(trend) \upsilon_t \tag{6}$$

where y_t is the original series under study and not the de-meaned and de-trended series x_t. $G(trend)$ is the trend component of specific functional form. Two commonly used trend variables are the linear trend or the square of the trend (referred in their paper as linear and nonlinear trend). υ_t is the error term.

The statistical interpretation of equation (6) is analogous to that of Oxley and Greasley (1995). If the income differential contains a nonlinear unit root ($\delta = 0$), the unemployment level of the two countries or regions is diverging over time. The absence of nonlinear unit root ($\delta < 0$) implies either nonlinear catching up, given the presence of deterministic trend ($\phi \neq 0$), or nonlinear long-run convergence if deterministic trend is absent ($\phi = 0$). As in the case of Kapetanios et al. (2003), the statistical significance of δ and ϕ can be tested using t statistics. However, the asymptotic distribution of the t statistic within this framework is unknown. Chong et al. (2008) simulated the corresponding critical values from 5000 replications for various sample sizes. The resulting critical values are tabulated in the paper.

We use this methodology to examine the existence of stochastic convergence of relative unemployment rates (in relation to country average) between *poviats* of Poland. Technically, we test for stationarity of the difference between unemployment rates for all possible pairs of *poviats*: $u_{ijt} = logU_{it} - logU_{jt}$, where U_{it} is the relative unemployment rate in *poviat* i at time t and U_{jt} is the relative unemployment rate in *poviat* j in the same period. We apply the modified KSS-CHLL nonlinear unit root test for all 379 *poviats*.

4 Data

We use a unique data set combining the official registry unemployment data from the Central Statistical Office with Ministry of Labour and Social Affairs database on the structure of unemployment at a local level. Data set covers the period of January 1999 till December 2008 of monthly data for 379 local labour markets at policy relevant NUTS4 level. It includes registry information about the number of job seekers, reported vacancies, basic structural characteristics of the local labour markets (*i.e.* share of inhabitants in the rural areas, etc.) and local labour market dynamics (*i.e.* vacancies and outflows into employment as well as inflows into unemployment[1]).

The choice of time boundaries was dictated by the data availability and seems to bear no serious limitations for the possible results except one. Namely, labour market evolutions have commenced in Poland in early 1990s. Unfortunately, NUTS4 data prior to 1999 do not exist, while only in 2001 separate metropolitan municipalities were established. Therefore, the study covers the periods when the differentials already existed and were subject by some cohesion policies. Nonetheless, the data set covers periods of both increases and decreases in the national unemployment rates.

Based on these data, we were able to define our three criteria of analysis. First of all, each of the NUTS4 unit belongs to a policy relevant NUTS2 unit. In Poland 379 *poviats* are located in 16 *voivodships*. Many of the social and labour market policies are implemented at community or *poviat* level but coordinated by NUTS2 authorities. Although there is no hierarchical dependence, NUTS2 authorities frequently distribute the financing to the implementing units. Lower level community authorities are always free to increase the financing, but it is a rare phenomenon.

Secondly, based in the distribution of unemployment in the first period (December 1998) we have generated ten equal sized groups. These decimal groups do not correspond to the above discussed *voivodship* structure. Namely, each NUTS2 unit contains both highest and lowest unemployment level NUTS4 units.

Finally, using the monthly reports by local labour offices to the Ministry of Labour and Social Affairs, we were able to generate structural variables describing the composition of the unemployed pool as well as local

[1]Since these are registry data, they suffer from many well-known shortcomings. First of all, vacancies are systematically underreported and therefore cannot serve for more than a proxy of the employers needs, Meyer and Sullivan (2003). Consequently, we rely on outflows rates rather than vacancies rates in providing the basis for clustering.

labour market dynamics. Namely, we have computed over the 2000-2006 period of the following variables: inflows rate, outflows rate, share of long-term unemployed, share of youth, share of rural areas inhabitants and share of unemployed with low or no qualifications. We subsequently used these variables to perform clustering of the *poviats*. We chose to use hierarchical clustering with Ward linkage. This procedure has created 8 groupings, for which CCC metric guarantees that they are more homogenous within and different between than in any other combination. Figure 1 presents boxplots of the structural variables with respect to their group averages.

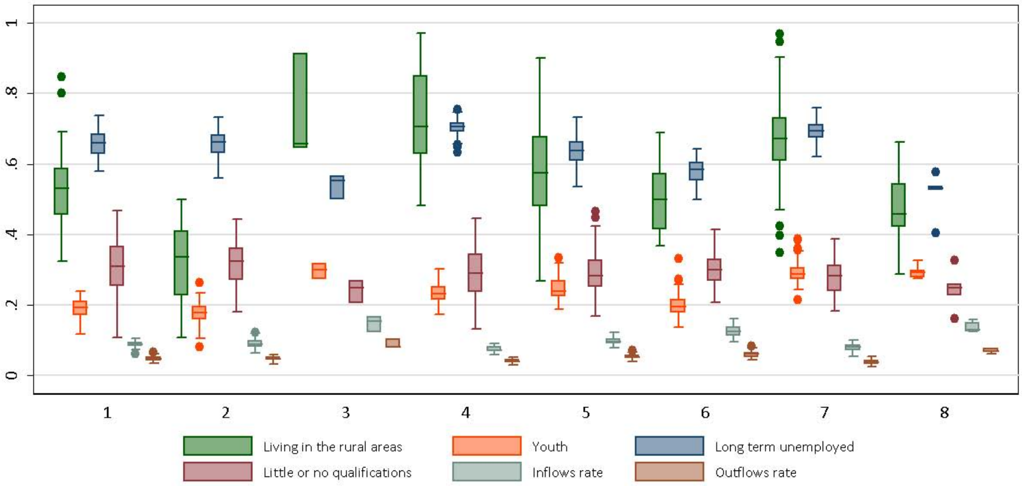

Figure 1: Clusters of *poviats*

Indeed, groupings of *poviats* differ indeed. Namely, *poviats* within the eight cluster are very similar (the boxplots are relatively narrow). The second cluster is clearly a municipal one, while the third and fourth cluster are characterised by very high rates of rural areas inhabitants, but also lowest rates of long-term unemployed. Fourth and seventh cluster are opposite in a sense that they score highest in long term unemployment and also very high in the rural unemployment. Clearly, these characteristics correspond to different labour market outlooks. This clustering is the third grouping criterion we use for the analysis.

5 Results

A necessary condition for testing cointegration between two series is that both are non-stationary (integrated of the same order). Therefore first we test for the order of integration of data series on (log) unemployment rates for all single *poviats* and the country level. Out of 380 (including the average for Poland) monthly time series 3 appeared to be stationary (namely *poviats* Poznan, poznanski and tatrzanski), therefore were not considered in further cointegration tests. Among the others huge majority seemed to diverge from the average with respect to unemployment rate level. For only six *poviats* indication of long-run convergence was found, while another four seemed to face the catching-up process. The converging or catching-up *poviats* names are listed in Table 5.

Half of the *poviats* with indication of long-run convergence process had relatively high initial unemployment rate (mragowski, Ostroleka and brzeski) and the other half (myszkowski, suwalski, wolominski) had rather low unemployment rates in the begining of the analyzed period. As far as catching-up process is concerned, the four *poviats* had rather high initial rates of unemployment.

The summary of number of *poviats* for which unemployment rate exhibits relationship to the national average can be found in Table 5, both with respect to *voivodship* of origin and with respect to initial decile group. Converging and catching-up *poviats* come rather from different *voivodships*. Regions facing long-run convergence process are located on the opposite ends of unemployment rate values (high or low decile groups), while these catching-up had rather high (but not the highest) initial unemployment rates.

Table 1: Converging or catching-up?

Result	*Poviat*	*Voivodship*
convergence	brzeski	Malopolskie
convergence	Ostroleka	Mazowieckie
convergence	wolominski	Mazowieckie
convergence	suwalski	Podlaskie
convergence	myszkowski	Slaskie
convergence	mragowski	Warminsko-mazurskie
catching-up	strzeliński	Dolnoslaskie
catching-up	inowroclawski	Kujawsko-pomorskie
catching-up	ostrolecki	Mazowieckie
catching-up	kamienski	Zachodniopomorskie

Note: poviats exhibiting convergence or catching up with respect to dynamics of the national unemployment rate.

After testing for convergence between the average and regional unemployment rates we applied similar procedure to all possible pairs of *poviats*, to see whether we can observe similarly behaving groups of regions. As mentioned before, data series for three *poviats* appeared to be stationary. The resulting 376 *poviats* were combined into all possible 70 500 pairs and cointegration between them was tested in the form described in equation (6). All statistical tests were performed on 1% significance level. We found 2 486 significant long-run relationships of regional relative unemployment rates (for $I(1)$ series), among which 1916 were interpreted as indication convergence and 570 of the catching-up phenomenon. The rest of pairs of *poviats* faced divergence in terms of relative unemployment rates.

We subsequently checked whether convergence patterns have spatial, structural or unemployment level dimensions. Firstly, we analysed if the *poviats* that have long-run relationship with respect to relative unemployment rate are close to each other institutionally and also geographicaly (belong to the same NUTS2 region - *voivodship*). Secondly, we inquired whether initially (Dec 1998) they were in the same decile group with respect to unemployment level. Finally, we also verified if structurally similar NUTS4 units are more likely to exhibit stochastic convergence.

The upper panel of Table 3 contains the summary of the spatial dimension of cointegration (percentage of pairs of *poviats* from different *voivodships* facing convergence of relative unemployment rates). The rows and the columns contain information for subsequent *voivodships*. The values in first 16 rows in each column sum up to 100 (%), showing the structure of long-run convergence within particular NUTS2 regions. Large numbers on the diagonal would indicate convergence of unemployment within *voivodships*, which is not observed. The strongest within *voivodship* convergence is observed in Mazowieckie (16% of convergence relationships for *poviats* from this *voivodship* are with another poviat from this *voivodship*), Zachodniopomorskie (16%) and Lubelskie (10%), while no convergence is observed within Lubuskie and Opolskie regions. The *poviats* from different *voivodships* are often converging with *poviats* from richest Mazowieckie (10-24% of relationships for majority of *voivodships*).

There are also many cointegrating patterns found with Zachodniopomoskie and Slaskie (for both of these are mainly *poviats* from southern and south-western *voivodships* like Lubuskie, Opolskie, Wielkopolskie and Dolnoslaskie). On the other hand there are indications of convergence between *poviats* located on the East - Lubelskie with Podkarpackie, part of Mazowieckie and Podlaskie. One can conclude that to some extent convergence pattern of regional unemployment rates has spatial dimension. Some convergence clubs can be observed here. Total number of cointegrating relationships is highest for Malopolskie, Zachodniopomorskie, Slaskie, Lubelskie and Dolnoslaskie and lowest for *poviats* from Opolskie and Lubuskie. When referred to number of *poviats* in *voivodships* also *poviats* from Mazowieckie seem to have relatively low number of unemployment rate cointegrating relationships with other *poviats*.

The lower part of Table 3 contains the summary of the spatial dimension of catching-up (percentage of pairs of *poviats* from different *voivodships* facing catching-up of relative unemployment rates). The cathing-up process is more diversified than convergence presented in previous table. Large numbers of *poviats* from most *voivodships* catch-up with *poviats* from Mazowieckie *voivodship* (12-36% for majority of *voivodships*), but relativelu large numbers appear in many columns also for Zachodniopomorskie, Lodzkie, Podlaskie or Podkarpackie. The total number of catching-up pairs of *poviats* was highest in Mazowieckie, Podlaskie,

Table 2: Relationships with the average unemployment rate

Voivodship	Catching-up	Convergence	Divergence	Total
	Number of *poviats* by *voivodship* of origin			
Dolnoslaskie	1	0	28	29
Kujawsko-pomorskie	1	0	22	23
Lubelskie	0	0	24	24
Lubuskie	0	0	14	14
Lodzkie	0	0	24	24
Malopolskie	0	1	21	22
Mazowieckie	1	2	39	42
Opolskie	0	0	11	11
Podkarpackie	0	0	25	25
Podlaskie	0	1	16	17
Pomorskie	0	0	20	20
Slaskie	0	1	35	36
Swietokrzyskie	0	0	14	14
Warminsko-mazurskie	0	1	20	21
Wielkopolskie	0	0	33	33
Zachodniopomorskie	1	0	20	21
Total	4	6	366	376
	Number of *poviats* by the initial decile group			
Decile group 1	0	0	33	33
Decile group 2	0	1	36	37
Decile group 3	0	2	35	37
Decile group 4	0	0	37	37
Decile group 5	0	0	37	37
Decile group 6	0	0	37	37
Decile group 7	0	0	37	37
Decile group 8	3	1	33	37
Decile group 9	1	1	35	37
Decile group 10	0	1	36	37
Total	4	6	356	366

Note: Results for *poviats* exhibiting relationship to the national average unemployment rate. Some *poviats* did not exist in Dec 1998, therefore it was not possible to attribute initial decile group.

Lodzkie and Podkarpackie, whereas lowest in Lubuskie, Opolskie and Warminsko-mazurskie. While number of *poviats* in *voivodships* was taken into account, there was a very low number of catching-up relationships also in Slaskie and relatively high in Zachodniopomorskie.

Another way of summarizing the results of the analysis was observing what happens within the decile groups. The *poviats* were divided into 10 equal sized groups with respect to the initial unemployment rate level in December 1998 (i.e. group 1 contained 10% of *poviats* with the lowest unemployment rates, while group 10 included the opposite 10% of *poviats* with highest initial unemployment rates). Some *poviats* did not exist in December 1998 - they were established later, therefore the analysis was performed for 366 *poviats*. The upper panel of Table 4 shows the summary of the initial unemployment level dimension of cointegration (percentage of pairs of *poviats* from subsequent decile groups having convergence of unemployment rates).

It is interesting to observe that many *poviats* from most decile groups converge in terms of unemployment with *poviats* of relatively higher unemployment rates ($8-10th$ decile groups). Looking at the diagonal of the table one can observe relatively high percentage in extreme decile groups, which suggests that to some extent convergence of clubs is observed. Convergence is confirmed separately for *poviats* with highest and with lowest unemployment rates. When total number of converging relationships is concerned, more long-run convergence predictions are observed for *poviats* with higher unemployment rates and relatively few for first decile group (*poviats* with lowest unemployment rates). This conclusion is corroborated after correction for number of *poviats* as all the groups (except the lowest) are equal-sized. Therefore not only spatial dimension, but also "initial" level of unemployment rate relates to the convergence pattern of unemployment in Poland.

The lower panel of Table 4 shows analogous summary of the initial unemployment level dimension for catching-up in terms of unemployment rate levels (percentage of pairs of *poviats* from subsequent decile groups facing catching-up process). The *poviats* from decile groups $2-7$ seem to catch-up in terms of unemployment rates with *poviats* from higher unemployment rates (groups $8-9$) and the other way around, which means the catching up process with widely understood middle of the distribution of unemployment rates. Another catching-up process is found for low unemployment rate *poviats* (decile groups 1 and 2).

Table 3: Relationships with respect to *voivodship* of origin

Voivodship	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Convergence															
1	4	3	2	4	7	7	3	5	2	2	4	10	9	4	5	7
2	5	6	8	8	10	16	7	5	6	9	6	12	9	1	5	7
3	4	8	10	4	7	7	14	2	16	11	5	3	9	9	10	3
4	2	2	1	0	1	2	2	2	0	0	3	4	1	3	1	5
5	9	7	5	3	4	2	6	5	8	9	7	5	6	5	6	6
6	10	14	6	5	3	2	8	11	4	8	8	4	2	11	7	6
7	10	12	24	14	14	17	16	17	18	14	8	11	21	5	10	11
8	2	1	0	1	1	3	2	0	1	1	2	2	0	3	0	3
9	3	4	11	1	8	3	7	5	8	7	5	4	6	8	3	3
10	2	7	8	1	9	7	6	5	7	4	6	6	9	12	6	1
11	4	3	3	7	5	5	3	5	4	4	4	5	5	3	6	7
12	17	14	3	16	7	6	7	13	6	8	10	4	3	12	13	13
13	7	5	5	1	5	1	6	0	4	7	5	1	4	5	5	2
14	4	1	5	7	4	8	2	10	6	10	4	7	6	5	5	5
15	5	4	7	4	5	6	4	2	3	5	8	8	6	5	6	7
16	13	9	3	23	10	9	7	16	5	2	16	15	4	10	12	16
Total	188	296	318	74	221	540	261	63	216	228	167	335	158	186	207	374
Per 1 *poviat*	6.5	12.9	13.3	5.3	9.2	24.5	6.2	5.7	8.6	13.4	8.4	9.3	11.3	8.9	6.3	17.8
	Catching up															
1	10	10	8	6	6	12	4	16	3	8	7	8	7	9	9	3
2	10	5	9	0	9	14	5	9	5	6	2	3	14	6	8	1
3	7	9	5	0	4	0	15	0	12	6	7	0	0	3	4	7
4	1	0	0	0	2	3	1	3	0	3	7	3	4	0	1	0
5	7	11	5	12	4	3	16	0	5	10	5	3	5	13	5	11
6	9	10	0	12	2	0	8	6	6	2	7	0	2	0	0	13
7	9	13	36	6	32	26	14	6	15	13	5	16	25	6	12	4
8	6	4	0	6	0	3	1	0	3	1	2	3	2	6	4	9
9	4	6	14	0	5	10	8	9	19	11	5	0	9	13	4	4
10	11	8	8	18	12	3	8	3	13	4	15	5	7	28	8	15
11	4	1	4	18	2	5	1	3	2	6	0	16	4	3	5	3
12	4	1	0	6	1	0	3	3	0	2	15	16	0	3	7	7
13	5	10	0	12	3	2	8	3	5	4	5	0	0	3	8	7
14	4	3	1	0	4	0	1	6	4	8	2	3	2	0	3	0
15	9	8	4	6	4	0	5	9	3	6	10	13	11	6	5	15
16	2	1	6	0	8	17	2	22	3	10	5	13	9	0	15	3
Total number	82	79	78	17	95	58	183	32	94	106	41	38	56	32	74	75
Per 1 *poviat*	2.8	3.4	3.3	1.2	4.0	2.6	4.4	2.9	3.8	6.2	2.1	1.1	4.0	1.5	2.2	3.6

Note: Numbers in rows' and columns' headers mean subsequent *voivodships*: 01. dolnoslaskie, 02. kujawsko-pomorskie, 03. lubelskie, 04. lubuskie, 05. lodzkie, 06. malopolskie, 07. mazowieckie, 08. opolskie, 09. podkarpackie, 10. podlaskie, 11. pomorskie, 12. slaskie, 13. swietokrzyskie, 14. warminsko-mazurskie, 15. wielkopolskie, 16. zachodniopomorskie. Values in each column sum up to 100 %.

The final analysis takes into account structural similarities between *poviats* and seeks for convergence or catching-up with respect to the cluster in which *poviat* is situated. The upper panel of Table 5 summarizes the convergence phenomenon. The highest number of converging relationships is found in clusters 7, 5 and 4 (the seventh and the fourth have relatively larger share of the long-term unemployed and living in the rural areas shares), while lowest in cluster 8, 3, 6 and 2 (municipal cluster). *Poviats* from most clusters (except 7 and 4) converge with regions belonging to cluster 5 (29-56%) and do not converge with *poviats* from clusters 3 and 8 (to some extent this is the matter of these clusters' sizes). As far as within cluster convergence is concerned, it is the strongest in group 7, where 43% of converging relationships for that group are between its poviats, while only 15% of total number *poviats* are there. Relatively strong within cluster convergence is also found in group 5 and to some extent in clusters 2, 4 and 6 (share of within cluster converging relationships are higher than relative cluster sizes). The *poviats* from clusters 4 and 7 are also converging more often than territorial units from other groups.

The lower panel of Table 5 shows the summary of catching-up results for different clusters. Similarly to convergence process, *poviats* from clusters 4 and 7 are related (again, high share of rural inhabitants and long-term unemployed - as opposed to the third cluster - seem to be the common denominator). The within cluster catching-up process is again strongest in group 7 and most frequent partners for that process are again *poviats* from group 5. Comparing the results for all dimensions analyzed, one can conclude that the structural similarity of *poviats* has highest influence both on convergence and catching-up process.

Table 4: Structure of relationships with respect to the initial level of unemployment (decile group)

	1	2	3	4	5	6	7	8	9	10
	Convergence									
Decile group 1	15	6	3	2	1	1	3	4	6	4
Decile group 2	15	5	3	4	10	12	15	14	12	13
Decile group 3	6	3	8	12	5	7	8	10	11	8
Decile group 4	6	4	14	14	10	10	10	9	12	9
Decile group 5	1	8	5	8	7	7	12	7	7	14
Decile group 6	4	12	10	11	10	11	15	12	9	10
Decile group 7	7	15	10	10	15	14	9	11	9	4
Decile group 8	15	19	17	13	11	16	15	13	14	11
Decile group 9	19	14	16	15	10	10	10	11	9	10
Decile group 10	12	15	13	11	21	11	5	9	10	16
Total number	145	389	302	365	307	404	398	527	441	448
Per 1 *poviat*	4.4	10.5	8.2	9.9	8.3	10.9	10.8	14.2	11.9	12.1
	Catching up									
Decile group 1	21	32	5	0	2	2	2	3	8	14
Decile group 2	16	0	3	1	0	3	1	4	4	1
Decile group 3	6	6	5	6	4	5	10	10	12	3
Decile group 4	0	3	9	9	5	12	10	17	12	12
Decile group 5	4	0	8	6	6	10	16	21	14	21
Decile group 6	3	9	8	12	9	7	4	15	19	13
Decile group 7	3	3	13	9	11	3	6	10	11	11
Decile group 8	12	29	30	35	36	29	25	9	8	14
Decile group 9	15	15	18	12	12	19	14	4	3	8
Decile group 10	21	3	4	10	15	11	11	6	7	4
Total number	68	34	80	115	139	120	96	235	118	101
Per 1 *poviat*	2.1	0.9	2.2	3.1	3.8	3.2	2.6	6.4	3.2	2.7

Note: Values in each column sum up to 100 %.

6 Conclusions

Convergence of unemployment rates was tested for 379 *poviats* and the average level of unemployment rate in Poland. Long-run relationships were found for few *poviats*, therefore we can conclude that convergence of unemployment rates in Poland was not observed. Subsequently convergence between all possible pairs of *poviats* has been tested. We analyzed spatial, structural and unemployment level dimensions of convergence pattern, checking if *poviats* that have long-run relationship with respect to relative unemployment rate are close to each other in space (in the same NUTS2 region - *voivodship*), whether initially (Dec 1998) they were in the same decile group with respect to unemployment level or whether converging *poviats* are structurally similar.

We conclude that convergence pattern of regional unemployment rates has to some extent spatial dimension - *poviats* from the East and separately from South and South-West seem to have relatively high degree of convergence. Therefore, some convergence of clubs can be confirmed. It is also observed that convergence and catching-up appears more often within some *poviats* clusters, namely, *poviats* with larger share of the unemployed leaving in the rural areas and the long-term unemployed. This overlaps partly with the evidence concerning South and South-West of Poland. The East of Poland - traditionally thought of as lagging behind, is characterised by relatively lower shares of the long-term unemployed in the registries due to the nature of agricultural activities in these areas.

In addition, more long-run convergence predictions are observed for *poviats* with higher unemployment rates and relatively few for *poviats* with lowest unemployment rates. This suggests that units experiencing local labour markets hardships are probably reaching their limits in terms of the possible unemployment magnitudes and this naturally imposed ceiling necessitates stochastic convergence. On the other hand, neither middle-range nor lower level *poviats* seem to exhibit convergence among each other or across, which suggests the cohesion policies have had limited effect for the time being.

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Table 5: Structure of converging relationships with respect to the segment of origin

	1	2	3	4	5	6	7	8
	Convergence							
Cluster 1	13	11	6	11	14	15	7	0
Cluster 2	9	21	17	7	10	16	3	25
Cluster 3	0	1	0	0	1	1	0	0
Cluster 4	18	14	11	19	16	14	26	25
Cluster 5	41	36	56	30	38	38	22	42
Cluster 6	9	11	11	5	7	14	1	8
Cluster 7	11	5	0	26	12	2	43	0
Cluster 8	0	1	0	1	0	0	0	0
Total	371	301	18	572	1051	207	584	12
per 1 *poviat*	8.6	6.4	6.0	10.8	10.0	6.1	11.0	2.4
	Convergence							
Cluster 1	12	10	33	10	13	11	7	9
Cluster 2	8	21	17	4	11	13	3	9
Cluster 3	2	1	0	1	1	0	0	0
Cluster 4	16	8	17	18	16	11	26	0
Cluster 5	39	42	33	31	31	34	31	55
Cluster 6	7	10	0	5	7	13	5	0
Cluster 7	14	6	0	31	19	16	27	27
Cluster 8	1	1	0	0	2	0	2	0
Total	98	77	6	154	299	61	188	11
Per 1 *poviat*	2.3	1.6	2	2.9	2.8	1.8	3.5	2

Note: Values in each column sum up to 100 %.

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