Regional unemployment disparities and their dynamics: Evidence from the Czech Republic

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Abstract. Regional disparities have become a debated topic in the last two decades. Aim of this paper is to estimate trends in regional disparities at the level NUTS 3 during the period 2005-2011. This paper looks at unemployment in the Czech Republic and its persistence over time. The Czech labor market has faced many changes during this period, which were reflected not only at the national but also at the regional level. It also attempts to identify the factors responsible for this persistence. Regional unemployment trends during this period show that they have been characterized by a high degree of synchronicity, and regional unemployment disparities by a remarkable persistence. This persistence mostly reflects the existence of an underlying interregional equilibrium structure of unemployment differences, rather than prolonged inter-area labor market disequilibrium. Another aim of this paper is to test if regional and national unemployment rates are co-integrated, in other words if the long-term relationship between regional and national unemployment rates exists. Monthly Czech Ministry of Labor and Social Affairs data were used for the analysis. The Johansen test was applied on 2005-2011 data to examine co-integration between the regional and national unemployment rates. On the basis of the unit root test, we found that both variables are integrated of order I(1). Cointegration relationship thus has been demonstrated for Praha and the national unemployment rate only. So does the ECM. ECM implies deviation from equilibrium in short-run. About 23 % of deviation is corrected each month.

Keywords: cointegration, unemployment, regional disparities.

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AMS Classification: 62P20

1 Introduction

Unemployment is a phenomenon in the economy when there is a mismatch between labor demand and labor supply. It means that greater labor supply quantity exists than is demanded. In other words, unemployment (or joblessness), as defined by the International Labour Organization, occurs when people are without jobs and they have actively sought work within the past four weeks. The unemployment rate is a measure of the prevalence of unemployment and it is calculated as a percentage by dividing the number of unemployed individuals by all individuals currently in the labor force.

Existing empirical studies have shown the correlation between the phases of the business cycle and changes in the unemployment rate. Typically, the number of available jobs is rising and the unemployment rate is declining in a time of economic growth. On contrary, the unemployment rate is increasing during the economic crisis. The question whether these changes take place with the same intensity at the regional level [1].

The aim of this paper is to estimate, based on econometric approach, relationship between the national rate of unemployment and regional rates of unemployment in the Czech Republic. In the parlance of economic time series analysis, this is equivalent to hypothesizing that regional and national unemployment rates are co-integrated, in other words that a stable linear relationship exists between these two variables. For this purpose the paper is divided into several parts. The first part is devoted to description of analytical tools. The second part contains empirical results of cointegration analysis and the final section summarizes all the key findings. We used Czech Statistical Office and Ministry of Labor and Social Affairs annual and monthly data between the year 2005 and 2011.

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2 Econometric methodology

Cointegration is an econometric technique for testing the relationship between non-stationary time series variables. This technique is often used because of many macroeconomic time series are not stationary in their levels. If two or more series each have a unit root, that is I(1), but a linear combination of them is stationary, I(0), then the series are said to be cointegrated. Thus cointegration analysis is an extension of the simple correlation based analysis. The objective of this article is to analyze the effects of economic growth on unemployment in the Visegrád group countries.

The problem then is to find a way to work with two possibly non-stationary series in a fashion that allows us to capture both short run and long run effects. In more technical parlance, cointegration is the link between integrated processes and steady state equilibrium. If the time series are stationary in first differences than it is fulfilled requirements for the implementation of cointegration. Although we have two non-stationary time series, their common cointegration long-term shift in time moves towards some equilibrium.

We used Phillips-Perron (PP) test as the unit root test. We used this approach to test the null hypothesis that a time series in integrated of order 1. The PP method estimates the non-augmented DF test equation, and modifies the *t*-ratio of the α coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test makes a non-parametric correction to the t-test statistic.

The PP test is based on the statistic [9]:

$$\bar{t}_\alpha = t_\alpha\left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0-\gamma_0)(se(\hat{\alpha}))}{2f_0^{1/2}s} \tag{1}$$

where $\hat{\alpha}$ is the estimate, and t_α the *t*-ratio of α, $se(\hat{\alpha})$ is coefficient standard error, and *s* is the standard error of the test regression. In addition, γ_0 is a consistent estimate of the error variance. The remaining term, f_0, is an estimator of the residual spectrum at frequency zero.

Cointegration test is based on the determination of r cointegration relations in the VAR model. Cointegration is confirmed, if true, that r > 0. For testing purposes, we used Johansen cointegration test [6].

It is necessary to obtain an indication of optimal time delay before the implementation of Johansen cointegration test, which was in our case according to the Schwarz information criterion (SC) applied to estimate the VAR model of differentiation two periods. The SC criterion is defined as [5]:

$$SC = n^{k/n}\frac{\sum \hat{u}^2}{n} = n^{k/n}\frac{RSS}{n} \tag{2}$$

where RSS means the residual sum of squares, k/n is the penalty factor.

We used two tests for determining the number of cointegration vectors: (i) the Trace test; and (ii) the Maximal Eigenvalue test.

The Trace test for the number of cointegrating vectors determines the number of cointegrating equations r:

$$(r) = -N^* \sum_{i=r+1}^{m} \ln(1-\hat{\lambda}_i) \tag{3}$$

We tested hypothesis by the Trace test for H_0 r=0 (there are no cointegration vectors) and H_1 r≤1 (there is cointegration equation). We did not reject the H_0 hypothesis if the Trace statistics is no larger than the 5% critical value).

Another test is the Maximal Eigenvalue test:

$$(r, r+1) = -N^* \ln(1-\hat{\lambda}_{r+1}) \tag{4}$$

We tested hypothesis by the Maximal Eigenvalue test for the same H_0 and H_1 like the Trace test. We also do not reject the H_0 hypothesis if the Maximal Eigenvalue statistics is no larger than the 5 % critical value.

As the following step the Error Correction Term (ECT) should be estimated and test for stationarity. The result of the PP test for the unit root should confirm integration in order I(0). It means that the Y_t and X_t are cointegrated or that the regression of equation in no longer spurious, and we can also find the linear combination

that connects Y_t and X_t in the long run [3] or we can say that there is a long-run equilibrium relationship between X and Y:

$$\hat{\mu}_t = Y_t - \hat{\beta}_1 + \hat{\beta}_2 X_t \tag{5}$$

Finally the Error Correction Model (ECM) should be estimated (if Y_t and X_t are cointagrated). Thus, we can express the relation between Y_t and X_t with an ECM specification as [3]:

$$\Delta Y_t = \alpha_0 - \alpha_1 (Y_{t-1} - \beta_1 X_{t-1}) + \beta_0 X_t + \varepsilon_t \tag{6}$$

where current changes in Ψ are a function of current changes in Ξ (the first difference of Ξ) and the degree to which the two series are outside of their equilibrium in the previous time period. Specifically, β_0 captures any immediate effect that Ξ has on Ψ, described as a contemporaneous effect or short-term effect. The coefficient, β_1 reflects the equilibrium effect of Ξ on Ψ. It is the causal effect that occurs over future time periods, often referred to as the long-term effect that Ξ has on Ψ. Finally, the long-term effect occurs at a rate dictated by the value of α_1.

Arlt [2] shows that it should be stressed that the importance of the ECM lies in the fact that it allows us to combine statistical and econometric approach to modelling economic time series.

3 Empirical results

Unemployment in the New Member States of the European Union has had both cyclical and structural nature. Moreover, the long-term lack of some professions existed in some regions. On the other hand, we can find some regions where a surplus of offered jobs existed. Another aspect, that prevents the matching process of supply and demand, is the lack of mobility and flexibility of the labor force. For this reason economic growth does not contribute significantly to improving labor market performance in the affected regions. Structural changes are continuing in some regions of the Czech economy, ie changes in the sectoral (industry) structure of the economy and the related changes in the professional and qualification structure of the labor force - during the transition process has been a marked shift of labor from the primary and secondary to the tertiary sector, while in the tertiary sector recorded the steepest rise in banking and insurance industry. Measured by the share of sectors in total employment in the economy the Czech economy belongs to the advanced economies of the world.

The main question is if this trend was reflected also in a regional context - in some regions were much more complex structural changes, mainly due to the current structure of the economy of these regions. The influence of these structural changes in different regions has different intensity, and among the most affected regions were the regions with large concentrations of heavy industry. The process of structural changes significantly influences the differences in unemployment rates among Czech NUTS III regions. The huge problem for maintaining the economy's growth rate, among other aspects, was a persistence of unemployment, which is significantly higher in the Czech Republic than in other EU countries. As stated by the Ministry of Labor and Social Affairs, the basic problems of regional unemployment is low labor mobility, qualifications of job seekers, particularly the long-term, which does not meet the labor market, a high proportion of job seekers with lower education and last but not least, it is the qualification structure of labor supply which does not correspond with needs of labor demand.

If we look at empirical data concerning unemployment in particular regions of the Czech Republic´s regions (see Table 1), we could assume that the lowest unemployment rate will be in metropolitan region. This assumption has proved to be valid; however it is possible to reproach some other implications, which are by their nature rather surprising. If differences between the unemployment rate reached in the metropolitan areas and the regions with the highest unemployment rate were significant (sustained period of high regional disparities in unemployment indicates low labor market flexibility mobility of the population, especially low regional mobility – [4]), similar relation for long-term unemployment was not so remarkable. Although the remarkable decrease of the unemployment rate has been recorded in the problematic regions Ústecký and Moravskoslezský kraj since the year 2005, the number of unemployed has stayed higher in these regions in comparison with other regions and it means a longstanding problem of highly regionalized structural unemployment. This is partly because of wide geographic diversity in a level of structural reforms and dynamics of economic growth, but also because of weak labor mobility. Two parallel phenomena occurred simultaneously in all Czech NUTS 3 regions – (i) a decrease of the total unemployment rate in all regions in the period 2004-2008; (ii) a significant increase of the share of long-term unemployment in total unemployment with its peak in 2006; and (iii) deterioration of labor market performance during 2009. However, intensity of the unemployment rate decline was quite different dur-

ing the observed period between 2004 and 2008. The unemployment rate did not decrease with the same intensity in Czech regions and we can state that its change ranged from –2.2 p.p. to -7.4 p.p. If we look at higher values of the unemployment rate in problematic regions Ústecký and Moravskoslezský kraj, we can assume persisting problems in these regions. Unsatisfactory labor market performance was confirmed by another indicator in these regions – the share of long-term unemployment in total unemployment. This share exceeded 60 % in some years, which means that six out of ten were unemployed for more than 12 months. Another finding is that this share was increasing gradually during the observed period, until outbreak of the economic crisis. An increase of the number of unemployed was one among consequences of the crisis and thus increasing the denominator in the formula for calculating the share of long-term unemployment, which resulted in a reduction of the share. Higher unemployment rate in these regions means also lower competitiveness (for more detailed analysis see [8]). The same trend was noticed on a national level. What is interesting is the fact that this trend was associated with all regions with no exceptions, even region Praha which still stayed below the whole national average. However, the share of long-term unemployment in total unemployment, which was over 39.2 % in 2008, is too high for the region with the highest concentration of foreign capital, a strong tertiary sector and the highest GDP per capita in the country. We take the view that this finding validates considerations that many of the unemployed are in principle unemployable in the Czech Republic due to the lavish social system and even though they meet conditions for inclusion into the category of unemployed, they are not its part de facto.

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Czech Republic	7.9	7.2	5.3	4.4	6.7	7.3	6.7
Praha	3.4	3.0	2.5	2.1	3.0	3.9	4.0
Středočeský kraj	6.3	5.7	4.6	4.0	5.8	7.1	7.1
Jihočeský kraj	6.3	6.0	4.8	4.0	6.5	7.4	7.3
Plzeňský kraj	6.4	5.9	4.9	4.2	7.0	7.8	7.1
Karlovarský kraj	10.2	9.5	8.0	6.9	9.9	10.8	10.2
Ústecký kraj	15.4	14.5	12.2	9.9	12.4	13.4	12.9
Liberecký kraj	7.8	7.4	6.5	6.0	10.0	10.6	9.6
Královéhradecký kraj	7.3	6.6	5.2	4.2	6.8	7.7	7.2
Pardubický kraj	8.3	7.3	5.8	5.0	8.0	9.1	8.3
Vysočina	8.2	7.4	6.1	5.2	8.7	9.6	9.1
Jihomoravský kraj	10.1	9.2	7.6	6.2	8.9	10.2	9.6
Olomoucký kraj	11.0	9.6	7.4	6.2	10.2	11.5	11.1
Zlínsky kraj	9.2	8.4	6.6	5.5	9.1	10.4	9.4
Moravskoslezský kraj	14.7	13.4	11.0	8.4	11.1	11.9	11.3

Table 1 Regional Unemployment Rates (annual data 2005-2011)

The data used for cointegration analysis were the national and regional unemployment rates between the years 2005 and 2011. We can find another ways how to estimate regional differences like DEA method (e.g. see Nevima and Ramik [10] or indices of geographical concentration (for more see Tvrdon [11]). We applied monthly data from the Czech Ministry of Labor and Social Affairs database. These data were not seasonally adjusted. We have selected four regions – two problematic regions with high unemployment (Moravskoslezský kraj and Ústecký kraj) rates and two regions with traditionally low unemployment rates.

We applied methodology which is taken from Martin [7]. Ústecký and Moravskoslezský region have the greatest average unemployment rate; on the contrary Praha and Středočeský region have the smallest average unemployment rate (see Figure 1). We used monthly data between January 2005 and December 2011. We found out time series are integrated of order 1, I(1), i.e. stationary at the first difference.

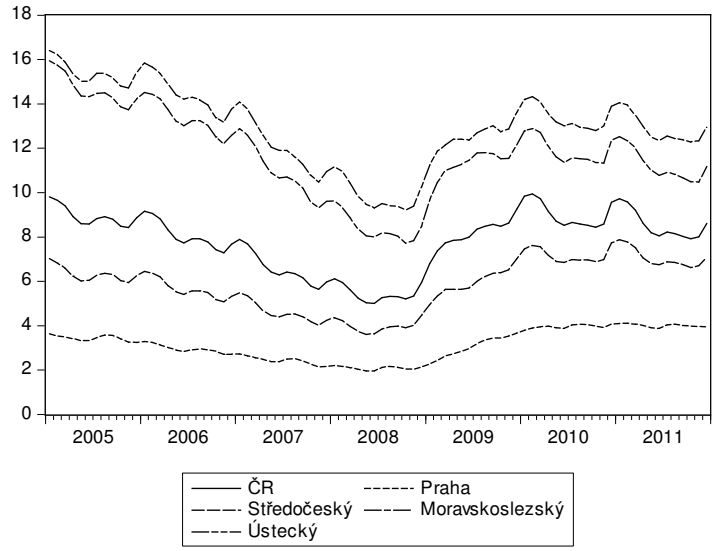

Figure 1 Unemployment rate, monthly data (%)

Next step was to obtain an indication of optimal lag length before performing Trace test and Maximum Eigenvalue test. The optimal time delay through Schwarz information criterion equals to 12. Trace test and Maximum Eigenvalue were performed to determine the number of *r* and ECM. Results of the unrestricted cointegration test can be seen in Table 2[3].

Area	H_0	Trace statistic	5 % critical value	Probability 5 %
Praha	r = 0	48.65562	20.26184	0.0
	r = 1	3.948413	9.164546	0.4199
Středočeský	r = 0	44.00313	20.26184	0.0
	r = 1	4.528271	9.164546	0.3391
Moravskoslezský	r = 0	53.01105	20.26184	0.0
	r = 1	5.954942	9.164546	0.1942
Ústecký	r = 0	60.15372	20.26184	0.0
	r = 1	7.211175	9.164546	0.1157

Table 2 Unrestricted cointegration rank test (Trace test)

The null and alternative hypotheses were established to determine the number of *r*: H_0: r = 0 against H_1: r > 0. We reject the null hypothesis at 5 % significance level; therefore the number of cointegrating equations is not equal to zero. In next round we established: H_0: r = 1 against H_1: r > 1. We accepted null hypothesis, thus the number of cointegrating equation *r* equals to one.

Based on previous tests of cointegration, we yield the following equations:

$$CR = 1.170206\,PRA + 4.381402 + e_t \tag{7}$$

$$CR = 0.494633\,STR + 5.099111 + e_t \tag{8}$$

$$CR = -0.099610\,MOR + 9.785900 + e_t \tag{9}$$

$$CR = -0.198305\,UST + 11.10721 + e_t \tag{10}$$

where CR, PRA, STR, MOR, UST denotes unemployment rates of the Czech Republic, Středečeský, Moravskoslezský and Ústecký region. If we look at equations (9) and (10) we can see negative relationship which is not consistent with economic theory and variables do not trend together.

Time series of errors (ECT) were non-stationary at levels, therefore they are not integrated of order 0, I(0); except relationship between unemployment rates of the Czech Republic and Praha region thus is confirmed for

[3] We present the trace results only for economy of space.

these time series only. Increasing unemployment in Praha about 1 percentage point will cause increasing unemployment rate almost 1.2 percentage point in the Czech Republic. ECM implies deviation from equilibrium in short-run. About 23 % of deviation is corrected each month.

4 Conclusion

The aim this paper was to perform an empirical analysis of long-term relationship between national and regional unemployment rates of selected regions. In other words, we try to find possible cointegration between changes of the national unemployment rate and the regional unemployment rates. On the basis of the unit root test, we found that in all regions, unemployment rates are integrated of order I(1). This result allowed us to continue and after establishing a period of lag (twelve periods), we implemented the Johansen cointegration test. This test showed that although one cointegration relationship. ECT, however, showed that residues are not stationary at I(0) except relationship between Prague and national unemployment rates. Cointegration relationship thus has been demonstrated for Praha and the national unemployment rate only. So does the ECM. ECM implies deviation from equilibrium in short-run. About 23 % of deviation is corrected each month.

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