Peer-reviewed and Open access journal
ISSN: 1804-5006 | www.academicpublishingplatforms.com
The primary version of the journal is the on-line version

BEH - Business and Economic Horizons
Volume 14 | Issue 5 | 2018 | pp.970-987
DOI: http://dx.doi.org/10.15208/beh.2018.66

Estimates of structural unemployment rates at a regional level: Example of the Czech economy

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Abstract: While there are typically plenty of estimates of structural unemployment rate for an economy as a whole, the analysis of this phenomenon at the regional level is rather sparse. Of course, the task is quite different as the concept of structural unemployment as an image of the medium-run or long-run equilibrium of the economy does not need to hold at a regional level. This paper proposes an econometrical approach based on the search theory of the labor market. The generalized method of moments is employed to estimate the so-called stationarized unemployment rates in the fourteen regions of the Czech economy. By comparing the estimates and actually observed levels of unemployment rates, the effects of economic upswings and recessions after the year 2000 may be analyzed. Indeed, from the regional perspective the economic impacts differ substantially in certain periods of time.

JEL Classifications: E32, J63, J64

Keywords: Flows in the labor market, GMM, regional analysis, stationary unemployment rate, unemployment rate

Citation: Pošta. V. (2018). Estimates of structural unemployment rates at a regional level: Example of the Czech economy. *Business and Economic Horizons, 14*(5), 970-987. http://dx.doi.org/10.15208/beh.2018.66

1. Introduction

The concept of equilibrium unemployment has long been a subject of both theoretical and empirical research.

At the level of the whole economy the approach typically rests on drawing a line between the short-run and the long-run adjustments while the difference between the two stems from the idea that due to the existence of nominal and/or real rigidities the output of the whole economy may diverge from its long-run level, potential output, however, only from a short-term perspective as the rigidities, nominal or real, are treated as only temporary.

While this concept of only temporary divergences is disputable even at the level of the whole economy, it seems rather unacceptable at a level beneath it, i.e. regional level. From a regional point of view, it does not require much to imagine some persistently underperforming regions due to unfavorable structural shifts or vice versa. As some of the negative consequences may be expected to be eliminated at the economy level due to labor and professional mobility, at the regional level it is much less probable to occur given a certain period of time. On the contrary, the idea of regions under or overperforming in the long course of time is well acceptable. From an empirical point of view, persistent discrepancies in the performance of regional labor markets are documented by OECD (2005). Much more insight offers Suedekum (2004) who shows that free mobility of labor in fact does not need to result in reduction of regional disparities but, on the contrary, it may intensify them if the mobility is strongly skillbiased. This means that while at the level of the whole economy the effects of labor mobility may help reduce its fluctuations, the image of the same mechanisms may be quite the opposite from a regional perspective. From a different point of view, Epifani & Gancia (2005) show that mobility between regions may lead to negative search externalities in the region hit with outflow of labor. The result is that in the long run the effect of labor migration may lead to more profound disparities.

This renders the standard empirical approach useless. At the level of the whole economy it is especially the concept of the Phillips curve which is employed as a background to the empirical analysis. It may either go along the lines of the older exposition summed-up in the triangular model of Gordon (1996) with a well-known application on the European economy in Fabiani & Mestre (2004) or be more in touch with the so-called new Keynesian Phillips curve (NKPC), for the estimation of NKPC in case of the middle and eastern European economies see Mihailov, Rumler, & Scharler (2010) and Vašíček (2011), while the application of the model to estimate time-varying structural unemployment is found in Pošta (2015).

At a regional level typically purely statistical or almost purely statistical filtering is employed. Cuéllar-Martín, Martín-Román, & Moral (2017) make use of stochastic cost frontiers to disentangle the structural part of unemployment from the overall figure in some Spanish regions. Their approach is very close to purely statistical approach with the setback in the form of limited room for economic analysis. Parker (2015) uses a structural decomposition of the total unemployment rate based on the information about state business cycle, state demographics, state labor-market policies and the composition of the employment base. With this approach he estimates structural unemployment for the states of the US economy. De Oliveira & Carvalho (2016) present the approach which is closest to the approach proposed in this paper. They make use of the search model of the labor market which they apply on a sample of several regions of the Brazilian economy. However, their goal is not to estimate structural unemployment but rather several sensitivity parameters which come from the search model.

The idea applied below comes from the concept of stationarity in the search model of the labor market, which given the flows into and out of unemployment makes it possible to establish a concept of stationarized unemployment. The stationarized unemployment rate is well known, as it lies behind the widely used Beveridge curve: the view of the labor market as combinations of vacancy rate and unemployment rate. More precisely, the Beveridge curve consists of such combinations of vacancy rate and unemployment rate which would yield the unemployment rate stable.

The concept of stationarized unemployment rate is formally presented in the next part as well as the empirical model. Then the data used for the estimations is explained and statistically analyzed. Next, the paper proceeds with the estimates themselves together with the discussion of the results. The final part of the paper concludes the results.

2. The model

One of the three building blocks of the search model in context of the labor market is the Beveridge curve relationship. The concept is summarized below based on Pissarides (2000); Yashiv (2007) provides a clear-cut synthesis of the approach.

Let ur, v, m and L be unemployment rate, vacancy rate, rate of matches and labor force, respectively. Then the concept of the matching function may be established:

$$m * L = f(v * L, ur * L), \tag{1}$$

which means that during a given period of time, the number of vacancies, $v * L$, and the number of unemployed, $ur * L$, give rise to the number of newly occupied jobs, $m * L$. The efficiency of this transformation is dependent on the structural characteristics of the economy which are embodied in the matching function itself.

The function is assumed to be homogeneous of degree one, hence dividing through by uL leads to:

$$pfj = f(\theta), \tag{2}$$

Where, the ratio of vacancy rate and unemployment rate is denoted as θ and represents the so-called labor market tightness and the ratio of matching rate and unemployment rate, pfj, presents probability of finding a job. The viability of the assumption of constant returns to scale of the matching function was in depth both empirically and theoretically examined by Petrongolo & Pissarides (2001) with the results that the assumption of constant returns to scale is plausible. Kohlbrecher, Merkl, & Nordmeier (2016) show that the assumption of homogeneity of degree one of the matching function is one of the two possibilities to achieve observed comovements of matches, unemployment and vacancies.

Given (2), labor market tightness increases with the increase of vacancy rate or/and decrease of unemployment rate and so does probability of finding a job.

Proceeding further, the change in unemployment in a given period of time depends on the inflow to and outflow from the unemployment. The inflow is derived from the number of employed during the period of time and the separation rate, sr, which presents the rate at which the occupied jobs are lost. On the other hand, the outflow from unemployment is given by the number of unemployed and the probability of finding a job. More precisely, the change in unemployment may be expressed as:

$$\Delta(ur * L) = sr * (1 - ur) * L - pfj * ur * L \tag{3}$$

Solving equation (3) for stationarized unemployment rate, i.e. $\Delta u = 0$, yields:

$$ur = \frac{sr}{g_L + sr + pfj}, \tag{4}$$

where gL is the growth rate of labor force. From (4) it reads that stationarized unemployment rate decreases with increasing growth rate of labor force and/or probability of finding a job and/or with decreasing separation rate.

Equation (4) is the above mentioned Beveridge curve given non-zero growth of labor force. As proper data for labor force at a monthly frequency and at the regional level is lacking, one more assumption, frequently employed, is made which is a constant labor force. Equation (4) then collapses into:

$$ur = \frac{sr}{g_L + sr + pfj} \tag{5}$$

Along the lines of Pissarides (2000), as supported by his response, Pissarides (2009), to the paper by Dickens (2009), the shifts of the Beveridge curve should not be interpreted as structural changes without formulating the full search model of the labor market. Shifts in the Beveridge curve may as well come about as results of temporary and pure demand side shocks, which are not typically associated with structural changes in the economy.

The econometrical strategy which immediately comes up is cointegration. While the series of unemployment rate, separation rate and probability of finding a job may be considered non-stationary given a minor adjustment of the data, see further below, no statistically significant cointegration relationships were detected.

Given the endogeneity among the three variables, I resort to generalized method of moments as an appropriate econometrical model.

The stationarized unemployment rate is therefore estimated using a linear equation:

$$ur_t = \alpha + \beta_1 sr_t + \beta_2 pfj_t + \varepsilon_t , \tag{6}$$

Where, ε is the error term assumed to be without autocorrelation.

The generalized method of moments employs instrumental variables, which serves to extract the endogeneity bias from the principal equation. There is no recipe to choose the instruments, however, typically constant and lagged values of explanatory variables of the principal equation are utilized. Below constant, lagged values of separation rate, probability of finding a job and growth of gross domestic product of the Czech economy (as a variable which comprises a large number of information on the evolution of an economy) are employed. Further information regarding the estimation follows in the third and the fourth part.

3. The data

The model is applied and stationarized unemployment rate is estimated for all the NUTS regions of the Czech Republic, which comprises: Prague (PRA), Středočeský region (STR), Jihočeský region (JIH), Plzeňský region (PLZ), Karlovarský region (KAR), Ústecký region (UST), Liberecký region (LIB), Královéhradecký region (KRA), Pardubický region (PAR), region Vysočina (VYS), Jihomoravský region (JIH), Olomoucký region (OLO), Zlínský region (ZLI), Moravskoslezský region (MOR).

Monthly data is employed to make the estimations. The preference is given to monthly data (over quarterly data) for the reasons of continuity of my other work regarding the regional labor markets of the Czech economy. The monthly data for labor force at the regional level is not available given the whole sample which runs from 2000 up to 2015. This is because unemployment as such is no longer published by the MPSV (Ministry of Labour and Social Affairs); the ratio of unemployed and working age population is published instead. However the concept of labor force is needed to express unemployment rate.

The unemployment rate is defined as the ratio of the not placed candidates registered at labor offices at the end of the month to labor force and the separation rate is the ratio of the newly registered candidates in the given month to the labor force. Therefore, labor force is employed to obtain a relative measure of separation, which from the point of view of (5) does not pose any problem because the separation rate is considered exogenous in this setting. The labor force data used for this come from the Labor Force Survey statistics carried out by the Czech Statistical Office. While they are available at the required regional level, they come as quarterly data. It is assumed that between the months in a given quarter the labor force changed evenly. This way the monthly series of the labor force is obtained.

Probability of finding a job is computed as a ratio of newly placed candidates in the given month and the number of registered candidates in the same period.

TABLE 1A. STATISTICAL PROPERTIES OF THE DATA

REGION	VARIABLE	MEAN	ST. DEVIATION	JARQUE-BERA	ADF LEVEL	ADF 1ST DIFF.
PRA	ur	0.044	0.012	14.950***	−1.67	−2.94**
PRA	sr	0.006	0.001	2.235	−2.41	−18.38***
PRA	pfj	0.082	0.020	30.013***	−1.66	−18.45***
STR	ur	0.071	0.011	12.996***	−2.43	−3.09**
STR	sr	0.009	0.001	32.102***	−2.28	−17.18***
STR	pfj	0.088	0.018	40.489***	−2.45	−17.19***
JIH	ur	0.070	0.013	5.793*	−2.41	−4.65***
JIH	sr	0.010	0.001	169.482***	−2.38	−15.17***
JIH	pfj	0.109	0.022	20.842***	−1.96	−13.96***
PLZ	ur	0.072	0.011	3.912	−2.51	−4.06***
PLZ	sr	0.010	0.001	221.736***	−2.39	−14.11***
PLZ	pfj	0.092	0.017	21.156***	−1.38	−13.45***
KAR	ur	0.103	0.015	19.054***	−2.19	−4.58***
KAR	sr	0.011	0.001	990.850***	−2.31	−14.89***
KAR	pfj	0.070	0.016	5.259*	−2.23	−14.14***
UST	ur	0.154	0.018	11.526***	−1.98	−3.09**
UST	sr	0.014	0.002	49.509***	−2.57	−16.56***
UST	pfj	0.058	0.011	14.641***	−2.05	−18.99***
LIB	ur	0.094	0.018	13.349***	−2.54	−3.09**
LIB	sr	0.011	0.002	230.695***	−2.51	−14.56***
LIB	pfj	0.084	0.019	4.401	−2.29	−13.42***

Source: Data of Ministry of Labour and Social Affairs, own estimate.
Notes: Sample: 2000M01:2015M12. Variables: unemployment rate (ur), separation rate (sr), probability of finding a job (pfj). Jarque-Bera statistic under the null of normal distribution. ADF: augmented Dickey-Fuller statistic under the null of unit root. *, **, *** - means rejection of the null at 10%, 5%, 1% level of statistical significance, respectively.

Tables 1A and 1B present the key statistical features of the data. Three series are needed for each region: unemployment rate, separation rate and probability of finding a job. The sample runs from 2000 up to 2015. The end was limited by the availability of the Labor Force Survey data from which the data on labor force was retrieved and not by the availability of the MPSV data (at the time these estimates were made).

TABLE 1B. STATISTICAL PROPERTIES OF THE DATA

REGION	VARIABLE	MEAN	ST. DEVIATION	JARQUE-BERA	ADF LEVEL	ADF 1ST DIFF.
KRA	ur	0.074	0.013	5.495*	−2.50	−3.29**
KRA	sr	0.010	0.001	218.418***	−2.49	−15.41***
KRA	pfj	0.095	0.021	12.389***	−1.88	−15.62***
PAR	ur	0.084	0.012	19.575***	−2.42	−4.41***
PAR	sr	0.011	0.002	75.774***	−2.48	−14.31***
PAR	pfj	0.094	0.019	11.612***	−2.36	−16.11***
VYS	ur	0.087	0.014	11.396***	−2.48	−3.99***
VYS	sr	0.010	0.002	250.576***	−2.51	−14.74***
VYS	pfj	0.092	0.019	16.406***	−2.37	−16.95***
JIH	ur	0.103	0.013	36.700***	−2.52	−3.81***
JIH	sr	0.011	0.001	95.993***	−2.33	−15.14***
JIH	pfj	0.075	0.012	14.944***	−2.48	−17.30***
OLO	ur	0.114	0.018	71.491***	−2.49	−3.74***
OLO	sr	0.012	0.002	154.580***	−2.00	−14.59***
OLO	pfj	0.075	0.014	13.813***	−1.96	−14.11***
ZLI	ur	0.095	0.014	18.401***	−2.23	−3.55***
ZLI	sr	0.010	0.001	121.254***	−2.51	−8.13***
ZLI	pfj	0.079	0.015	8.242**	−2.48	−17.16***
MOR	ur	0.140	0.021	6.433**	−2.03	−3.69***
MOR	sr	0.012	0.001	41.648***	−2.31	−15.48***
MOR	pfj	0.058	0.011	9.379***	−2.50	−15.37***

Source: Data of Ministry of Labour and Social Affairs, own estimate.
Notes: Sample: 2000M01:2015M12. Variables: unemployment rate (ur), separation rate (sr), probability of finding a job (pfj). Jarque-Bera statistic under the null of normal distribution. ADF: augmented Dickey-Fuller statistic under the null of unit root. *, **, *** - means rejection of the null at 10%, 5%, 1% level of statistical significance, respectively.

While it is not the goal of this section to analyze the data from the economic perspective, of course, the information included in Tables 1A and 1B draws an informative picture of the state of the labor markets in the respective regions.

The mean of the separation rates is relatively higher in the Ústecký, Olomoucký and Moravskoslezský regions. The mean of the probability of finding a job falls below 6% only in Ústecký and Moravskoslezský region. The unemployment rate reaches more than 10% in Karlovarský, Ústecký, Jihomoravský, Olomoucký and Moravskoslezský regions.

The data were found nonstationary at their levels but stationary at their first differences. As I have already commented above, although this feature of the data naturally leads one to consider application of cointegration techniques, the results generally did not point to the existence of statistically significant cointegration vectors among the variables. Therefore, econometrical techniques directly employing stationary variables were used.

To ensure the nonstationarity in levels, the series were filtered by the Hodrick-Prescott filter with lambda set at 100. This did not in any way significantly influenced the economic information given in Tables 1A and 1B. However, without any alteration, in some cases the levels of the series might be taken as stationary. Combination of stationarity and nonstationarity dramatically complicates most of the econometrical work. Furuoka (2014) documents well the differences in stationarity of unemployment series across the regions of the Czech economy. He finds that in nine regions unemployment rate follows unit root process while the unemployment rate in the other regions displays stationarity.

4. The estimates and discussion

The estimates of (6) using the generalized method of moments (GMM) are given in Tables 2 and 3.

TABLE 2. GMM ESTIMATES

REGION	OBSERVATIONS	CONSTANT	sr	pfj	gdp	sr	pfj
PRA	190	0.000	4.492***	−0.213***	(0, −1)	(−1)	(−1)
STR	190	0.000	3.625***	−0.280***	(0)	(−1)	(−1)
JIH	190	0.000	2.876***	−0.255***	(0, −1, −2)	(−1)	(−1)
PLZ	190	0.000***	3.383***	−0.193***	(0, −1, −2)	(−1)	(−1)
KAR	190	0.000	2.333***	−0.453***	(0, −1, −2)	(−1)	(−1)
UST	190	0.000**	1.852**	−0.706***	(0, −1, −2)	(−1)	(−1)
LIB	190	0.000	2.979***	−0.367***	(0, −1, −2)	(−1)	(−1)
KRA	190	0.000	2.630***	−0.308***	(0, −1, −2)	(−1)	(−1)
PAR	190	0.000*	3.453***	−0.202***	(0, −1, −2)	(−1)	(−1)
VYS	190	0.000*	2.660***	−0.247***	(0, −1, −2)	(−1)	(−1)
JIH	190	0.000	2.442***	−0.395***	(0, −1, −2)	(−1)	(−1)
OLO	190	0.000***	3.029***	−0.357***	(0, −1, −2)	(−1)	(−1)
ZLI	190	0.000**	3.063***	−0.283***	(0, −1, −2)	(−1)	(−1)
MOR	190	0.000*	2.346***	−0.475***	(0, −1, −2)	(−1)	(−1)

Source: Own estimate.

Notes: Sample (adjusted) 2000M03:2015M12. Variables: separation rate (sr), probability of finding a job (pfj), gross domestic product (gdp). Evaluation of the null of the coefficient being zero is given with the estimates. The number in brackets under the instruments signify the lags at which they enter the model. *, **, *** means rejection of the null at 10%, 5%, 1% level of statistical significance, respectively.

Table 2 gives the estimates of the constant in the principal equation (6) and the two coefficients: one of separation rate and the other of probability of finding a job. Then it states the information on the composition of instruments. In all of the cases constant was used as an instrument, one lag of separation rate and one lag of probability of finding a job. In addition to this contemporary growth rate of gross domestic product and its various lags were also used.

This means that all of the models were overidentified. This helps to evaluate the validity of the instruments using the Sargan-Hansen J-statistic under the null hypothesis of validity of the instruments chosen. The value of the J-statistic is given in Table 3. In all of the cases the composition of the instruments was found valid.

Another important test of the validity is their so-called weakness. This characteristic rests on comparing the results of the GMM estimates and OLS (ordinary least squares) estimates allowing for only a certain level of bias. Table 4 states the required level of Cragg-Donald F-statistic for a maximum of 5% bias and the actual Cragg-Donald F-statistic of the particular model. In all of the cases the actual F-statistic greatly exceeded the minimum required level. The weakness of the instruments was therefore ruled out.

TABLE 3. EVALUATION OF THE INSTRUMENTS

REGION	J-STATISTIC	DURBIN-WU-HAUSMAN DIFFERENCE IN J-STATISTIC	CRAGG-DONALD F-STATISTIC AT 5%	CRAGG-DONALD F-STATISTIC
PRA	3.493	10.627***	11.04	311.577
STR	2.000	7.471**	13.43	346.502
JIH	5.674	5.781*	13.97	202.541
PLZ	4.877	5.116*	13.97	242.074
KAR	3.967	4.806*	13.97	227.785
UST	4.259	5.981*	13.97	195.516
LIB	4.188	4.862*	13.97	241.024
KRA	4.373	7.290**	13.97	226.679
PAR	5.568	5.750*	13.97	250.967
VYS	3.223	7.660**	13.97	261.938
JIH	4.821	6.327*	13.97	209.027
OLO	4.385	5.899*	13.97	242.634
ZLI	4.129	5.443*	13.97	229.297
MOR	3.810	5.192*	13.97	228.263

Source: Own estimate.
Notes: Sample (adjusted) 2000M03:2015M12. J-stastistic of Sargan-Hansen test under the null of validity of the over-identifying restrictions. Durbin-Wu-Hausman tests endogeneity of the regressors by comparing J-statistic of models when regressors are included among instruments and when they are not. The statistic is stated under the null of exogeneity of the regressors, i.e. they are not explained by the instruments. Cragg-Donald test of weak instruments is presented by F-statistic at 5% which means minimum value of F-statistic required so that the null of weak instruments at the maximum of 5% bias relative to OLS may be rejected. *, **, *** - means rejection of the null at 10%, 5%, 1% level of statistical significance, respectively.

I include results of one more procedure which tests the endogeneity of the regressors. The idea of the test rests on the comparison of the particular model with an alternative where the regressors are included among instruments. Given the presented Durbin-Wu-Hausman difference in J-statistic of the two models, the exogeneity of the regressors was ruled out.

All the estimations were performed using the HAC (heteroskedasticity and autocorrelation consistent) weighting matrix.

From the point of view of the estimates in Table 2, highly statistically significant positive impact of separation rate and negative impact of probability of find a job on the stationarized unemployment rate were confirmed. Given the estimates and the whole structure of the models stationarized unemployment rate were retrieved. They are depicted together with the actual unemployment rates in Figures 1 to 14 (see **Appendix**).

The first question examined is the existence or nonexistence of the relation between the actual and "equilibrium" unemployment rate over the course of the economic cycle.

It is very interesting to note that the typical image is present only in the cases of Prague region, Středočeský region. Only in these two cases may one observe some measurable declines of actual unemployment rate below the stationarized unemployment rate during the expansion of the whole economy in the period 2006 - 2008.

In the other cases we can see improvement in the sense that the actual unemployment rate was getting closer to the equilibrium one, however, it did not fall below it, taking account of the 95% confidence interval of the estimate of the time-varying stationarized unemployment rate.

The reaction of the stationarized rate to the first recession of the Czech economy, which began in the last quarter of 2008, was such that the equilibrium unemployment rate increased, and in many cases rather sharply. The reaction during the second recession which covered the year 2012 and the first quarter of 2013 (given the current data of the Czech Statistical Office) was in most of the cases also marked with an increase in equilibrium unemployment; however, this one was generally less significant.

The standing exception is Prague, where the impact of the second recession was more profound than the first one and in this respect the region is more or less in line with the development of the whole economy. When we consider the data for the Czech economy as a whole, we find out that the negative shock coming from increasing separation rate really came about in 2008, however, the falling probability of finding a job started to come into play especially during the second recession in 2012. It was especially in that period when consumption of households was hit as compared with the first recession.

In fact Prague also stands out because the stationarized unemployment rate did not show any significant improvement by the end of 2015. It must of course be taken into consideration that in comparison with most of the regions it is relatively low.

The fact that the equilibrium unemployment rate in most regions declined after the recession, however, does not goes to say that the situation as such improved. Most of the regions except for Prague, Středočeský region and Jihočeský region are marked by high divergences between the actual and stationarized rates of unemployment, in many case these differences reach over 4 percentage points given the point estimates and little less taking into account the upper bound of the confidence intervals.

This may be interpreted in the following way. On the one hand, it is true that the situation on the labor market after the two recessions improved given the decrease in the inflow and increase in the outflow to and from unemployment, or in other words given the increases in the probability of finding a job and decreases in the separation rate, which is reflected in the estimate of the equilibrium unemployment rate. On the other hand, this fact did not translate (in some cases absolutely) fully into the actual levels of unemployment. This is indicative of potentially huge structural problems of some of the regional labor markets, given the divergence of the actual and stationarized unemployment rates, especially in the cases of Moravskoslezský, Zlínský, Olomoucký, Ústecký and Karlovarský regions where the disparities are the biggest and most persistent at the same time.

5. Conclusion

The paper made use of the concept of stationarized unemployment rate based on the search model of the labor market to estimate equilibrium unemployment rates at the regional level.

This in turn enables a structural evaluation of the particular labor markets and it was argued that given the economic models, it is the only approach which stands up to economic reasoning. The reason is that applying traditional model strategies which are applied from the point of view of the whole economy would mean the assumption of only short-term regional rigidities, which is an idea hardly defendable. For this reason the approach presented in the paper otherwise focused solely on the Czech economy may be of interest to a wider range of economists.

The estimates confirmed the negative impacts of the two recessions of the Czech economy which took place after the year 2000 on the concept of equilibrium unemployment. Generally, the impact of the first recession in terms of stationarized unemployment rate was more severe. The second recession influenced the situations of the regional labor markets especially in the sense of further divergence of the actual and equilibrium rates of unemployment with the latter not being hit so severely as during the first recession. The key exception to this development was the Prague region.

In several regions the disparity between the post-recessional actual unemployment rate and stationarized unemployment rate remained huge and rather persistent. This clearly points to existing structural problems of such regions.

The results indicate that further work is necessary to evaluate the existing structural obstacles in the respective regions. The main drawback of the approach applied in this paper is that while it is sufficient to detect existence of such obstacles, it lacks theoretical foundations broad enough to try to pinpoint their sources. In other words, the model needs to include specific variables from the point of view of demand and supply in the respective labor markets. Naturally, extending the applied model, it would seem obvious that this question might be solved by estimating full-fledged search models at the regional levels. However, such an approach would rest on calibration of many deep parameters for which there are typically no bounds that might be deduced given some previous studies, which is a completely different situation when full search models are applied at the level of the whole economies. Therefore, I suppose, at the regional level a more flexible, semi-structural, approach would be needed to answer the question of the origins of the identified structural problems.

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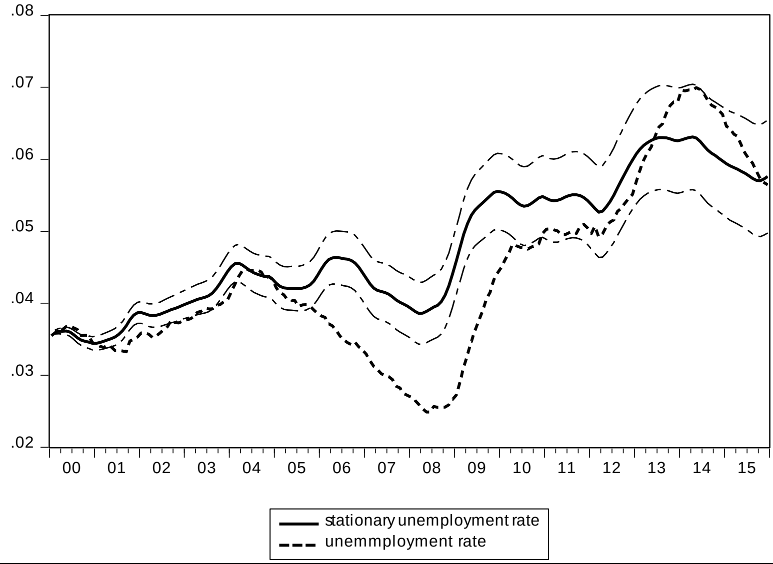
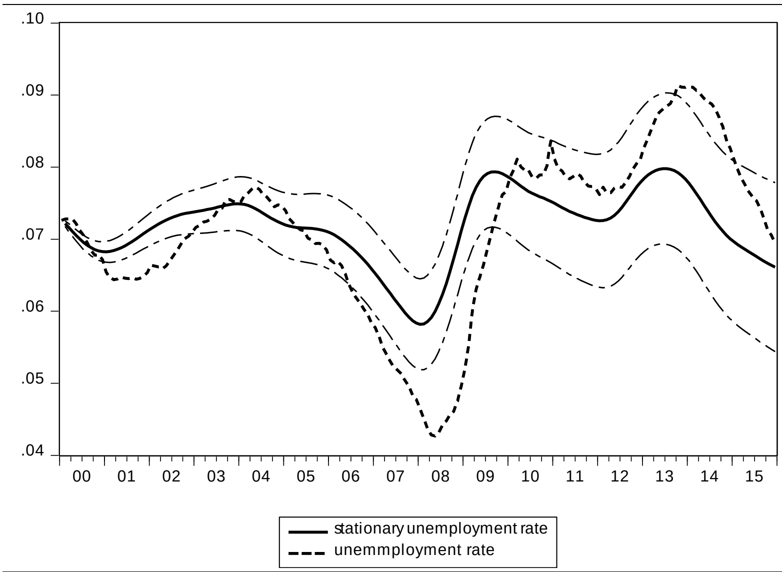
Appendix

FIGURE 1. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR PRAGUE REGION (95% confidence interval)



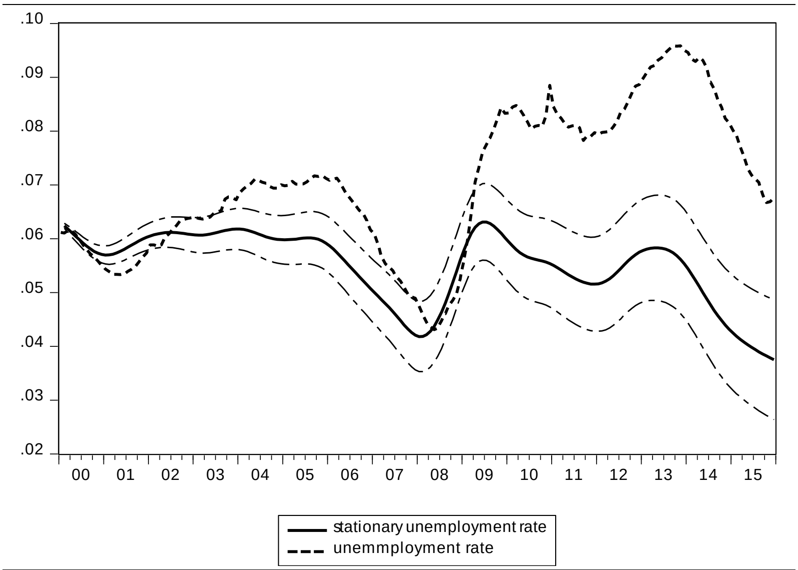
Source: Own estimate.

FIGURE 2. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR STŘEDOČESKÝ REGION (95% confidence interval)



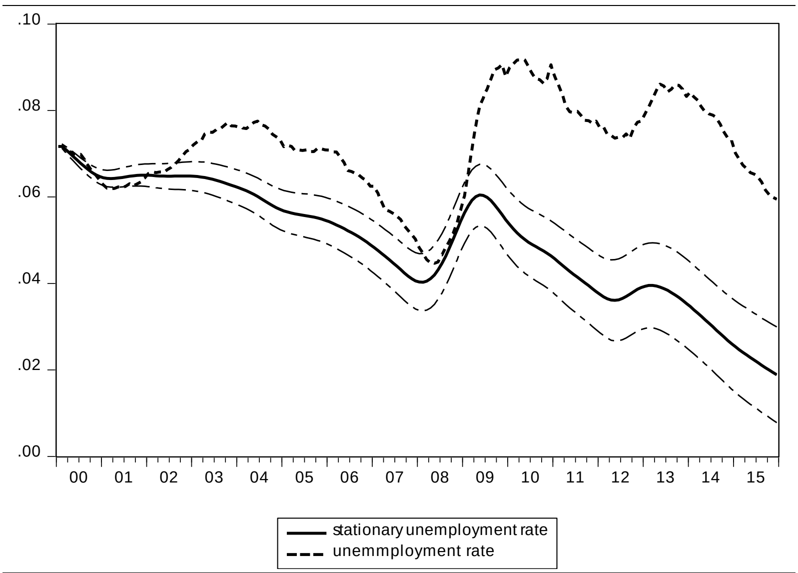
Source: Own estimate.

FIGURE 3. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR JIHOČESKÝ REGION (95% confidence interval)



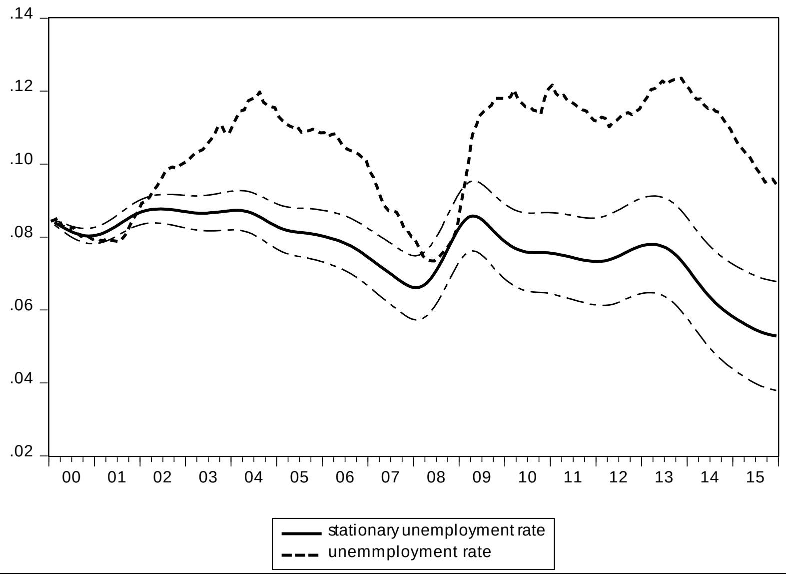
Source: Own estimate.

FIGURE 4. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR PLZEŇSKÝ REGION (95% confidence interval)



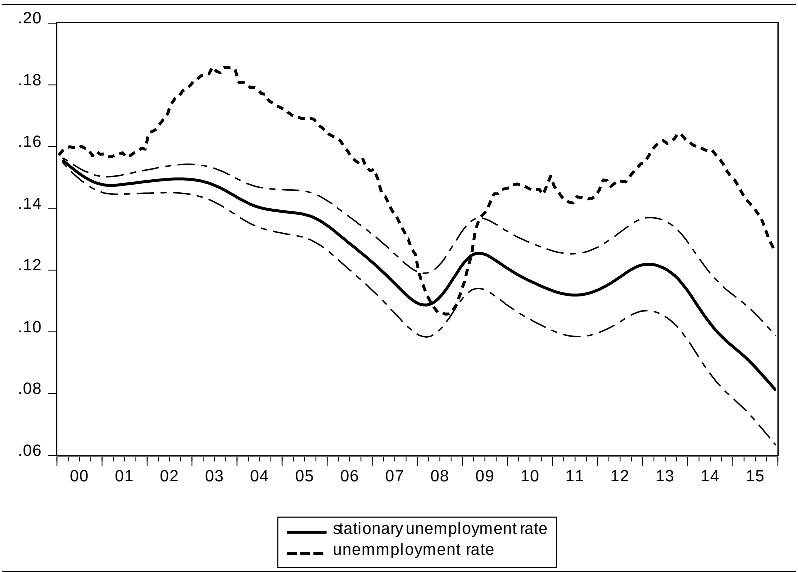
Source: Own estimate.

FIGURE 5. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR KARLOVARSKÝ REGION (95% confidence interval)



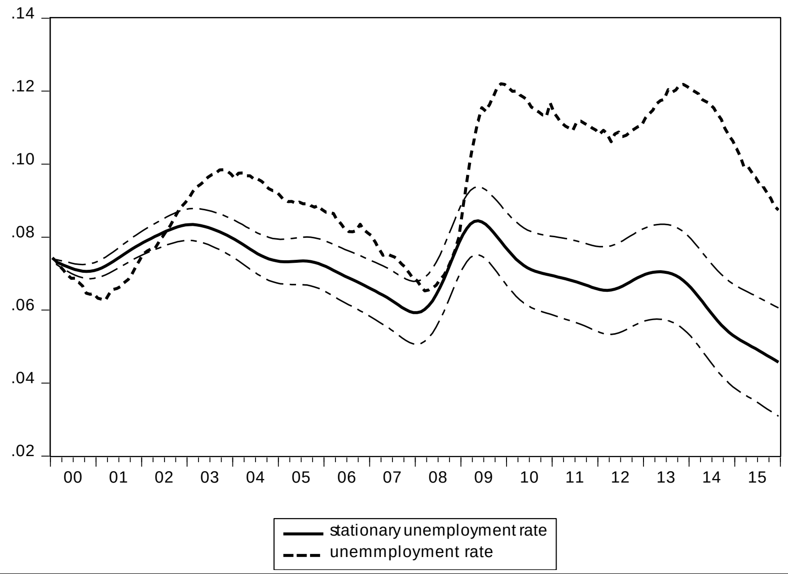
Source: Own estimate.

FIGURE 6. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR ÚSTECKÝ REGION (95% confidence interval)



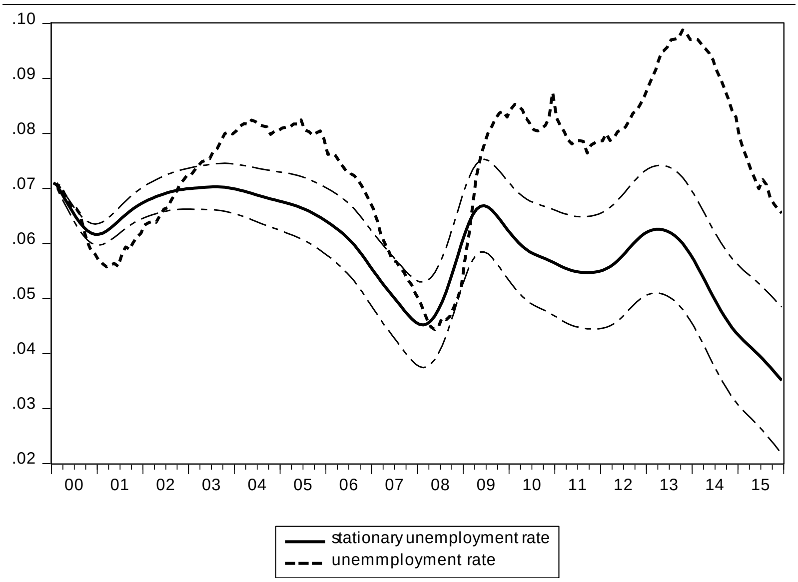
Source: Own estimate.

FIGURE 7. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR LIBERECKÝ REGION (95% confidence interval)



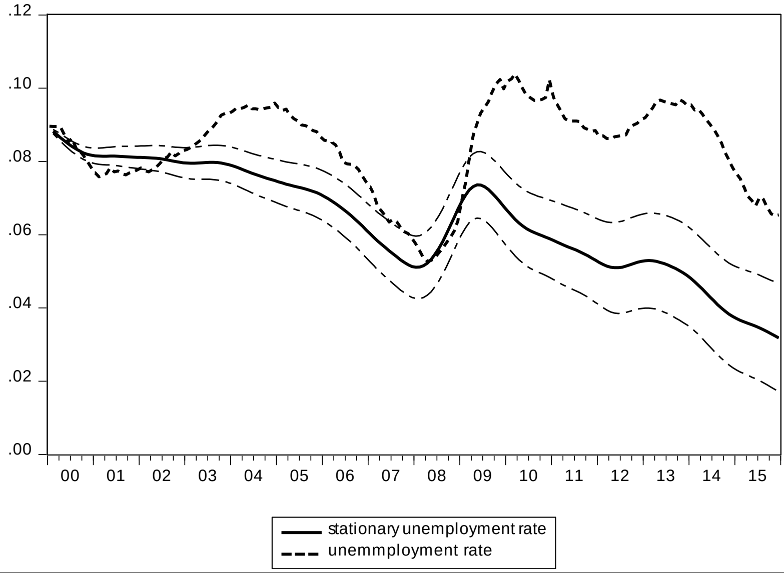
Source: Own estimate.

FIGURE 8. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR KRÁLOVÉHRADECKÝ REGION (95% confidence interval)



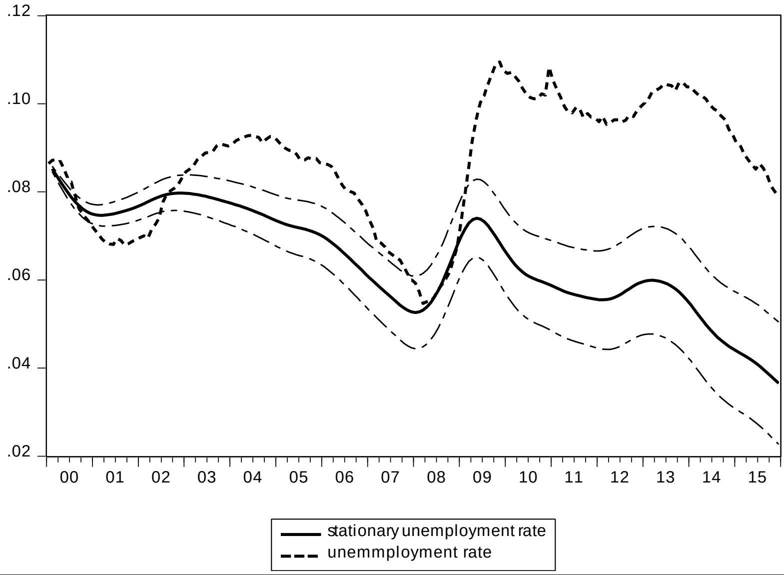
Source: Own estimate.

FIGURE 9. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR PARDUBICKÝ REGION (95% confidence interval)



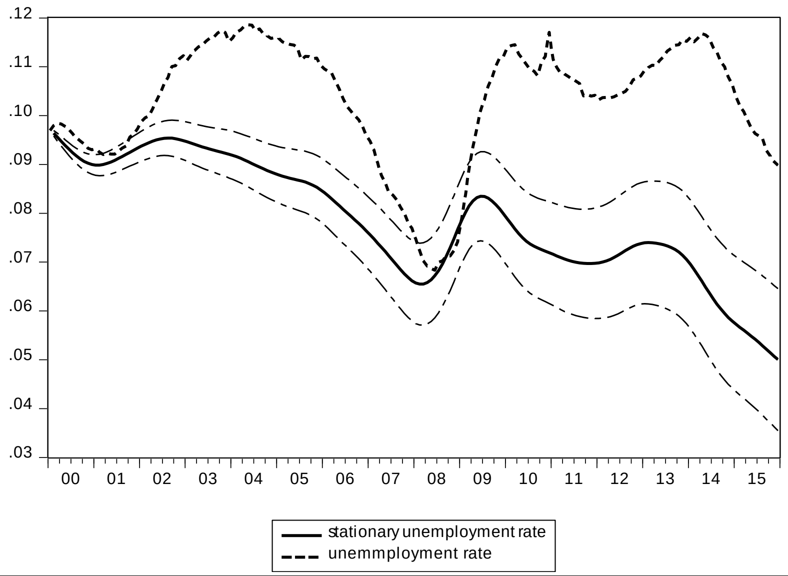
Source: Own estimate.

FIGURE 10. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR VYSOČINA REGION (95% confidence interval)



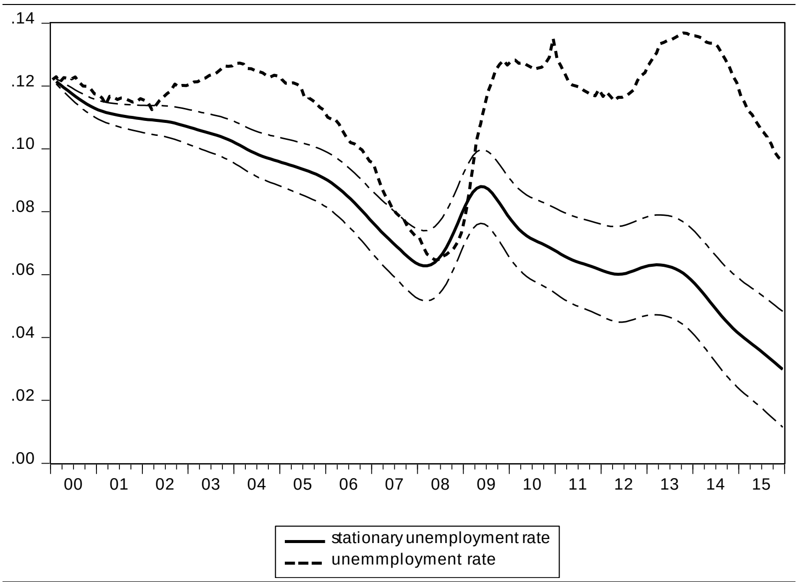
Source: Own estimate.

FIGURE 11. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR JIHOMORAVSKÝ REGION (95% confidence interval)



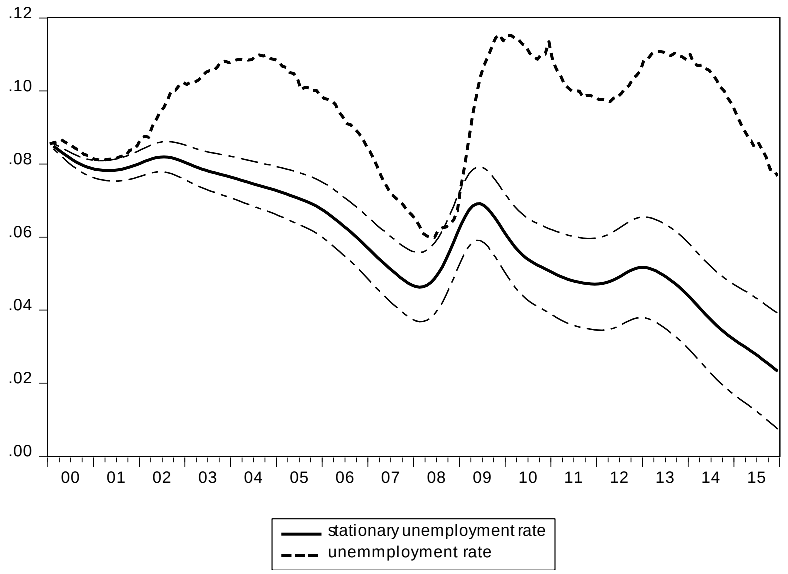
Source: Own estimate.

FIGURE 12. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR OLOMOUCKÝ REGION (95% confidence interval)



Source: Own estimate.

FIGURE 13. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR ZLÍNSKÝ REGION (95% confidence interval)



Source: Own estimate.

FIGURE 14. ESTIMATE OF STATIONARIZED UNEMPLOYMENT RATE FOR MORAVSKOSLEZSKÝ REGION (95% confidence interval)

Source: Own estimate.