Time-Varying Rigidity of the Czech Regional Labor Markets

*Vít POŠTA**

Abstract

While the empirical economic research has long focused on capturing the rigidities of the labor markets on the level of the whole economy, the structural policy might benefit much more from a regional perspective. This paper follows exactly this path, focusing on the regional differences in labor market rigidities. The concept of the labor market rigidity is captured by the sensitivity of probability of finding a job on the labor market tightness, a key relationship behind the search model of the labor market referred to as matching function. The relationship is estimated as time-varying using the Kalman filter procedure. Indeed the results go to prove that the situation among the regional labor markets in the Czech economy varies with respect to space as well as time.

Keywords: *Kalman filter, matching function, regional analysis, rigidity of the labor market, search model*

JEL Classification: E32, J63, J64

Introduction

Economic theory as well as empirics have long been focused on the analysis of the structural features of the aggregate labor markets, typically on the level of the whole economies. The modelling approach is well established and rests on applying the framework of the Phillips curve model or the search model in the context of the labor market.

From a regional perspective the notion of and understanding persistent disparities among regional labor markets may serve as a basis for structural policy. This is emphasized by the fact, as shown below, that standard equilibrating mechanisms, which rest especially on labor mobility, may not lead to diminishing differences between the regions, but, on the contrary, may even aggravate them.

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The paper presents by far the most detailed estimates of the efficiency of the matching process on the regional level in the Czech Republic as well as the estimated impact of some of the determinants of the matching process, whose choice is based on previous analyses by other researchers. The results may serve to identify, along with other variables, the weakest regions of the Czech Republic and also to evaluate the impact of the structural policies aimed at improving the situation in the respective regions.

In the review below the first part focused on the possibility of permanent under or overperformance on a regional level, which is closely related to labor mobility, explains the modelling strategy taken in this paper. The second part of the review is focused on the empirics mostly concerned with the analysis of the matching process in the Czech Republic and its determinants.

As far as the Phillips curve is concerned, two approaches may be followed. The first one, historically older, is well captured by the triangular model of Gordon (1996). The more modern one follows the path of the new Keynesian Phillips curve (NKPC) and typically has a more structural nature as the underlying structure, NKPC, indeed encourage. Some useful estimates for Middle and Eastern European economies may be found in Mihailov, Rumler and Scharler (2010), Vašíček (2011) and Basarac, Skrabic and Soric (2011). Partially structural estimation of structural unemployment based on NKPC for more or less the same set of economies is presented in Pošta (2015).

Focusing on regional aspects of labor markets, the modelling strategy should take account of the fact that regions of an economy may under or overperform over the long course of time as opposed to the plausible view applied to the economy as a whole, which after positive or negative shocks, given the standard assumptions, tends to return to equilibrium. From an empirical point of view persistent discrepancies between the performances of regional labor markets are documented by OECD (2005). Blanchard and Katz (1992) documented persistent labor market discrepancies in Massachusetts, pointing to rather inflexible wages. They find labor mobility to be the driving factor of erasing some discrepancies, however, labor mobility only occurs when the expected marginal gains are big enough. 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 skill-biased. From a different perspective, Epifani and Gancia (2005) show, in a framework based on new economic geography, 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. In the context of the Czech economy, Pauhofová and Stehlíková

(2018) show that the Czech regions which are more closely linked to Austria and richer parts of Germany permanently display overall lower rates of unemployment, and they draw a similar conclusion for Hungary and those regions which are economically connected with Austria and Slovenia. The reason is a much higher inflow of investment in these regions and better infrastructure. Rašovec and Vavřinová (2014) show that about 35% work force have attained a different educational level than required. They show that overeducation is more frequent, which is also supported by McGowan and Andrews (2015). According to Rašovec and Vavřinová (2014) roughly 10% of work force have higher literacy and numeracy skills than required by the employer and about 10% have lower level of these skills than required. The fact that regions may over or underperform over a long period of time is also indirectly supported by the persistently different price levels as shown in Kramulová et al. (2016).

The idea of this paper is to uncover possible structural problems via the employment of the search model of the labor market, more precisely the concept of the matching function, see Pissarides (2000). The application of the complete search model at a regional level is not conceptually implausible, as it is in case of the Phillips curve model, however, it would be a very daunting task given the variety of structural parameters which need to be calibrated or estimated.

On the other hand, the data published by the Ministry of Labour and Social Affairs (MLSA) is sufficient enough to set up a model focused on the examination of the matching process in the regional perspective. MLSA data is employed for reasons of comparability of the results with my other research into the regional labor markets.

The paper employs the concept of the matching function to estimate time-varying relationships between the unemployment and vacancy on one hand and newly occupied jobs on the other hand. The results of the model make it possible to evaluate the absolute value of this relationship, i.e. the matching efficiency, as well as its evolution over time. The set-up of the model is also made in the way to evaluate its cyclicality and some of the structural determinants of the matching process. The model is applied in the context of the Czech regional labor markets, however, the approach taken in the paper might be interesting to a larger number of economists.

From the perspective of the research focused on the Czech economy, the presented paper follows up on Galuščák and Munich (2007), Pedraza (2008) and Němec (2015).

Galuščák and Munich (2007) use regional data but with the aim to make a panel estimation, which might be explained by the relatively short series they had to use. The most interesting of their results is the procyclicality of the sensitivity

of the number of the newly employed to the stock of unemployed and the inflow of unemployed. Panel data is used also by Pedraza (2008) who focuses on the examination of the efficiency of the matching process with respect to other variables. He finds that the matching efficiency is positively influenced by the level of education of the labor force. Most recent and relevant paper by Němec (2015) also makes use of the MLSA data, however, as in the case of the already mentioned studies, he resorts to panel analysis. He finds that the matching efficiency is negatively influenced by the number of the unemployed of 50 years and older and by the number of the long-term unemployed.

The so-called matching efficiency has been subject of extensive international research some of which is also directly linked with the Czech economy.

Barnichon and Figura (2011; 2013) examine the matching process with respect to the composition effects. They distinguish two of them: the first one is related to the composition of the unemployment pool with respect to the duration of unemployment and the second one captures changes in the distribution of the unemployed across segments with different average matching efficiency. They show that the first effect, measured by the ratio of long-term unemployed, had a significant impact on the matching efficiency until 2006, while the second one came to be significant after this year. From Barnichon (2009) it may be deduced that, on average, it is an indirect impact of one of the two effects especially on the vacancy posting as job separation trends to play significant role in the evolution of unemployment only around the turning points.

Arpaia, Kiss and Turrini (2014) argue that the key drivers of the matching efficiency are the duration of unemployment and sectoral and skill mismatch. In the case of the Czech economy they conclude that there is a rising trend of the matching efficiency based on a declining trend of the skill mismatch throughout the sample and declining regional mismatch since 2008. Sectoral mismatch increased temporarily with the onset of the recession which began in 2008 and then between the years 2012 and 2013.

Vanhala, Bonthius and Jarvis (2013) and Bonthuis, Jarvis and Vanhala (2016) focus on the examination of the Beveridge curve of some of the euro economies. In the earlier paper they identify the share of young workers in the labor force as a factor with the potential to lower structural mismatch while they conclude that the share of older workers in the labor force as well as the shares of low-skilled workers and workers in construction, business and non-market services in the labor force as factors have the opposite potential. In the second study they conclude that only the share of construction in the employment may have permanent effects. They add another factor with a temporary negative effect which is home ownership rate, which may lower mobility in the labor market.

The concept of the Beveridge curve and structural shocks, however, represents a well-known problem and is also of significant importance for the choice of the modelling strategy of this paper. Diamond (2013) clearly discuss that changes in the matching efficiency don't need to have a structural nature. With respect to the concept of the Beveridge curve, in his response to a paper by Dickens (2008), Pissarides (2009) clearly explains why shifts in the Beveridge curve don't need to have structural origins. Therefore, the typical analysis based on the estimation of the Beveridge curve with the aim to identify its shifts to analyze cyclical and structural movements is rather flawed. For example, Hall and Schulhofer-Wohl (2015) show that while the decline in matching efficiency in the US since 2001 has long-term reasons it was not accompanied by an outward shift in the Beveridge curve. Last but not least the paper extends the analysis of Czech regional labor markets given by Pošta (2018) and Pošta and Hudeček (2017).

The paper is structured as follows: in the second section the theoretical relationship is introduced as well as the set-up of the empirical model, in the third section the data is presented, and in the fourth section the estimates and their analysis are given. Finally, the conclusion states the main results.

1. The Model

The matching function of the labor market transforms the available vacancies and unemployed into newly occupied jobs – matches. Let *ur*, *v*, m and *L* be unemployment rate, vacancy rate, matching rate and labor force, respectively. Then following loosely Pissarides (2000), the matching function may be established as follows:

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

The matching function is assumed to be homogeneous of degree one, however, no concrete form will be assumed, i.e. the Cobb-Douglas version. Given this assumption the transformation defined by (1) may be stated:

$$\frac{m}{ur} = f\left(\frac{v}{ur}\right) \tag{2}$$

The ratio of the vacancy rate and the unemployment rate is referred to as the labor market tightness and will be denoted as *lmt*. On the left side of (2) the ratio of the matching rate and the unemployment rate expresses the probability of finding a job, below it will be denoted as *pfj*.

The interpretation of (2) is straightforward. An increase in the vacancy rate and/or a decrease in the unemployment rate increases the labor market tightness

and thus the probability of finding a job. It is exactly the sensitivity of the probability of finding a job to the changes in the labor market tightness which is at the center of this analysis. Further on this sensitivity will be referred to as rigidity in the sense that higher level of the sensitivity parameter presents a lower level of rigidity of the matching process.

The rigidity presented in the transformation of the labor market tightness into the probability of finding a job depends on the structural features of the particular labor market. High level of rigidity may be interpreted as a sign of the presence of various factors which hinder the speed at which the unemployed meet the vacancies and create newly occupied jobs.

To evaluate the dynamics of the labor market rigidity, a basic state-space model based on the matching function (2) is set up:

$$pfj_t = \alpha_t * lmt_t + u_t \tag{3a}$$

$$\alpha_t = \beta * \alpha_{t-1} + v_t \tag{3b}$$

where u and v stand for the error terms of the signal equation and the state equation, respectively. The error terms are uncorrelated and follow normal distribution. From (3b) it follows that the measure of rigidity is assumed to be driven by AR(1) process. The variance of the error term of the signal equation, u, was estimated. The error term of the state equation was estimated the first time the model was run and held fixed for all other estimations given the respective region. The model is estimated with Kalman filtering approach.

The focus of the paper is centered on the augmented version of the state-space model, which is concerned with the factors of the measure of time-varying rigidity α. For this purpose the following version was applied:

$$pfj_t = \alpha_t * lmt_t + u_t \tag{4a}$$

$$\alpha_t = \beta * \alpha_{t-1} + \delta_1 * gdp_t + \delta_2 * age_t + \delta_3 * edu_t + v_t \tag{4b}$$

where *gdp* represents the growth rate of gross domestic product of the Czech economy, *age* stands for changes in the ratio of age group 50 – 64 to the labor force in the given region, and *edu* means changes in the ratio of the sum of people with basic, pre-primary and no education and people with secondary education without GCE to the labor force in the given region.

The age and education composition of the labor forced were found to be important explanatory factors behind the relationship between labor market tightness and probability of finding a job as show the studies analyzed above. The changes in the output of the Czech economy enters the equation to indirectly examine the regional mismatch of the Czech economy. Statistical significance of

this factor points to interlinkages between the region and the economy as a whole. Growth rates of trend GDP we also used as an alternative with very similar results.

Other alternatives were also used in the case of the education ratio. Excluding secondary education without GCE from the variable described above did not lead to any substantial changes in the estimates.

Second order autoregression in (3b) or (4b) proved insignificant as well as first order autoregression in (3a) or (4a).

The growth of GDP, the age and education ratios enter the state equation in lags. More precisely, the growth of GDP with a lag of three months, and the ratios with a lag of 9 months. The choice of lags was based on estimations of the state-space model and is economically justifiable as labor markets take time to adjust to changes in external conditions.

2. The Data

The necessary data were retrieved from the MLSA database and CZSO database (GDP, age groups and education levels of population). The number of unemployed is proxied by the number of candidates registered at labor offices by the end of the month. The number of vacancies is measured by the corresponding statistics published by the MLSA. The number of matches is proxied by the number of placed candidates in a given month.

It follows from (1) and (2) that it is not necessary to work with the labor force to arrive at the labor market tightness and the probability of finding a job. However, the tables below also contain information on the unemployment rate. This is no longer published by the MLSA so it was computed as the ratio of the registered candidates to the labor force. The data for the labor force come from the Labor Force Survey statistics, CZSO, which, however, comes at quarterly frequency. To obtain series at monthly frequency the quarterly series were interpolated using a second-degree polynomial.

The data runs generally from 2000 up to 2018. After accounting for losses of data due to its transformation the models are estimated on the sample that runs from November 2000 to December 2018. The estimates of time-varying rigidity as presented in the figures below run from the first half of 2013, allowing for convergence in all of the estimated models.

The data on age and educational structure of the population comes at yearly frequency. The ratios to labor force survey are based on the assumption that the data on age and education in absolute terms stay the same throughout the year. Its ratios to the labor force are, however, varying as the labor force obtained from the interpolation is varying.

The data presented in Table 1A and Table 1B was smoothed by Hoddrick-Prescott filter at lambda set to 100. This was carried out to ensure that they would be all convincingly nonstationary at their levels. Some series, especially of labor market tightness, seemed weakly stationary if left without this modification. After the filtering, all the data were nonstationary at levels and stationary at first differences. The data enter the model as stationary.

T a b l e 1

Statistical Properties of the Data

Region	Variable	Mean	St. Deviation	Jarque-Bera	Adf Level	Adf 1st Diff.
PRA	lmt	0.745	0.854	401.796***	0.659	−4.207***
PRA	pfj	0.085	0.020	40.158***	−1.892	−3.755***
STR	lmt	0.373	0.483	784.651***	3.806	−2.961**
STR	pfj	0.092	0.018	38.925***	−2.367	−3.575***
JIH	lmt	0.349	0.459	573.272***	1.301	−3.813***
JIH	pfj	0.114	0.023	6.798**	−2.230	−3.670***
PLZ	lmt	0.606	0.995	810.711***	1.320	−4.607***
PLZ	pfj	0.098	0.021	6.344**	−2.250	−3.525***
KAR	lmt	0.239	0.342	519.245***	−2.113	−2.937**
KAR	pfj	0.074	0.018	0.203	−2.23	−14.14***
UST	lmt	0.109	0.141	654.632***	2.243	−3.181**
UST	pfj	0.062	0.014	3.112	−1.481	−3.267**
LIB	lmt	0.257	0.275	434.142***	2.819	−4.666***
LIB	pfj	0.088	0.019	3.469	−2.486	−3.4295**
KRA	lmt	0.307	0.372	466.375***	0.667	−6.135***
KRA	pfj	0.100	0.023	7.197**	−2.571	−3.563***
PAR	lmt	0.581	1.081	782.166***	−1.387	−4.680***
PAR	pfj	0.102	0.027	25.273***	−2.427	−3.143**
VYS	lmt	0.221	0.271	463.823***	1.375	−4.585***
VYS	pfj	0.097	0.022	0.228	−2.060	−3.345**
JIM	lmt	0.177	0.204	320.686***	0.747	−4.586***
JIM	pfj	0.078	0.015	0.005	−2.454	−3.548***
OLO	lmt	0.169	0.199	401.390***	1.806	−4.682***
OLO	pfj	0.079	0.017	4.745*	−1.431	−3.899***
ZLI	lmt	0.223	0.297	616.928***	2.160	−3.062**
ZLI	pfj	0.085	0.020	10.412***	−2.110	−3.635***
MOR	lmt	0.107	0.114	202.873***	0.787	−4.899***
MOR	pfj	0.061	0.012	0.185	−2.360	−3.665***
CZE	lmt	0.265	0.353	629.794***	2.098	−4.161***
CZE	pfj	0.080	0.016	2.854	−2.279	−3.591***

Notes: Sample: 2000M01:2018M12. Variables: labor market tightness (lmt), 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.

Source: MLSA database, own estimates.

The model was estimated for all the fourteen NUTS regions and the Czech economy as a whole: 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), Vysočina region (VYS), Jihomoravský region (JIM), Olomoucký region (OLO), Zlínský region (ZLI), Moravskoslezský region (MOR) and Czech economy (CZE).

The descriptive statistics shows that the average labor market tightness of the Czech economy reached 26.5% while the average probability of finding a job was 8.0%. Relatively low levels of labor market tightness are found especially in the regions: Olomoucký (16.9%) and especially Moravskoslezský (10.7%) and Ústecký (10.9%). As far as the probability of finding a job is concerned, the lowest figures are found in the regions of Moravskoslezský, 6.1%, Ústecký, 6.2%, and Karlovarský, 7.4%.

A few further notes on the data used. The unemployment rate figures implicitly used in the analysis are higher than the typically presented because they come from the labor office statistics. While some might argue that they thus include a certain percentage of people who are registered but in fact have no intention of working or on the other hand are registered and have a labor income at the same time, it should be noted that the Labor Force Survey (LFS) statistics, due to its definition of unemployed person, counts as employed many underemployed. This comes as a result that the key aspect of the definition of an employed person from the point of view of the LFS is whether he or she worked at least one hour for remuneration during the reference week.

Since 2012 the employers are not obliged to report vacancies to local labor offices. Possible effects were evaluated by employing unit root test with a breakpoint to labor market tightness. While breakpoints were identified, more information will be given in the analysis of the results, they were not identified anywhere near this change in the reporting practices.

The dispersion of the ratio of age group 50 – 64 to the labor force is quite low among the regions, however, its evolution differs. For the economy as a whole the ratio has a clear tendency to decline since 2009. In six regions there is no clear tendency to decrease until 2015: Jihočeský region, Karlovarský region, region of Vysočina, Olomoucký region, Zlínský region and Moravskoslezský region. The development of the ratios of less skilled population to labor force paints a much clearer picture: there is a declining tendency visible in all of the regions including the economy as a whole.

3. The Results

Table 2a presents the augmented version summed up by equations (4a) and (4b), which include the growth rate of gross domestic product of the Czech economy and the age and education ratios as an explanatory variables in the state equation. The reaction of the rigidity of the labor market(s) to the movements of the economy as a whole captured by the growth of GDP was found significant on the level of the economy as a whole and in 10 other regions.

The results presented here show that the reaction of the regional labor markets to the movement of the whole economy in terms of GDP development is rather strong.

The sign of δ_1 shows that in the regions referred to above, higher GDP growths are on average associated with higher rigidity of the labor market (lower sensitivity of the probability of finding a job to the labor market tightness). The results say that in the periods of higher growth of the economy when labor market tightness typically increases as there more vacancies per unemployed the probability of finding a job decreases. In general, in the basic structure of the underlying search model the probability of finding a job is supposed to increase in such a situation. However, the underlying structure of the search model does not take account of, for example, regional and skill mismatch. The presence of both in the Czech Republic was outlined in the discussion above. The results thus point to the fact that in good economic times the skill mismatch is more pronounced and vacancies are getting harder to be filled. This would go against the results in Arpaia, Kiss and Turrini (2014) mentioned above, however, their analysis naturally does not include the period of the last expansion when the positive relationship between GDP growths and rigidity is very significant, see further below.

T a b l e 2a

State-space Estimates

Region	Obs	α	β	γ	δ_1	δ_2	δ_3
PRA	218	0.007**	0.957***	−13.499***	−0.016	0.074	−0.269**
STR	218	0.014**	0.994***	−13.922***	−0.661***	0.536**	−0.641***
JIH	218	0.028***	0.996***	−13.503***	−0.500***	0.210**	−0.669***
PLZ	218	0.011***	0.991***	−13.630***	−0.339***	0.353**	−0.295*
KAR	218	0.021***	0.994***	−14.061***	−0.401**	0.485	−0.719**
UST	218	0.069***	0.998***	−14.612***	−0.628*	0.555	−0.751*
LIB	218	0.017***	0.998***	−13.867***	−0.654***	0.733*	−0.222
KRA	218	0.017***	0.987***	−13.605***	−0.704***	0.381**	−0.054
PAR	218	0.013**	0.991***	−13.463***	−0.543***	0.950*	−0.273
VYS	218	0.014**	0.998***	−13.435***	−0.553**	0.9135*	0.219
JIM	218	0.017**	0.976***	−14.340***	−0.240	0.211	−0.629***
OLO	218	0.025**	0.997***	−14.244***	−0.399*	0.628	0.016
ZLI	218	0.020**	0.982***	−13.686***	−0.137	0.641	0.050
MOR	218	0.036***	0.966***	−14.318***	−0.309	0.341	−0.583
CZE	218	0.016***	0.981***	−14.009***	−0.646***	0.205	−0.567*

Notes: Sample 2000M11:2018M12. Coefficients alpha, beta, and delta 1-3 correspond to their description given above. Coefficient gamma relates to the error term of the signal equation (4a) estimated in form of exponential function. Evaluation of the null of the coefficient being zero is given with the estimates.

Source: Own estimates.

As the estimates given in Table 2a show, the ratio of age group 50 – 64 to the labor force in the given region plays a significant role in the determination of the rigidity in app. half of the sample. This ratio was found to be a significant factor

in case of 7 regions but not at the level of the whole economy. The decline of the ratio is associated with a decrease in the rigidity of the labor markets. This confirms the existing results referred to above for the whole economy in the environment of individual regional estimations.

T a b l e 2b

Autocorrelation of State-space Estimates Given in Table 2a. The Ljung-Box Q-statistics is computed as follows: $Q = T(T+2)\sum_{j=1}^{T}\frac{\tau_j^2}{T-J}$, where T is the number of observations, k is the lag, and τ is the autocorrelation

Region	Obs	lag 1	lag 2	lag 3
PRA	218	0.019	0.056	0.423
STR	218	0.028	0.062	0.066
JIH	218	0.003	0.035	0.057
PLZ	218	0.029	0.848	1.601
KAR	218	2.055	2.087	2.329
UST	218	0.015	0.181	0.191
LIB	218	0.005	0.025	0.632
KRA	218	0.006	0.008	0.418
PAR	218	0.037	0.043	0.054
VYS	218	0.046	0.098	0.098
JIM	218	0.067	0.077	0.941
OLO	218	0.006	0.018	0.032
ZLI	218	0.007	0.218	0.254
MOR	218	0.035	0.530	0.559
CZE	218	0.028	0.569	0.689

Notes: Lag 1 – 3 presents Ljung-Box statistics under the null of no autocorrelation in residuals. *, **, *** means rejection of the null at 10%, 5%, 1% level of statistical significance, respectively.

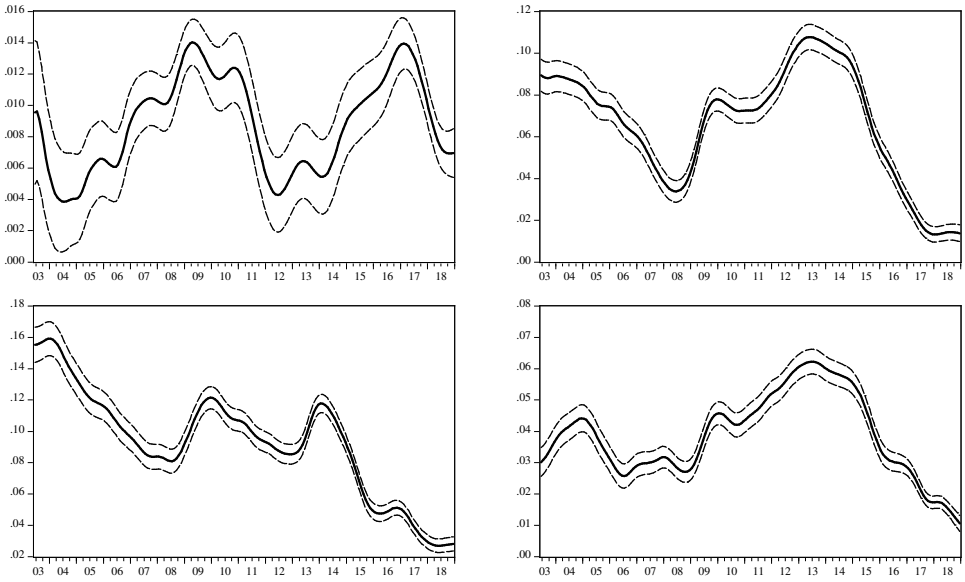
Source: Own estimates.

Similarly, the influence of the ratio of the sum of people with basic, preprimary and no education and people with secondary education without GCE to the labor force on the rigidity of the matching process is found to be statistically significant in 7 regions and in this case on the level of the whole economy as well. Given the discussion above it was expected that higher share of lower educated people in the labor force would increase the rigidity of the labor market, which was empirically confirmed. This relationship indirectly points to the question of skill mismatch mentioned above. A higher share of lower educated labor force tends to increase the mismatch and increase the rigidity of the labor market.

The estimates of β indicate that the dynamics of the rigidity shows a great deal of persistency. The estimates of α as presented in Table 2a represent the last estimated value of the rigidity of the labor market (sensitivity of the probability of finding a job to the labor market tightness). The dynamics of rigidity of the regional labor markets, in other words estimates of α for the whole sample, is presented in Figures 1 – 4.

F i g u r e 1

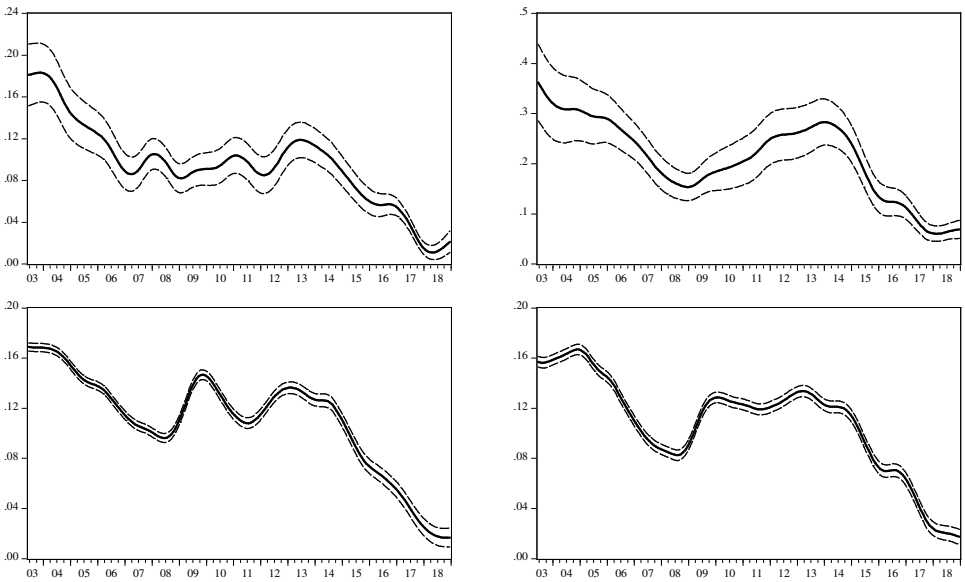
Estimate of Time-varying Rigidity for Prague and Středočeský Region (upper left and right) **and for Jihočeský and Plzeňský Region** (lower left and right). The bands present 95% confidence interval.



Source: Own estimates.

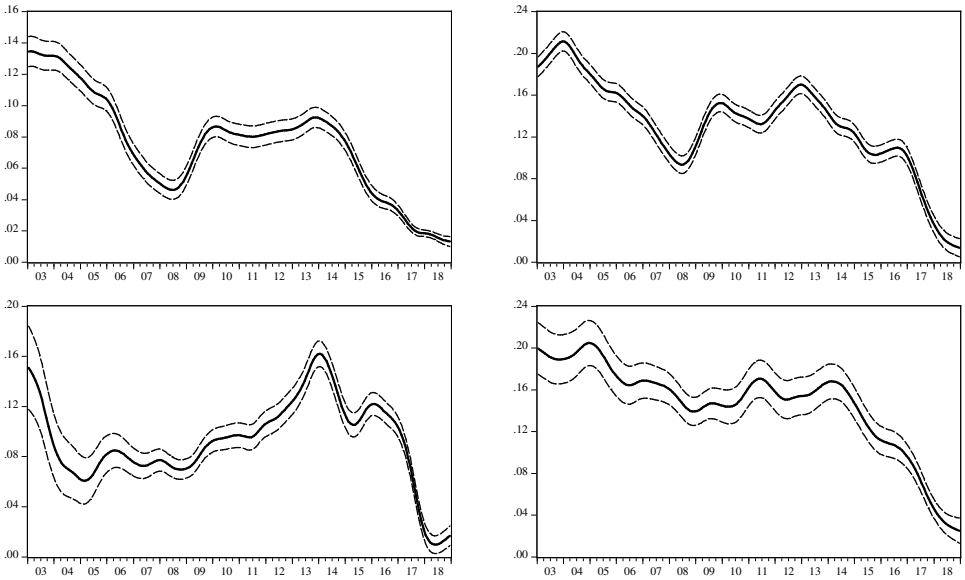
F i g u r e 2

Estimate of Time-varying Rigidity for Karlovarský and Ústecký Region (upper left and right) **and for Liberecký and Královéhradecký Region** (lower left and right). The bands present 95% confidence interval.



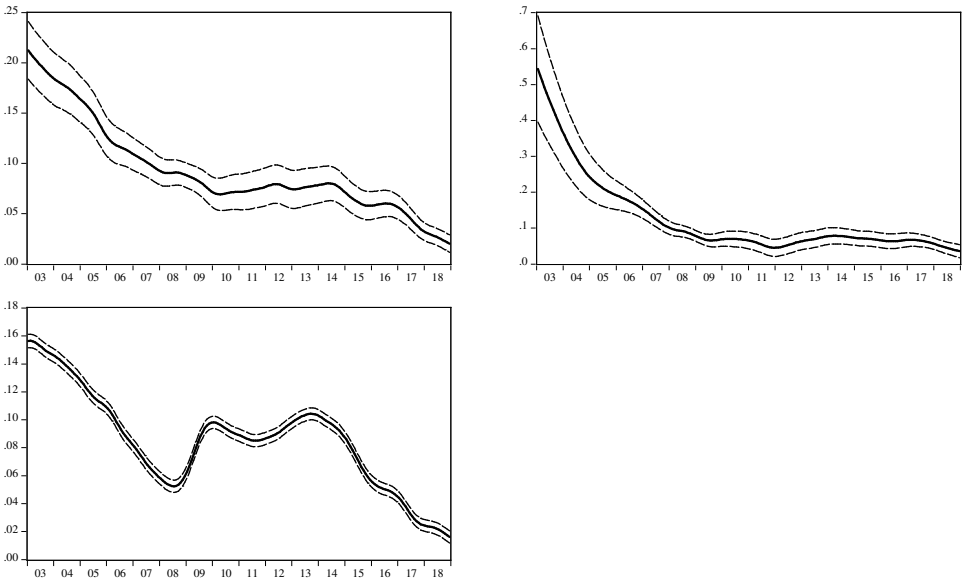
Source: Own estimates.

F i g u r e 3
Estimate of Time-varying Rigidity for Pardubický and Vysočina Region (upper left and right) **and for Jihomoravský and Olomoucký Region** (lower left and right). The bands present 95% confidence interval.



Source: Own estimates.

F i g u r e 4
Estimate of Time-varying Rigidity for Zlínský and Moravskoslezský Region (upper left and right) **and for the Czech Republic.** The bands present 95% confidence interval.



Source: Own estimates.

The rigidity of the labor market of the Czech Republic as a whole tends to increase in expansion and decrease in recession, which is observed in Figure 4. Most of the other regions follow this pattern as well. Most notable differences are: Moravskoslezský region with little reaction of rigidity whatsoever, Karlovarský, Zlínský and Olomoucký regions which on average show increasing rigidity over time and Ústecký region which shows prolonged periods of steady decrease and increase of the rigidity. Only Prague region shows that rigidity may decline with economic expansion.

The correlations between the estimated time-varying rigidities show that generally there is a very strong relationship between the Czech Republic and its regions, which means there the link in the development of the rigidity between those regions is also very strong. The correlation between the estimated time-varying rigidities of the Czech Republic and of the regions typically exceeds 85%. The exceptions are Středočeský region, Jihomoravský region and Moravskoslezský region with correlations between 70% and 85%. The relationship is very week as far as Plzeňský region and the Czech Republic are concerned. The evolution of the rigidity of the labor market in Prague region tends to move in the opposite direction when compared to the Czech Republic as whole with the correlation of –67%.

Using the Dickey-Fuller breakpoint unit root test, the series of time-varying rigidity of the labor market are found nonstationary, which may be deduced from the figures themselves, and, further, three groups of regions may be distinguished according to the identified breaks. In the Czech Republic, Prague region, Zlínský region and Liberecký region a break was identified in 2010 and in Moravskoslezský region in 2011. This means that the break is linked to the short period of time of a partial improvement of the economic activity after the Great recession. The second group of regions consists of Středočeský region, Plzeňský region and Karlovarský region where a break was identified in 2014. Which means that it is linked to the onset of the improvement of economic activity after the second recession that took place given the sample of the data. The third group consisting of the rest of the regions, almost half of the sample, saw a structural break in the evolution of the rigidity in 2016, which may be characterized as an onset of the advanced phase of the economic expansion.

Conclusions

The estimates of time-varying rigidity of the labor markets for the regions of the Czech Republic show that the rigidity capturing the (in)efficiency, of the matching process tends to increase with increases in economic activity. The results

hold for the Czech Republic as a whole and most of the regions with one clear exception which is Prague region.

The similarities between the economy as a whole on one side and the regions on the other side are confirmed by the typically strong correlations between the estimated time-varying rigidities. The only two exceptions are Plzeňský region with a very weak positive link to the economy as a whole and Prague region where the rigidity tends to move in the opposite direction when compared with the rest of the economy.

The possible impact of two structural variables, the ratio of age group 50 – 64 to the labor force and the ratio of the sum of people with basic, pre-primary and no education and people with secondary education without GCE to the labor force, on the rigidity of the labor market was tested. Both the variables proved significant in various cases with the latter having a statistically significant impact on the rigidity at the level of the whole economy as well.

The approach taken in the paper is applicable to other economies while the results are indeed specific to the case in question. The results show that the impact of the business cycle on the rigidity of the labor market is not straightforward as the underlying search model would indicate. The impact depends on the structural factors of the particular region, which broadly speaking, determine whether or not expansion or recession would pronounce problems with skill mismatch. This means that no a priori relationship netween these two variables should be expected.

The estimates confirm the presence of structural problems in the regions with generally weaker labor markets as those typically register increases in rigidity in a period of economic expansion. It shows that the policy aimed at mitigating the structural problems in those regions have not been generally successful as the estimates show that the rigidity remains high or increases despite the positive macroeconomic development of the economy in the last years.

References

ARPAIA, A. – KISS, A. – TURRINI, A. (2014): Is Unemployment Structural or Cyclical? Main Features of Job Matching in the EU after the Crisis. [Working Paper, No. 91.] Bonn: IZA. 52 pp. Available at: <https://ideas.repec.org/s/iza/izapps.html>.

BARNICHON, R. (2009): Vacancy Posting, Job Separation and Unemployment Fluctuations. Journal of Economic Dynamics and Control, *36*, No. 3, pp. 315 – 330.

BARNICHON, R. – FIGURA, A. (2011): What Drives Matching Efficiency? A Tale of Composition and Dispersion. [Working Paper, Finance and Economics Discussion Series 2011-10.] Washington: Board of Governors of the Federal Reserve System. 43 pp. Available at: <https://ideas.repec.org/s/fip/fedgfe.html>.

BARNICHON, R. – FIGURA, A. (2013): Labor Market Heterogeneity and the Aggregate Matching Function. [Working Paper, No. 727.] Barcelona: Graduate School of Economics. 40 pp. Available at: <https://ideas.repec.org/s/bge/wpaper.html>.

BASARAC, M. – SKRABIC, B. – SORIC, P. (2011): The Hybrid Phillips Curve: Empirical Evidence from Transition Economies. Finance a úvěr, *61*, No. 4, pp. 367 – 383.

BLANCHARD, O. J. – KATZ, L. F. (1992): Regional Evolutions. Brooking Papers on Economic Activity, *23*, No. 1, pp. 1 – 76.

BONTHIUS, B. – JARVIS, V. – VANHALA, J. (2016): Shifts in Euro Area Beveridge Curves and Their Determinants. IZA Journal of Labor Policy, *5*, No. 1, pp. 1 – 17.

DIAMOND, P. (2013): Cyclical Unemployment, Structural Unemployment. IMF Economic Review, *61*, No. 3, pp. 410 – 455.

DICKENS, W. T. (2008): A New Method to Estimate Time Variation in the NAIRU. [Working Paper, No. 53.] Boston: Federal Reserve Bank. 39 pp. Available at: <https://ideas.repec.org/s/fip/fedbcp.html>.

EPIFANI, P. – GANCIA, G. A. (2005): Trade, Migration and Regional Unemployment. Regional Science and Urban Economics, *36*, No. 6, pp. 625 – 644.

GALUŠČÁK, K. – MUNICH, D. (2007): Structural and Cyclical Unemployment: What Can Be Derived from the Matching Function? Finance a úvěr, *57*, No. 3 – 4, pp. 102 – 125.

GORDON, R. J. (1996): The Time-Varying NAIRU and Its Implications for Economic Policy. Journal of Economic Perspectives, *11*, No. 1, pp. 11 – 32.

HALL, R. E. – SCHULHOFER-WOHL, S. (2015): Measuring Job-Finding Rates and Matching Efficiency with Heterogeneous Jobseekers. [Working Paper, No. 20939.] Cambridge: NBER. 46 pp. Available at: <https://ideas.repec.org/s/nbr/nberwo.html>.

KRAMULOVÁ, J. – MUSIL, P. – ZEMAN, J. – MICHLOVÁ, R. (2016): Regional Price Levels in the Czech Republic – Past and Current Perspectives. Statistika, *96*, No. 3, pp. 22 – 34.

McGOWAN, M. A. – ANDREWS, D. (2015): Skill Mismatch and Public Policy in OECD Countries. [Working Paper, No. 1210.] Paris: OECD. 52 pp. Available at: <http://www.oecd.org/economy/growth/Skill-mismatch-and-public-policy-in-OECD-countries.pdf>.

MIHAILOV, A. – RUMLER, F. – SCHARLER, J. (2010): The Small Open Economy New Keynesian Philips Curve: Empirical Evidence and Implied Inflation Dynamics. Open Economies Review, *22*, No. 2, pp. 317 – 337.

NĚMEC, D. (2015): Measuring Inefficiency of the Czech Labour Market. Review of Economic Perspectives – Národohospodářský Obzor, *15*, No. 2, pp. 197 – 220.

OECD (2005): How Persistent are Regional Disparities in Employment? The Role of Geographic Mobility. [Chapter 2 of OECD Economic Outlook.] Paris: OECD. 51 pp. ISBN 92-64-01045-9. Available at: <https://www.oecd.org/els/emp/36780856.pdf>.

PAUHOFOVÁ, I. – STEHLÍKOVÁ, B. (2018): Identifying the Relationship between Unemployment and Wage Development in the Slovak Republic. Ekonomický časopis/Journal of Economics, *66*, No. 5, pp. 503 – 521.

PEDRAZA DE, P. (2008): Labour Market Matching Efficiency in the Czech Republic Transition. [Working Paper, No. 920.] Ann Arbor: William Davidson Institute. 48 pp. Available at: <https://deepblue.lib.umich.edu/bitstream/handle/2027.42/64357/wp920.pdf?sequence=1>.

PISSARIDES, C. A. (2000): Equilibrium Unemployment Theory. Cambridge, MA: MIT Press. ISBN 978-0-262-16187-9.

PISSARIDES, C. A. (2009): A New Method to Estimate Time Variation in the NAIRU – Comments. In: FUHRER, J., LITTLE, J. S., KODRZYCKI, Y. K., OlIVEI, G. and SAMUELSON, P. A. (eds): Understanding Inflation and the Inplications for Monetary Policy: A Phillips Curve Retrospective. Cambridge, MA: MIT Press, pp. 237 – 244.

POŠTA, V. (2015): Time-Varying NAIRU and Some of Its Determinants – A Semi-Structural Approach: Evidence from Eastern European Economies. Eastern European Economics, *53*, No. 2, pp. 149 – 165.

POŠTA, V. (2018): Interlinkages of the Czech Regional Labour Markets. Ekonomický časopis/ Journal of Economics, *66*, No. 4, pp. 350 – 366.

POŠTA, V. – HUDEČEK, T. (2017): Features of the Regional Labor Markets in the Czech Republic. Statistika, *65*, No. 2, pp. 36 – 69.

RAŠOVEC, T. – VAVŘINOVÁ, T. (2014): Skills and Educational Mismatch in the Czech Republic: Comparison of Different Approaches Applied on PIAAC Data. Statistika, *62*, No. 3, pp. 58 – 79.

SUEDEKUM, J. (2004): Selective Migration, Union Wage Setting and Unemployment Disparities in West Germany. International Economic Journal, *18*, No. 1, pp. 33 – 48.

VANHALA, J. – BONTHIUS, B. – JARVIS, V. (2013): What's going on behind the Euro Area Beveridge Curve(s)? [Working Paper, No. 1586.] Frankfurt: ECB. 48 p. Available at: <https://ideas.repec.org/s/ecb/ecbwps.html>.

VAŠÍČEK, B. (2011): Inflation Dynamics and the New Keynesian Phillips Curve in Four Central European Countries. Emerging Markets Finance and Trade, *47*, No. 5, pp. 71 – 100.