

ECONOMIC GROWTH AND UNEMPLOYMENT RATE OF THE TRANSITION COUNTRY - THE CASE OF THE CZECH REPUBLIC 1996-2009

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Introduction

In early 1960's, the economist Arthur Okun documented the negative correlation between the GDP growth and change in the unemployment rate. This relationship explains how the level of activity in the labor market affects the activity in the goods market during the business cycle. Number of empirical studies proved that this relation records persistency in results over the long-term period. This relationship is now called Okun's law and is cited in various macroeconomic textbooks. Students of macroeconomic courses learn that for every 1 percent excess of the natural unemployment rate, a 2-3% GDP gap is predicted. These estimations are based on empirical analysis from the data of US economy. These estimates are changing slightly through the time – they record a decline in a magnitude. For example, Okun, in his original article [6] predicted that each percentage point of real output growth above 4 percent was associated with a fall in the unemployment rate of 0.07 percentage point [5], while estimates based on data from more recent days show predicted 2% decrease in output for every 1% increase in unemployment [1]. Moreover, the relation in Okun's law embodies a high asymmetry - the short-run effects of positive cyclical unemployment are different from the negative effects [8]. The study of the Okun's law has been attracting many economists not only because of its robustness, but also because this rule together with the Phillips curve helps to model the aggregate supply curve.

Since 1989, the former Czechoslovakia and later the Czech Republic changed from a socialist country to the country based on democratic principles. The economy of the Czech Republic changed from the planned economy with full official employment to the western-type economy based

on the free-market principles. Now, the Czech Republic, as a member of the European Union, is based on the same principles as other west-European countries and the USA. Even though the regulations of free market are a bit stronger in the EU than in the USA, the basic relations between macroeconomic indicators have to be similar. Hence, the comparison of Okun's law estimates is the main objective of this analysis.

The main aim of this paper is to compare estimations and results for Okun's law relation coefficients of the Czech economy 1996-2009 with coefficients for economies of the US and France. These countries were chosen to compare the most discussed US economy with France as a representative of a western-European type of economy and the Czech Republic as a representative economy of a transition country. The analysis is based on two principles – the difference version and the dynamic version of the Okun's law. This paper is organized as follows: The next part is devoted to the explanation of relations between the economic growth and the unemployment rate. Data description and results of analysis are given in the third and fourth part, followed by the discussion, conclusion and the list of references.

1. Relations between the Economic Growth and the Unemployment Rate

The basic relationship between the economic growth and the unemployment rate is called Okun's law. The rule that links the increase in the economic growth with the decrease in the unemployment rate was introduced by Arthur M. Okun in his 1962 paper "Potential GNP: Its Measurement and Significance" [4]. From that time, "...Okun's law has been readily accepted as an

obvious regularity that did not require formal hypothesis testing..." [7]. In general, there are three main ways to interpret the Okun's law – the gap version, the difference version and the dynamic version.

The **gap version of the Okun's law** was originally derived from a production function [7]:

$$Y = T(KC)^\alpha (NH)^\beta \quad (1)$$

where Y represents the level of output, K is the capital input and C is its utilization rate. N and H represent number of workers and hours they work, T represents the technology factor, and α , β are input elasticities. For simplicity of the model usually $\alpha, \beta \in (0,1)$ and $\alpha + \beta = 1$, that assures declining the marginal product of capital and labor as well as the constant returns to scale. Potential output depends on the long-run sustainable values (indicated with "****"):

$$Y^* = T(K^*C^*)^\alpha (N^*H^*)^\beta \quad (2)$$

Natural logarithms of both sides of equations (1) and (2) lead to equations (3) and (4):

$$\ln Y = \ln T + \alpha \cdot \ln K + \alpha \cdot \ln C + \beta \ln N + \beta \ln H \quad (3)$$

$$\ln Y^* = \ln T + \alpha \cdot \ln K^* + \alpha \cdot \ln C^* + \beta \ln N^* + \beta \ln H^* \quad (4)$$

The output gap defined as $\ln Y - \ln Y^*$ can be derived as (5):

$$\ln Y - \ln Y^* = \alpha \cdot (\ln K - \ln K^*) + \alpha \cdot (\ln C - \ln C^*) + \beta (\ln N - \ln N^*) + \beta (\ln H - \ln H^*) \quad (5)$$

If L is a supply of workers, the unemployment rate is defined as (6):

$$u = \ln L - \ln N \quad (6)$$

with the natural rate u^* , representing equilibrium in the labor market (7):

$$u^* = \ln L^* - \ln N^* \quad (7)$$

After introducing (6) and (7) into (5) we receive a relation (8), which links the output gap to the unemployment gap:

$$\ln Y - \ln Y^* = \alpha \cdot (\ln K - \ln K^*) + \alpha \cdot (\ln C - \ln C^*) + \beta (\ln L - \ln L^*) - \beta (u - u^*) + \beta (\ln H - \ln H^*) \quad (8)$$

The coefficient ($-\beta$) linked with the unemployment rate gap $u - u^*$ is negative, thus one can expect the negative correlation between $\ln Y - \ln Y^*$, and $u - u^*$.

The equation that represents the Okun's law can be written as (9):

$$u - u^* = -\frac{1}{\beta} (\ln Y - \ln Y^*) + \Phi Z \quad (9)$$

where Z represents a vector of additional variables appropriate for the determination of the unemployment gap, ΦZ represents a function of such a variables.

Thus, there are several reasons why the output gap changes more rapidly than the unemployment gap. This disproportion can be caused by variations in working hours (variable H), and by the change in the total labor force available (variable L). Another reason comes from the capital side of the production function – variables C and K influences the expected relationship between the output and the unemployment rate.

It is difficult to estimate a model based on the equation (9) because values u^* and Y^* cannot be measured. Some economists compute the optimal level of the output and the unemployment rate using time series prediction (for example Villaverde and Maza, 2009 [11] used quadratic trend, the Hodrick-Prescott filter and the Baxter-King filter as detrending methods). However, to avoid problems with obtaining equilibrium values, the difference version of the Okun's law was introduced.

The **difference version of the Okun's law** relates changes in the unemployment rate to changes in the output as in the equation (10):

$$\Delta u = a + b \frac{\Delta Y}{Y} \quad (10)$$

This equation expresses the correlation between the output growth and movements in unemployment. The parameter b is expected to be negative and it is often called "Okun's coefficient". [5]

The ratio $\left(-\frac{a}{b}\right)$ gives the output growth rate

under a condition of the stable unemployment rate. Okun in his analyses used quarterly data with results $a=0.30$ and $b=-0.07$. From the Okun's law gap version derivation it is evident, that there are some variables missing. This led to the variation of Okun's original relationship. One of the variations is now widely used as so called dynamic version of the Okun's law.

The **dynamic version of Okun's law** relates the current change of the unemployment rate to

the current real output growth, past real output growth and past changes in the unemployment rate. For example, equation (11) expresses this relation with independent variables from period $t-1$; the relationship may cover more periods.

$$\Delta u_t = a + b \frac{\Delta Y_t}{Y_t} + c \frac{\Delta Y_{t-1}}{Y_{t-1}} + d \Delta u_{t-1} \quad (11)$$

The drawback of this relationship is in its not so simple interpretation as it was in the case of the gap and the difference version of Okun's law.

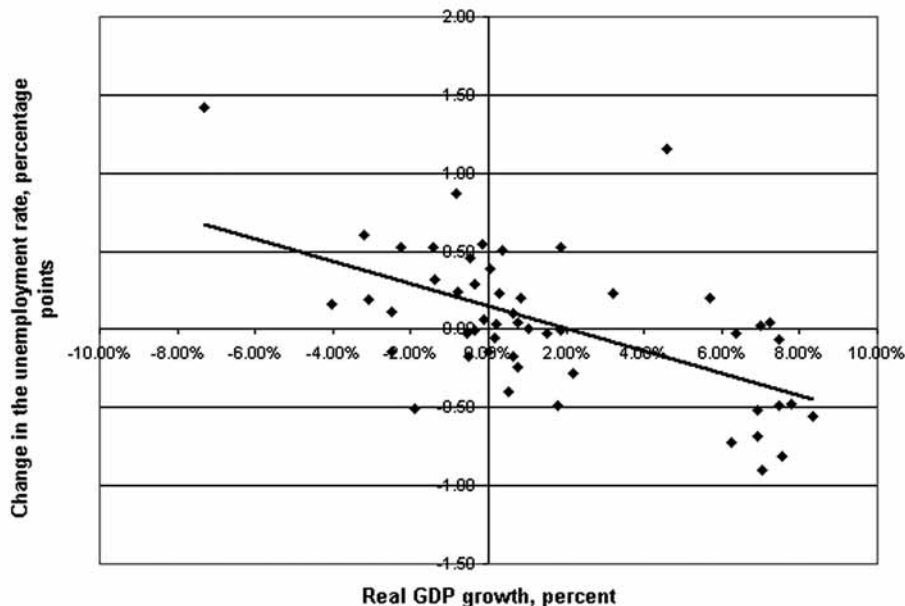
2. Data Description

Estimations for the case of the Czech Republic are based on the quarterly data of the unemployment rate and the real GDP for the period of II/1996-I/2009. Quarterly Czech macroeconomic data are available at the official site of the Czech Statistical Office (www.czso.cz). For illustration, the scatter plot of the data used in this analysis is given in Figure 1.

Estimations of Okun's law coefficients for the case of France were based on the quarterly data for the same period as in the case of the Czech Republic – the period II/1996-I/2009. Data are available at the official site of the National Institute of Statistic and Economic Studies (Institut national de la statistique et des études économiques, URL: <http://www.insee.fr>). For illustration, the scatter plot of change in the unemployment rate and the real GDP growth is given in Figure 2.

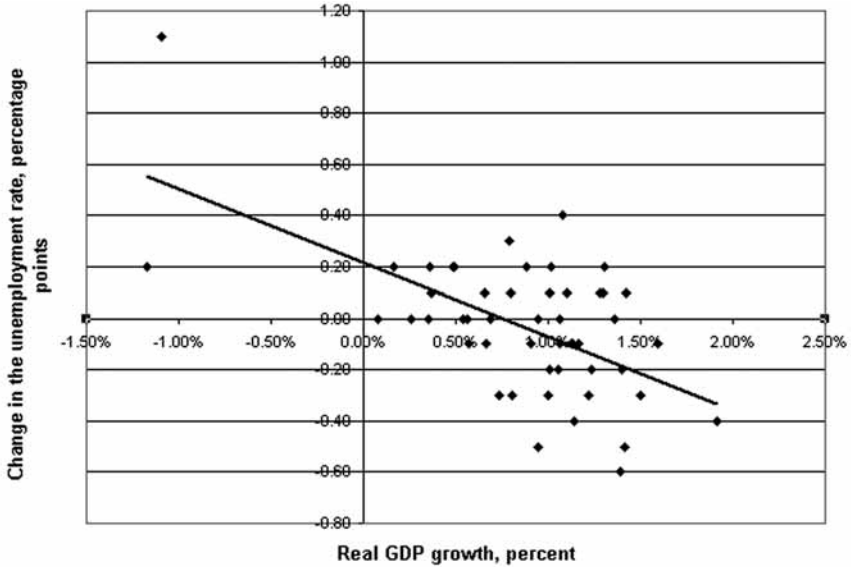
The data of the US unemployment rate are available at the official site of the Bureau of Labor Statistics (URL: <http://stats.bls.gov>); data of the US GDP were obtained from the official site of Bureau of Economic Analysis (URL: <http://www.bea.gov>). The time series used in this analysis are the same length as data series from the Czech Republic and France. The estimations were done for the period between the second quarter of 1996 and the first quarter of 2009. For illustration, the scatter plot of change in the unemployment rate and the GDP growth is given in Figure 3.

Fig. 1: Scatter plot of Czech quarterly data of change in the unemployment rate and the real GDP growth for the period between the second quarter of 1996 and the first quarter of 2009



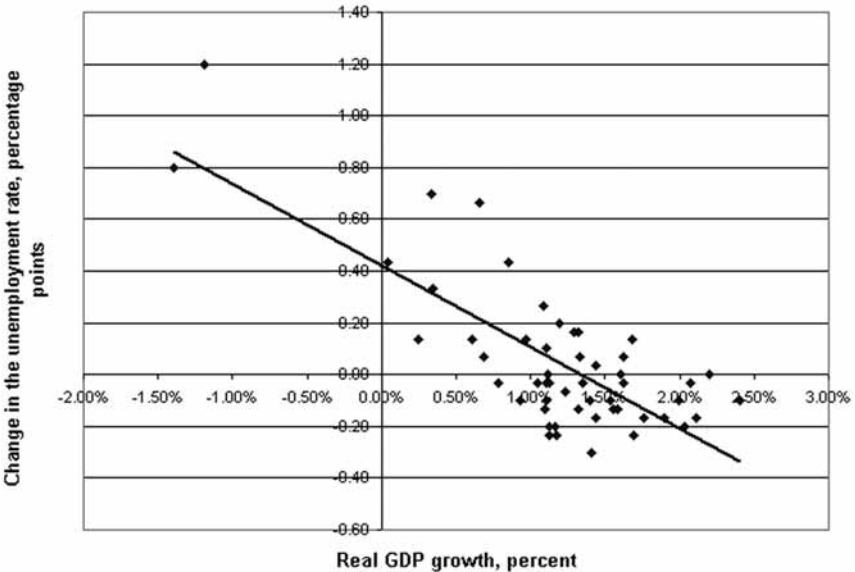
Source: [9] [10].

Fig. 2: Scatter plot of French quarterly data of change in the unemployment rate and the industrial production index growth for the period between the second quarter of 1996 and the first quarter of 2009



Source: [3].

Fig. 3: Scatter plot of the US quarterly data of change in the unemployment rate and the real GDP growth for the period between second quarter of 1996 and the first quarter of 2009



Source: [9], [10].

3. Results and Discussion

The aim of this paper is to use common econometric tools to estimate coefficients of Okun's law equation for the case of the Czech Republic, France and the USA. The first model – the difference version of Okun's law has a form of the estimation equation (12):

$$\Delta u = \hat{a} + \hat{b} \frac{\Delta Y}{Y} + \varepsilon \quad (12)$$

Where \hat{a} and \hat{b} are estimated coefficients with ε as vector of residuals.

Results of the ordinary least squares estimation, together with values of R^2 , Durbin-Watson statistics, and t-values together with the significance level (P-value) for estimated coefficient \hat{b} are given in Table 1. The results of t-statistics and the respective significance levels show that all estimated coefficients \hat{b} are statistically significant. Moreover, estimated values of Okun's coefficient \hat{b} are negative for all three countries. This result corresponds to expectations of a negative influence of the output change on the unemployment rate change.

For the case of the Czech Republic, the relationship expresses, that each increase of the GDP by approximately 12 % causes the decrease in the unemployment rate by 1 percentage point. These numbers are different for France and the USA; the 1 percentage point decrease in the unemployment rate is bound with 2.7% increase of the real GDP in France and with 1.8% increase of the real GDP

in the USA for the same time period. Moreover, the output growth rate under a condition of the stable unemployment rate for the case of the Czech Republic is the highest of all three countries – it is 2.1, while in France and in the USA the estimated increases are equal to 0.76 and 1.34, respectively.

Even though the computed results for the case of the Czech Republic are consistent with the Okun's law, the value of Durbin-Watson statistic reveals a problem with autocorrelation of residuals. These problems are not present in estimations based on the French and US data. Hence, to avoid problems with autocorrelation in residuals, the model was recalculated using Prais-Winsten estimation method. Results of this estimation procedure are given in Table 2.

In the re-estimated model, there are no more problems with autocorrelation of residuals, and the value R^2 indicates that more than 59 % of the variation in the unemployment rate can be explained by the model. The estimation results express that the 1 percentage point decrease in the unemployment rate is bound with 10.1% increase of the real GDP. The output growth rate under a condition of the stable unemployment rate for the case of the Czech Republic is 2.4 %.

The estimated Okun's coefficient is very small in the case of the Czech Republic comparing to that of France and the USA. The value of the Okun's coefficient has the influence on the output growth rate under a condition of the stable unemployment rate as well as on the percentage increase in the real GDP causing one percentage point decrease in the unemployment rate. The

Tab. 1: Results of OLS estimations for the difference version of Okun's law for the case of the Czech Republic, France and the USA

	\hat{a}	\hat{b}	t statistics	P-value	R^2	Durbin-Watson	$\left(-\frac{a}{b}\right)$
Czech Republic	0.152	-0.072	-4.908	1.02E-05	0.325	0.816	2.1
France	0.216	-0.286	-5.168	4.15E-06	0.348	1.735	0.76
USA	0.421	-0.315	-8.515	2.68E-11	0.592	1.833	1.34

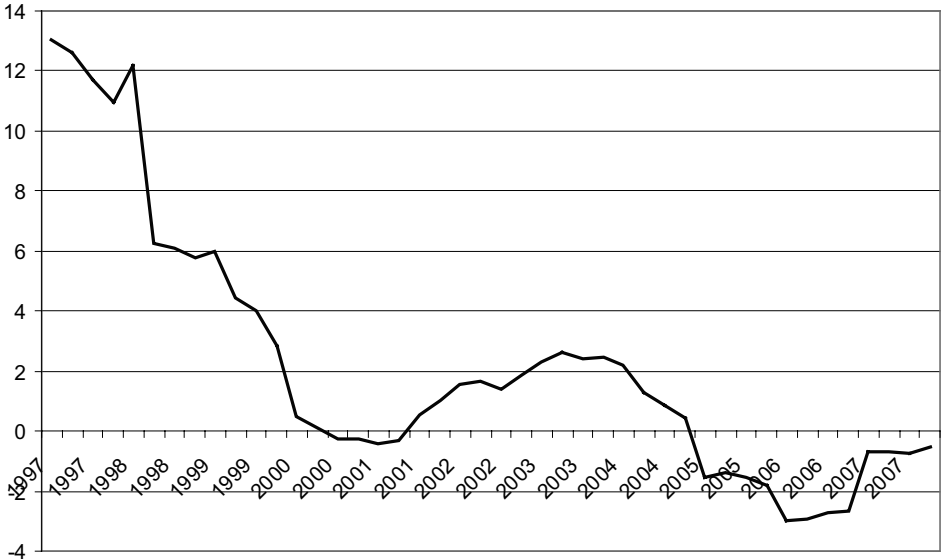
Source: own computations

Tab. 2: Results of Prais-Winsten estimations for the difference version of Okun's law for the case of the Czech Republic

	\hat{a}	\hat{b}	t statistics	P-value	R^2	Durbin-Watson
Czech Republic	0.192	-0.08	-8.476	3.08E-11	0.594	2.079

Source: own computations

Fig. 4: The Czech GDP growth rate under a condition of the stable unemployment rate

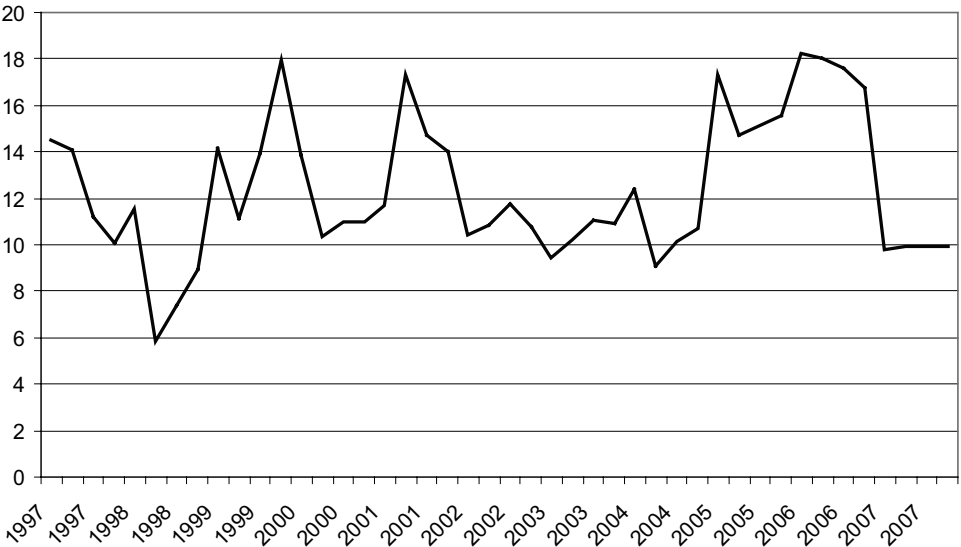


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question is, if there is some change in Okun's coefficients over time such that the correlation between these macroeconomic indicators app-

roaches values of the developed countries of the western type (in this case France and the USA).

Fig. 5: Time series of the percentage increase in the real GDP causing one percentage point decrease in the unemployment rate



Source: own computations

In general, the estimation of Okun's relationship does not cover time variation in coefficients. To capture the variation, Knotek [5] proposed the technique of so-called "rolling regressions". A rolling regression estimates a particular relationship over many different moving sample periods; if the relationship is stable over time, then the estimated coefficients should be similar over time.

Estimations of rolling regressions for the Czech data were done using data from the moving periods of the length 12 (3 years). Originally, the proposed algorithm was used on the length of period 52; however, the small amount of data did not allow much a longer moving period. The estimated regressions' coefficients served as basic data to compute moving values of the output growth rate under a condition of the stable unemployment rate, as illustrated in Figure 4. Moreover, they were used to compute values of a percentage increase in the real GDP causing one percentage point decrease in the unemployment rate, as presented in Figure 5.

Estimated values of the GDP under a condition of the stable unemployment rate indicate the decreasing trend; this trend might be caused by continuing transformation of industries. Another reason can be in quite high overemployment at the beginning of the studied period (1996-1998) followed by a period of high increase in the unemployment rate (1998-2000). Thus, the expected stable unemployment rate at the beginning of the period significantly exceeds the stable stay of the unemployment rate. The interesting point is that the real GDP would be under the stable unemployment rate negative for the period of 2005-2007. This relation indicates that the existing GDP growth during the period was due to the decreasing unemployment rate. This relation indicates that the Czech economy was in a bad condition.

The second chart, given in Figure 5, shows how much the real GDP increases when the

unemployment rate decreases by one percentage point. Average values for the US economy are about 2-3 % over a long time period. Values computed for the same period for the economy of the USA and France are 1.8 % and 2.7 %, respectively. For the same time period, this number is 10.1 % for the Czech Republic. The interesting point is that this value is not decreasing in time, as illustrated in the Figure 5. Values are varying from 6 % to 18 % and the trend is slightly increasing.

All above estimations were done using the difference version of the Okun's law. The dynamic version of Okun's law expects estimation of the equation (13) for first-order lags in the unemployment rate change and the real GDP growth:

$$\Delta u_t = \hat{a} + \hat{b} \frac{\Delta Y_t}{Y_t} + \hat{c} \frac{\Delta Y_{t-1}}{Y_{t-1}} + \hat{d} \Delta u_{t-1} + \varepsilon \quad (13)$$

Results of this model estimation for the data from the Czech Republic, France and the USA are given in Table 3. All coefficients are statistically significant at 5% level of significance with one exception; the coefficient \hat{d} for the French data is not statistically significant. Coefficients associated with Okun's coefficient in the difference model – coefficients \hat{c} and \hat{b} – are negative with one exception – estimated coefficient for the Czech data is positive. The dynamic model in general explains more of data variation (value of R^2 is higher than in the difference model).

Economic explanation of the dynamic model is not so straightforward than those of the difference model. Adding lagged variables into estimation of relationship between the unemployment rate and the GDP growth allows omitting other variables that influence the outcome or the unemployment rate.

Tab. 3: Results of estimations for the dynamic version of Okun's law for the case of the Czech Republic, France and the USA

	\hat{a}	\hat{b}	\hat{c}	\hat{d}	R^2	Durbin-Watson
Czech Republic	0.081	-0.086	0.043	0.608	0.566	2.196
France	0.289	-0.182	-0.174	0.189	0.463	2.210
USA	0.463	-0.201	-0.152	0.273	0.775	2.310

Source: own computations

Conclusion

The basic relationship between the economic growth and the unemployment rate – the Okun's law – usually explains how much the change of the GDP invokes the change in the unemployment rate. This relationship has been studied since 1960's: the empirical evidence revealed that in the case of the US economy, for every one percent excess of the natural unemployment rate, a 2-3% GDP gap is predicted.

The main aim of this study was to estimate the same relationship for the Czech data set and to compare estimated values with estimations on data from developed western-type countries. The comparisons were done for two developed countries, the USA and France. For all three countries, the same time period – the period between the second quarter of 1996 and the first quarter of 2009 – was chosen.

Estimations of difference version of Okun's law coefficients show the persistence of the basic rule – the GDP growth causes the unemployment decrease. However, the difference between estimations done on Czech data and other two countries indicate a much higher ratio of the GDP change to the unemployment rate change. The time changes in coefficients reveal the decreasing trend of the Czech GDP growth rate under a condition of the stable unemployment rate. The ratio of the GDP-change to the unemployment rate change has increased during the studied period. Estimations of the dynamic version of Okun's law have shown the same tendencies in the Czech Republic as in other two countries.

The shortcoming of this analysis is in the length of the Czech data sets. The Czech Republic has been existing since 1993, possible data sets cover only 16 years; moreover, the country was in the phase of transition to western-type free-market economy country, thus the estimated behavior differs from long term values.

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Key Words: Okun's law, GDP growth, unemployment rate.

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