THE REAL CONVERGENCE OF SELECTED COUNTRIES TO THE EURO ZONE AVERAGE ECONOMIC LEVEL

Jana Kovářová, Monika Šulganová

Abstract: *The convergence of the economic level occurs when a converging country approaches to the economic level of another country, respectively group of countries. This process is generally known as the catching - up and it is mostly measured via the gross domestic product per capita. The aim of this paper is to research the convergence/divergence of the Euro zone countries and the Czech Republic to the average economic level of the Euro area. The determined goal is solved helped by a panel data analysis.*

Keywords: *Convergence of economic level, The Czech Republic, The Euro zone, Panel regression, Spatial point of view.*

JEL Classification: *C23, O52, O57.*

Introduction

Upon entry into the European Union on 1 May 2004 the Czech Republic (CR) committed to join the European Economic and Monetary Union (Euro area, Euro zone, EA17)[11], i. e. country undertook an aim to move to a higher degree of economic integration. However the date of this step is not exactly defined and is restricted to the fulfillment of the Maastricht convergence criteria. Many authors include the achievement of the convergence criteria in the nominal convergence, see e. g. Vintrová and Ždárek [9]. Studies thematically focused on the topic of convergence pointed to a fact that the nominal convergence of economies is not sufficient for the entry to the monetary area. Therefore there is a need to examine the real convergence (respectively the convergence of the economic level).

This paper is focused on the convergence of the economic level of the EA17 countries and the Czech Republic to the average economic level of the Euro zone. The aim of this paper is to determine whether there was a beta convergence or beta divergence to the average euro area economic level, both for the individual countries of EA17 and the Czech Republic. Panel regression analysis is a tool used to meet the determined objective.

1 Theoretical background of convergence

The term convergence intuitively means that difference between two variables (or among more variables) declines and converges to the zero value [7]. Then the real convergence (divergence) determines whether the economic level of a country or a group of countries converges to (diverges from) the economic level of other country

[11] 17 countries of the European Union are the members of the Euro area: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain.

respectively, group of countries. The most often used indicator for researching the real convergence is the gross domestic product per capita in the purchasing power parity (GDP p. c. in PPP). Furthermore the real convergence can be understood as a structural convergence or catching up in technology level [7]. In this paper the real convergence is understood as a decrease of differences between the economic levels, i. e. the convergence of economic level.

The article is focused on the popular concept of the absolute (unconditional) beta convergence. It assumes that the poorer countries or countries with lower income per capita grow faster than wealthier countries (and this growth is not caused by the various conditions of economies). This concept also works with the assumption that economies converge to the common stable state. On the other hand the concept of relative (conditional) convergence rejected the postulate of the common stable state for all economies because of possibility that country with a higher income per capita can grow faster than the country with the lower one. This can be caused by different levels of important economic fundamental variables such as savings rate or government policies [7].

The nominal convergence is a process when the differences of nominal variables such as prices or wages are reduced between the economies [1]. As above mentioned the nominal convergence can be understand also as a fulfillment of the Maastricht convergence criteria, which are composed of the fiscal criteria (public deficit, public debt), followed by monetary criteria (price stability, exchange rate stability and stability of long-term nominal interest rates). The convergence criteria are legally entrenched in article 140 of the Treaty on Functioning of The European Union and also in the Protocols attached to the Treaty on European Union and the Treaty on the Functioning of the European Union as amended by the Lisbon Treaty.

Between the nominal and real convergence a mutual relation exists. The position of individual authors towards this relationship is not uniform. Some understand the nominal and real convergence as mutually supporting processes and so that the fulfillment of the criteria of the nominal convergence helps the stability of macroeconomic environment and thereby promotes economic growth, see for example [3]. Other authors (e. g. [6]) see them as rival processes where in a strict compliance with the fiscal and inflation criteria they see the possibility to constrain the economic growth.

2 Methods of evaluating the convergence

To analyze the convergence of economic level of the Czech Republic and Euro area member states the concept of unconditional beta convergence is used. The default relation used to research the beta convergence concept is the equation of Slavík [7]:

$$\frac{1}{T}\log\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha + \beta \log y_{i,0} + \varepsilon_i, \qquad (1)$$

where $y_{i,T}$ is the gross domestic product per capita at the end of the studied period, $y_{i,0}$ is GDP p. c. at the beginning of the period, T is the overall number of years for which

the analysis is provided, α is the level constant, β is the regression coefficient and ε_i is the random component. The left side of the regression equation is an average economic growth of the studied period, which depends on the initial level of product ($y_{i,0}$).

Following the adoption of the assumption that there are totally T of initial values, used regression equations can be modified as follows:

$$\log\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta \log y_{i,t-1} + \varepsilon_i, \tag{2}$$

where $y_{i,t}$ is the gross domestic product per capita in the year t, $y_{i,t-1}$ is the GDP p. c. in the year $t-1$, α is the level constant, β is the regression coefficient and ε_i is the random component. The left side of the regression equation is an inter - annual economic growth that is dependent on the previous product level ($y_{i,t-1}$).

2.1 Panel data model

Greene [2] generally distinguishes three basic panel data models. The first one is a *pooled regression model* which is used when the individual effect is only a unit vector; i. e. the parameter α is a common constant. The second one is a *model with fixed effects* (Fixed Effects Model – FEM). It is characterized by the fact that individual effects are unobservable but correlated with the explanatory variables, in the model there is a specific constant α_i for each cross-sectional unit. The third one is a model with random effects (Random Effects Model – REM), which differs from the previous one in the fact that individual effects are both unobservable and uncorrelated with the explanatory variables.

In order to evaluate the convergence, from the spatial point of view, the model expressed by the equation (2) is modified in the following way:

$$\log\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta \log y_{i,t-1} + \delta D_i + \varepsilon_i, \tag{3}$$

where the symbolism is equivalent to the one used in the equation (2) and δD_i represents the cross-sectional effects.

The model can be estimated in two basic ways. The first one is that the model can be estimated as a regression model without a level constant. In the second method there is one cross-sectional unit chosen as a basic and its value then represents the absolute member of the model and only n-1 dummy variables are used for the re – estimation [4].

The second way is chosen to explore the real convergence. The selected cross-sectional unit is the Euro area average economic level. The resulting spatial effects for individual countries EA17 and the CR can be then obtained using the following equation [4]:

$$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \alpha_1 + \begin{bmatrix} 0 & \cdots & 0 \\ i & & 0 \\ \vdots & & \vdots \\ 0 & \cdots & i \end{bmatrix} \begin{bmatrix} \alpha_2 - \alpha_1 \\ \alpha_3 - \alpha_1 \\ \vdots \\ \alpha_n - \alpha_1 \end{bmatrix} + \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \beta + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{bmatrix}, \quad (4)$$

3 Analysis of the convergence of the economic level

3.1 Identification of input data

First, there is a description of the data base and subsequently, a graphical analysis of input data is performed. Via this the basic assumptions of convergence or divergence of studied Euro area economies and the Czech Republic are adopted. The studied time period covers the years 1995-2010. The selected indicator of economic level is a gross domestic product per capita in purchasing power parity (PPP). Data are obtained as the absolute values from the database of the World Bank [10]. For the purposes of the graphical analysis the input data are adjusted to reflect the relative value of GDP per capita in PPP to the average Euro area value of GDP p. c. in PPP. The calculated relative values are captured in the Tab. 1

Tab. 1: Share of GDP per capita in PPP of the EA17 countries and the Czech Republic to the average Euro area level in the years 1995 – 2010

country/year	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Austria	123	123	121	120	120	118	117	116	115	115	114	113	113	114	116	117
Belgium	119	118	118	115	114	113	112	111	110	110	109	108	106	106	108	109
Cyprus	90	88	86	86	85	85	86	85	84	84	83	82	82	84	86	86
Estonia	35	36	39	40	39	41	44	47	50	52	56	60	62	59	54	55
Finland	98	99	101	102	101	102	102	102	103	104	104	105	106	106	103	105
France	113	111	109	108	107	105	105	103	102	101	100	98	97	96	98	98
Germany	124	122	119	117	115	113	112	110	109	107	105	106	105	107	108	110
Greece	79	78	78	77	76	76	77	78	82	83	82	84	83	82	84	80
Ireland	96	101	107	111	116	121	123	127	129	129	131	130	130	123	120	117
Italy	113	112	109	107	104	103	103	102	100	98	95	94	91	89	89	88
Luxembourg	216	212	213	216	222	228	226	229	227	228	231	231	234	232	228	228
Malta	75	76	76	77	77	77	73	73	72	70	71	70	70	73	74	76
Netherlands	127	128	128	127	127	126	125	122	120	120	119	119	119	120	122	122
Portugal	78	79	79	80	79	79	78	77	75	74	72	71	69	69	72	72
Slovakia	48	50	51	51	49	47	48	50	51	53	55	57	61	64	65	67
Slovenia	71	72	73	73	74	74	74	76	77	78	80	81	83	86	83	83
Spain	94	94	94	94	94	94	94	94	94	93	93	92	90	89	91	89
Czech Republic	70	71	68	65	63	63	64	64	65	67	69	71	72	73	74	75

Source: [10], self –elaboration.

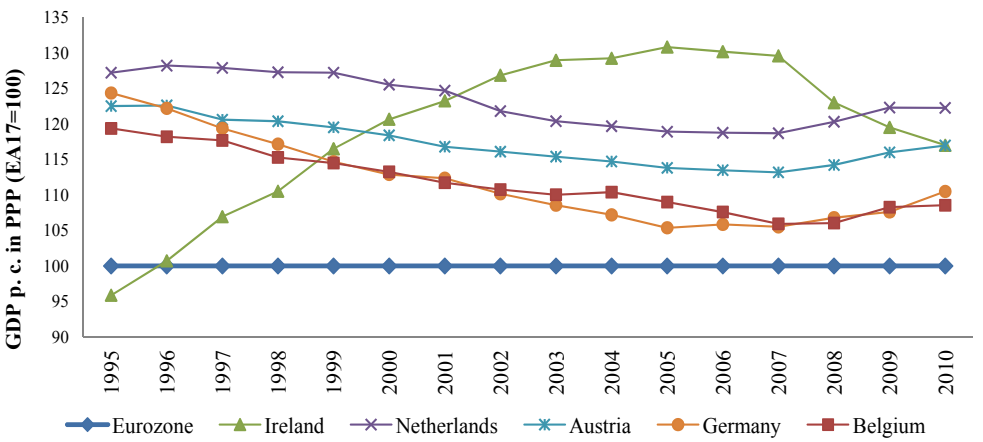
The table indicates that countries like Estonia, Slovakia, Slovenia or Czech Republic, which achieved low initial values of GDP p.c. grow faster. While countries showing high values of economic level, such as Netherlands or Austria, grow more slowly.

3.2 Graphical analysis

The graphical analysis shows the economic development of the selected countries (EA17 and CR) in the observed time period of 1995 – 2010. The analysis includes economies that achieved the lowest and highest initial level of GDP p.c. in PPP at the beginning of studied time period (1995).

In Fig. 1 trends in the development of GDP p.c. in PPP of the chosen "old" countries of the Euro area are observed. An interesting trend is noticeable in Ireland which in almost whole observed period registered strong economic growth. Country diverged from the average Euro area economic level until 2007 when its economic level noted a relatively significant decline. This caused the turn of the trend and country approached to the Euro zone again (convergence from above)[12]. In 1995 countries like Germany, Austria and Netherlands reached initial level of GDP p.c. in the range of about 120 -130 % of Euro area level. By 2010 these countries approached to the average of the Euro zone so we can assume that their economic growth was slower compared to the Euro zone (this trend was the most significant in Germany and Belgium).

Fig. 1: Graphical analysis of selected "old" member states

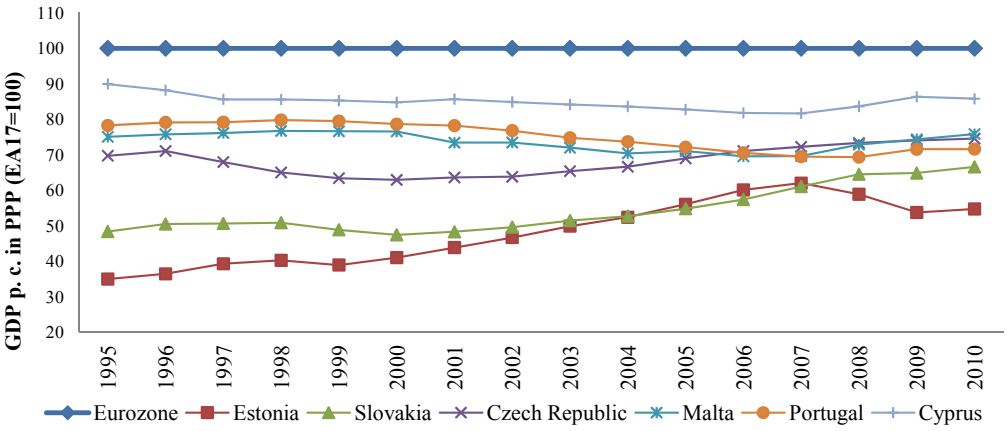


Source: [10], self – elaboration.

Fig. 2 describes the level of GDP p.c. in the selected "new" member states of the Euro zone. Estonia and Slovakia had the lowest level of the GDP p.c. in PPP in the 1995; the graph shows that these two states converge in fastest way to the EA17 average. This trend is not so significant for Cyprus, Malta and the Czech Republic; it is due to the fact that these states had, in comparison to Slovakia and Estonia, higher initial economic level (in 1995).

[12] A possible cause of this development can be the World´ s financial and subsequent economic crisis which has significantly affected Ireland.

Fig. 2: Graphical analysis of selected "new" member states



Source: [10], self – elaboration.

3.3 Results of the regression model

The subject of an empirical analysis is the convergence/divergence of 18 selected countries to the average Euro area economic level. To examine a defined regression model the method of the least squares is used. At first the estimation with 19 dummy variables is made. As above mentioned, 19 dummy variables represent the Czech Republic, the Euro zone countries and the average Euro zone level. The latter is denoted as dummy variable D5 and is selected as the basic cross-sectional unit which is consequently used to calculate the final effects (convergence/divergence) of individual countries. The results of the first estimation are shown in Tab. 2.

Tab. 2: Overall results of the model with 19 dummy variables

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/12/12 Time: 17:48
Sample: 1996 2010
Periods included: 15
Cross-sections included: 19
Total panel (balanced) observations: 285

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.105711	0.012563	-8.414188	0.0000
D1	0.483585	0.056680	8.531851	0.0000
D2	0.480034	0.056425	8.507423	0.0000
D3	0.468772	0.054925	8.534695	0.0000
D4	0.461780	0.053704	8.598676	0.0000
D5	0.477667	0.055818	8.557508	0.0000
D6	0.455795	0.051683	8.818995	0.0000
D7	0.480728	0.055947	8.592515	0.0000
D8	0.475085	0.056004	8.483103	0.0000
D9	0.479383	0.056428	8.495485	0.0000
D10	0.467805	0.054594	8.568847	0.0000
D11	0.491405	0.056765	8.656862	0.0000
D12	0.470670	0.055830	8.430359	0.0000
D13	0.516340	0.060234	8.572211	0.0000
D14	0.463844	0.054142	8.567144	0.0000
D15	0.486093	0.056955	8.534694	0.0000
D16	0.462068	0.054273	8.513790	0.0000
D17	0.457885	0.052373	8.742849	0.0000
D18	0.469857	0.054391	8.638448	0.0000
D19	0.472689	0.055412	8.530424	0.0000

R-squared	0.296607	Mean dependent var	0.009433
Adjusted R-squared	0.246175	S.D. dependent var	0.014070
S.E. of regression	0.012216	Akaike info criterion	-5.904499
Sum squared resid	0.039548	Schwarz criterion	-5.648184
Log likelihood	861.3912	Hannan-Quinn criter.	-5.801749
Durbin-Watson stat	1.446846		

Source: Calculations in EViews 7.

The next step is to re - estimate the model without basic cross-sectional unit. The results are presented in Tab. 3.

Tab. 3: Overall results of the model with 18 dummy variables

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/12/12 Time: 17:59
Sample: 1996 2010
Periods included: 15
Cross-sections included: 18
Total panel (balanced) observations: 270

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.105160	0.012953	-8.118668	0.0000
D1	0.481102	0.058434	8.233315	0.0000
D2	0.477563	0.058171	8.209625	0.0000
D3	0.466366	0.056625	8.236107	0.0000
D4	0.459428	0.055365	8.298194	0.0000
D6	0.453532	0.053282	8.511951	0.0000
D7	0.478277	0.057678	8.292172	0.0000
D8	0.472632	0.057736	8.186043	0.0000
D9	0.476912	0.058174	8.198045	0.0000
D10	0.465414	0.056283	8.269241	0.0000
D11	0.488919	0.058521	8.354573	0.0000
D12	0.468224	0.057558	8.134885	0.0000
D13	0.513701	0.062098	8.272404	0.0000
D14	0.461473	0.055817	8.267599	0.0000
D15	0.483598	0.058717	8.236068	0.0000
D16	0.459691	0.055952	8.215843	0.0000
D17	0.455592	0.053992	8.438072	0.0000
D18	0.467475	0.056074	8.336758	0.0000
D19	0.470262	0.057126	8.231955	0.0000

R-squared	0.296553	Mean dependent var	0.009471
Adjusted R-squared	0.246107	S.D. dependent var	0.014244
S.E. of regression	0.012368	Akaike info criterion	-5.879678
Sum squared resid	0.038393	Schwarz criterion	-5.626456
Log likelihood	812.7565	Hannan-Quinn criter.	-5.777995
Durbin-Watson stat	1.438980		

Source: Calculations in EViews 7.

Final effects for the Euro zone countries and the Czech Republic are calculated according to the equation (4). The effect of basic cross-sectional unit (D5 dummy variable in Tab. 3) is subtracted from effects for individual countries (dummy variables in Tab. 4). The results of these calculations are presented in Tab. 4.

Tab. 4: Final effects of the selected countries

Country	Dummy	Effect δD_i	Significance
Austria	D_1	0,003435	0,000
Belgium	D_2	-0,000104	0,000
Cyprus	D_3	-0,011301	0,000
Estonia	D_6	-0,024135	0,000
Finland	D_7	-0,000600	0,000
France	D_8	-0,005035	0,000
Germany	D_9	-0,000755	0,000
Greece	D_{10}	-0,012253	0,000
Ireland	D_{11}	0,011252	0,000
Italy	D_{12}	-0,009443	0,000
Luxembourg	D_{13}	0,036034	0,000
Malta	D_{14}	-0,016194	0,000
Netherlands	D_{15}	0,005931	0,000
Portugal	D_{16}	-0,017976	0,000
Slovakia	D_{17}	-0,022075	0,000
Slovenia	D_{18}	-0,010192	0,000
Spain	D_{19}	-0,007405	0,000
Czech Republic	D_4	-0,018239	0,000

Source: self - elaboration.

4 Discussion

Model as a whole, explanatory variable and dummy variables are statistically significant. The value of non-standardized beta coefficient of explanatory variable (representing an initial level of economic level - in Tab. 3 and 4 denoted as the variable X) came out negative what indicates that in average the Euro zone countries (EA17) and the Czech Republic converged to the Euro area economic level in studied time period. In result, totally 14 economies converged, 4 countries diverged. The converging countries include Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Italy, Malta, Portugal, Slovakia, Slovenia, Spain and the Czech Republic. The diverging countries are Austria, Ireland, Luxemburg and Netherlands. The fastest convergence was observed in Estonia and Slovakia, while the slowest e.g. in Belgium, Finland and Germany.

Conclusion

The paper is divided into three main parts. The content of the first part is focused on the general characteristic of convergence concept. Since the objective is to determine whether there was a beta convergence or beta divergence towards the average economic level of the Euro area countries the panel model with fixed effects was chosen as an instrument of regression analysis. Due to the inclusion of dummy variables (artificial variables) this model is also called LSDV model (Least Squares

Dummy Variable). The specificity of this model is that it can be estimated either without a constant or with the one cross-sectional unit chosen as the basic unit. The latter procedure is used in this paper. As the basic cross-sectional unit the average economic level of the Euro area was chosen. Finally the resulting effects for individual economies are calculated so that the value of the effect of cross-sectional unit is deducted from the effect of individual economy. This methodological procedure is subject of the second part of the article.

In the third part there is a characteristic and graphical description of the input data of EA17 economies and CR in the years 1995- 2010. To analyze the real convergence/divergence the indicator of gross domestic product per capita in purchasing power parity is chosen. Data are obtained as absolute values from database of the World Bank. Because of a need of the graphical analysis data were recalculated to reflect the relative share of the GDP per capita of individual countries to the Euro zone average value. The graphical analysis shows for example that the converging economies include Estonia, Slovakia, Czech Republic, Slovenia (convergence from the bottom) or Belgium and Germany (convergence from above).

The third part is further dedicated to empirical analysis of the beta convergence concept. The created regression model as a whole, explanatory variable and also the dummy variables are statistically significant. The value of non-standardized beta coefficient of explanatory variables, which represents the initial level of income, came out negative; this indicates that in average countries of the Euro area (EA17) and the Czech Republic converged to the Euro zone average economic level from 1995 to 2010. According to the final effects of individual economies the converging countries include Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Italy, Malta, Portugal, Slovakia, Slovenia, Spain and the Czech Republic. The divergent countries were Austria, Ireland, Luxembourg and Netherlands. Estonia and Slovakia were the fastest converging countries; on the contrary, the slowest were Belgium, Finland and Germany.

The paper understands the nominal convergence as a fulfillment of the Maastricht convergence criteria. An effort of the Czech Republic to achieve the convergence criteria is annually a subject of a document *Evaluation of the fulfillment of the Maastricht convergence criteria and the degree of economic alignment of Czech Republic with the Euro area.* In the year 2011 the Czech Republic did not fulfill the criterion of sustainability of public finances (since 2009 is the country in the excessive deficit procedure) and did not participate on the exchange rate mechanism (ERMII). To the year 2012 the failure of achieving the criterion of price stability due to increase of the reduced value added tax rate was predicted. The Czech Republic fulfills the long - term interest rate criterion and the same development is expected in the near future.

Czech Republic is inconsistent with the conditions of nominal convergence required by the Maastricht convergence criteria. The concept of unconditional beta convergence confirmed that the economic level of Czech Republic converged to the average level of Euro area in 1995 - 2010. Although in comparison with the new member Euro zone countries, such as Estonia and Slovakia, the convergence rate is considerably slower. Non-fulfillment of the nominal convergence and a low rate of the

real convergence of the CR points to its lack of preparedness to move to a higher integration degree of economic integration and to adopt the common euro currency.

Acknowledgement

This contribution was supported by Student Grant Competition of Faculty of Economics, VŠB-Technical University of Ostrava: SP2012/102 "Econometric analysis of the Maastricht convergence criteria as a key determinant of the real convergence of the selected countries"

The authors are grateful for all helpful comments to the article presented at the international doctoral conference MEKON 2012.

References

[1] DVOROKOVÁ, K. Ekonometrická analýza konvergence inflace České republiky k vybraným zemím Eurozóny *In Evropská unie po českém předsednictví* [CD ROM], VŠB – TU Ostrava, Ekonomická fakulta, Katedra evropské integrace, 2009. 1 – 9 p. ISBN 978-80-248-2057-6.

[2] GREEN, W., H. *Econometric analysis*. New Jersey: Prentice Hall, 2003. 1232 p. ISBN 978-0131395381.

[3] KUTAN, A., M., YIGIT, T., M. Nominal and real stochastic convergence of transition economies. *In Journal of Comparative Economics*, 2004, Vol. 32, Iss. 1, pp. 23 – 36 . ISSN 0147-5967.

[4] LUKÁČIKOVÁ, A., LUKÁČIK M. *Ekonometrické modelovanie s aplikáciami.* Bratislava: Ekonóm, 2008. 344 p. ISBN 978-80-225-2614-2.

[5] MINISTERSTVO FINANCÍ ČR, ČESKÁ NÁRODNÍ BANKA. *Vyhodnocení plnění maastrichtských konvergenčních kritérií a stupně ekonomické sladěnosti ČR s eurozónou 2011*. MFČR [cit. 2012-01-13]. Available from WWW: <http://www.mfcr.cz/cps/rde/xchg/mfcr/xsl/eu_vyh_maastricht_kriterii_66324.html>

[6] NACHTIGAL, V., TOMŠÍK V. *Konvergence zemí střední a východní Evropy k Evropské unii*. 1. vyd. Praha: Linde, 2002. 231 p. ISBN 80-7201-361-0.

[7] SLAVÍK, C. Reálná konvergence České republiky k Evropské unii v porovnání s ostatními novými členskými zeměmi. *In Politická ekonomie*, 2007, Vol. 54, Iss. 1, pp. 23 – 40. ISSN 0032-3233.

[8] SMRČKOVÁ, G. et al., *Reálná konvergence – souvislosti a příčiny,* 2008. MFČR. [cit. 2012-15-01]. Available from WWW: <http://www.mfcr.cz/cps/rde/xbcr/mfcr/Proces_realne_konvergence_MF_2008_pdf.pdf>.

[9] VINTROVÁ, R., ŽĎÁREK, V. Vztah reálné a nominální konvergence v České republice a nových členských zemích EU. *In Working paper CES VŠEM*, 2007, Vol. 6, Iss. 8. ISSN 1801-6863.

[10] WORLD BANK. *GDP per capita, PPP (constant 2005 international $),* 2012. World dataBank. [cit. 2012-10-01]. Available from: <http://databank.worldbank.org/ddp/home.do?Step=3&id=4>.

Contact Address

Ing. Jana Kovářová
VŠB – Technical University of Ostrava, Faculty of Economy, Department of Economics
Sokolská třída 33, 701 21 Ostrava 1, Česká republika
E-mail: jana.kovarova.st2@vsb.cz
Phone number: +420 597 322 271

Ing. Monika Šulganová
VŠB – Technical University of Ostrava, Faculty of Economy, Department of Economics
Sokolská třída 33, 701 21 Ostrava 1, Česká republika
E-mail: monika.sulganova@vsb.cz
Phone number: +420 597 322 271

Received: 22.06.2012
Reviewed: 07.01.2013
Approved for publication: 23.01.2013