The Price Convergence of the Czech Republic and Euro Zone Countries

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Abstract

The subject of the article was to study a price convergence of the Czech Republic (CR) and Euro zone countries in the two aspects: spatial and time aspect. In the first one the convergence of selected economies to the Euro zone average price level was researched. In the second one the convergence or divergence process was studied in the individual years of the analysis. The main aim was to prove the hypothesis that the price level of the CR converged to the average price level of the Euro zone in the selected time period 1995-2010. An analysis was conducted by the panel data regression model. The data of comparative price levels of GDP (CPL) used in the analysis were obtained in the Eurostat database.

Key words: convergence, beta convergence of price levels, comparative price levels, speed and half–life of convergence, financial and economic crisis

1. INTRODUCTION

The nominal convergence can be understood in the two ways - the wide or narrow understanding. The broad perception at the nominal convergence is associated with the fulfillment of the Maastricht Convergence Criteria (MCC), which consist of the fiscal criteria (public finance deficit, public debt), followed by monetary criteria (price stability, exchange rate stability, the stability of long-term nominal interest rates). The MCC are legally anchored in Article 140 of the Treaty on European Union and further also in the protocols annexed to the Treaty on European Union and the Treaty on European Union amended the Treaty of Lisbon. The fulfillment of the MCC of the Czech Republic (CR) is a subject to an annual report named Assessment of the Fulfillment of the Maastricht Convergence Criteria and the Degree of Economic Alignment of the Czech Republic with the Euro Area. According to this document, the Czech Republic did not fulfill the criterion of the sustainability of the public finances in 2011 (since 2009 the CR is in the excessive deficit procedure). Currently the Czech Republic fails to accomplish the exchange rate stability criterion because it is not a member of the exchange rate mechanism ERM II. It is assumed that CR will not fulfill the criterion of the price stability due to increase of the reduced rate of the value added tax in 2012. The criterion of the long-term interest rate stability is fulfilled regularly and it is predicted the same in the short term.

The narrow concept of understanding the nominal convergence is focused on the price level convergence. That represents a process when price levels of particular countries (eventually a price level of a group of countries) converge, that means they are catch-up to each other (Vintrová & Žďárek, 2007). This process of reducing the differences between the price levels is one of the three possible ways of the price level development in the time. Except of this variant there could be a process of a divergence (enlarging the differences) or a process of price level stagnation, when the price level is stable compared to the other price level in a given time period.

In the monetary union, the price level convergence and the high degree of harmonization of the price levels are important characteristics of the economic environment. That is because the high degree of price level convergence restricts the possible inflationary pressures and reduces the likelihood of asymmetric effect of the single monetary policy. The Czech Republic does not fulfill all Maastricht convergence criteria, so it fails to accomplish the conditions of the nominal convergence (in the wide way of understanding). To base a conclusion in the narrow understanding of nominal convergence is necessary to analyze the price level convergence.

The term "convergence" has its roots in the neoclassical theory of economic growth. In the case of reducing the differences between the economic levels of countries, the most studied indicator is the Gross Domestic Product per capita (GDP p.c.) measured in the purchasing power parity (PPP). The convergence of different countries was and still is the object of research in various areas of modern economic theories. In the frame of this process the term "unconditional convergence" was defined and specified as a situation, where countries with the different starting positions of the economic level are catching-up to the common value - stable state (Sala–i–Martin, 1996). The unconditional convergence is measured by popular concepts of the beta and sigma convergence. The beta convergence concept measures the reduction of a gap of the economic level between the catching–up economy and economy to which it converges (Pfaffermayr, 2009), (Furceri, 2005), (Michelacci, 2000). The sigma convergence is defined as a process, when the variance of economic levels of compared economics declines in the time (Barro, 1992), (Dalgaard, 2001), (Lucke, 2008), (Miller, 2002). Between these concepts exists a casual relation. If the sigma convergence exists, the beta convergence exists as well. But reversely this relation does not need to be valid. This implicative relation has been the object of the following studies Sala-I-Martin (1996), Furceri (2005), Wodon and Yitzhaki (2006).

When the price level convergence is measured, the GDP p.c. in PPP is replaced by indicators focused on illustrating the price development. The selection of this indicator depends for example on the chosen level of the research (macro or micro level). At the macroeconomic level the consumer price index (CPI), harmonized consumer price index or comparative price level of GDP (CPL) could be used. Comparative Price Level of GDP (CPL) specifies the percentage of the price level of the examined economy reached in comparison with the price level in the economy chosen as the comparison basis. That means CPL expresses how many money units are needed to buy the identical consumer basket in every country. This indicator is computed as a ratio of the purchasing power parity (PPP) and spot exchange rate. Closer see Kadeřábková et al. (2007). The price level research at the microeconomic level is focused on prices of particular goods, commodities, etc. In the case of a complex study of the price convergence both levels need to be analyzed because the micro level focuses on the structural aspects of the price convergence and the macro level brings knowledge on the aggregate basis.

The subject of the article is to analyze the price level convergence or divergence to the Euro zone in two aspects. The first one is to identify whether the Euro zone countries and the Czech Republic converge/diverge to the Euro zone average price level in the time period 1995–2010 (**spatial aspect**). The second one analyzes whether the selected countries in average converge or diverge to the Euro zone price level in individual years of defined time period (**time aspect**).

The beta convergence concept is used to verify the hypothesis that the price level of the Czech Republic (CR) converged to the average price level of the Euro area (EA) in years 1995 to 2010. Confirmation of the hypothesis is the first aim of the paper. The second goal is, to analyze the price convergence/divergence process of the Euro zone countries and the Czech Republic in the light of the financial and economic crisis, i.e. to conclude, whether the convergence or divergence prevailed in the years affected by these crises (2008–2010). To fulfill defined aims the method of panel data analysis is used.

The article consists of two main parts: the first one is focused on the theoretical background of the price convergence; the second one brings the empirical research results. The theoretical part includes a definition of the price convergence, a brief overview of the studies on the related topic, a description of the beta convergence concept and the calculation of the speed and half-life of the convergence. The empirical regression models and their results are presented in the second section.

2. EMPIRICAL BACKGROUND OF THE PRICE CONVERGENCE AT THE MACROECONOMIC LEVEL

The price convergence on the macroeconomic level is partially a topic of Vintrová and Žďárek (2007) paper, where the authors classified the price convergence under the nominal convergence (nominal indicators like prices or wages are getting closer to each other). In this analysis the CPL values from 1995 to 2006 time period are used and they are obtained from the World Bank International Comparison Programme (ICP) respectively from its part: European Comparison Programme (ECP). The authors of this study came with the conclusion that the price convergence in the Czech Republic is mostly achieved through the exchange rate channel in the last decade, specifically by the nominal exchange rate appreciation. That means the inflation channel doesn't play a significant role in the price convergence in this country. Via this conclusion the authors point out that the Czech Republic should pay attention to this fact while entering the European Exchange Rate Mechanism II (ERM II), or adopting the common currency Euro because this could have a significant influence on the price convergence of the country in the Euro zone. By entering the ERM II, the exchange rate channel is limited and by adopting the common currency this channel does not play role any longer, i.e. further the price convergence could be reached only by inflation channel. The latest Žďárek study focused on the nominal convergence is from 2011. The subject of this study is the nominal convergence of the new EU's member states (NMS). The EU new member states (NMS) include 10 countries (joined the EU after the 2010 enlargement): Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Slovakia, Slovenia and Poland. The price level convergence is measured using the σ-convergence and β-convergence concepts.

Yazgan and Yilmazkuday (2010) in their study research the price level convergence in Turkey (the inner state convergence) and compare its rate to other countries such as China, India, Russia, USA, European Union etc. Authors deal with the question, whether the regional convergence of former socialistic (mostly less opened) economies reach the higher rate of economic integration compared to the capitalistic countries.

The Dreger et al. (2007) study deals with the price convergence in the enlarged EU internal market and for example compares the price trends among the old and new EU member states. The lower CPL values in the NMS are linked with the lower economic level in these countries, further with the imperfect integration into the internal market, defections in the tradability of goods and services or with the reputation of products coming from the NMS's markets. The author's team notices the price trends in particular regions of the EU as well. The higher price levels are observed in the geographical peripheries like Finland or Ireland; on the contrary the lower price levels are in the southern regions and in the above mentioned NMS. Finally the paper describes the price trends in EU countries in the chosen time period (1995–2005). In the NMS there was the CPL values rise observed (for example a significant increase of CPL in the Czech Republic and Baltic States more than 15 % and a slight rise in the Slovenia approximately 1 % in the studied time period), conversely in some old member states like Germany, France, Belgium or Austria the comparative price levels declined. The empirical analysis of this paper is based on the beta and sigma price convergence concepts, the data are processed by the panel regression analysis and the authors conclude that in the studied time period in the NMS there is a convergence to the Euro zone price level.

Danijel Nestićs (2005) deals with price convergence of the European transitive economics, especially he focuses on how the Croatian price level is reaching the average price level of the European Union. The data necessary for a research were extracted from the European Comparison Programme. The author pointed out the relatively higher CPL value in Croatia in comparison with other transitive economics and highlighted this fact as the advantage for Croatia in the context of the future price and exchange rate's adaptation which is associated with joining the European Union. Based on this the author assumes that the pressure exerted on prices and exchange rates in Croatia will be relatively weaker in comparison with the other transitive economics.

In the Allington et al. (2005) paper a team of authors test the hypothesis whether the creation of the internal market and adopting the common currency Euro help to validate the Law of One Price throughout the EU member states. To answer this question authors research the price variance in the Euro zone countries in comparison with a control group of countries standing out of the Euro zone. The results of this analysis indicate that the common currency has an influence on the price convergence of tradable products of the Euro zone countries and helps the general trend of reducing the price variance among the Euro zone countries.

The price development and its dynamic in the former EU candidate countries from central and eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) in the time period 1992–2001 is in the interest of the Backé et al. (2002) study. The price dynamics in the transformation period (divided into five separate phases) is researched through the changes in consumer prices where the authors describe the major trends in prices but also point out the main inflation shocks that influenced the price development in given countries in the studied period. A part of this paper is dedicated to price convergence of former EU candidate countries to the EU price level. The comparative price levels in this study are used again from 1989 to 2000 and the German price level is the base level (the German price level was chosen as the baseline, because the Germany was the biggest trade partner to the former EU candidate countries moreover the German Mark played a sig-

nificant role of an anchor for the European Monetary System). The authors came to conclusion that the price convergence in the 90's was relatively quick and the strong negative relation between the starting CPL values and the inflation rate was confirmed in the former EU candidate countries of Central and Eastern Europe.

Rogers (2001) study is devoted to the relation between the price convergence and inflation rate throughout the Eurozone in the period 1990-1999. Author assumed that the countries with the lower price levels could imply the higher inflation, although he remarked other factors which participate on the inflation differential of the Eurozone countries. In a study from 2002 author researched the prices dispersion in the European cities compared to the American ones. He observed a decline of the price dispersion of tradable good, in the little extent also of non–tradable good, in Europe. Based on that, author searched for possible explanations of this process like tax harmonization, incomes and labor costs convergence, trade liberalization and higher degree of monetary policy coherence. The topic of price level convergence in relation to inflation differentials is also subject of Égert (2007) and Staehr (2010) study.

3. THEORETICAL BACKGROUND OF THE BETA CONVERGENCE OF PRICE LEVELS

Besides the confirmation of the convergence a further description of this process is defined by the calculation of the speed and half-life of the convergence. In this paper the model of unconditional convergence is used, i.e. that the catching-up economy is getting closer to a stable state. The functional relationship also indicates that the lower the initial level is, the greater the average growth is (assuming that the economy is below a stable state).

Mathematically the beta convergence of the price levels can by written by the following equation:

$$\frac{1}{T}\cdot\left[\ln\left(CPL_{i,T}\right)-\ln\left(CPL_{i,0}\right)\right]=\beta_0+\beta\left(CPL_{i,0}\right)+\varepsilon_{i,t}, \tag{1}$$

where $CPL_{i,T}$ represents the comparative price level of the i-country at the end of the selected time period (alternatively the beginning of the time period is market by 0 in the subscript), β_0 is the absolute term, the regression coefficient β signals the convergence (by negative values) or divergence (by positive values), $\varepsilon_{ij,t}$ is the residuum which represents a part of the time series not chaptered by the model, defections in measurement etc.

The above mentioned relation (1) can be written in the following way which is inspired by Barro and Sala-i-Martin (1992) model of the beta convergence of the economic level. The indicator of GDP is replaced by CPL values and the logarithm transformed mathematical equation looks as followed:

$$\Delta cpl_{ij,t}=\beta_{ij}+\beta\cdot cpl_{ij,t-1}+\varepsilon_{ij,t}, \tag{2}$$

where $\Delta cpl_{ij,t}$ indicates a data change about the price level between the countries i and j in a time t, β_{ij} is the absolute term, β is the regression coefficient and $\varepsilon_{ij,t}$ is a residuum. The CPL values are constructed according to the following relation:

$$cpl_{ij,t} = \left|\ln P_{i,t} - \ln P_{j,t}\right|, \tag{3}$$

where ln *P* is a natural logarithm of price levels between economies i and j in the time t. The price level is usually connected to a given country or to an integration grouping (e.g. Eurozone, EU). The logarithmic transformation of CPL ensures that the indicator is interpreted as an approximation of percentage differences. These price differences among countries can return to the average zero or non-zero value in the time period. In this case we can speak about a non-stationary process with a unit root. The overview of unit root tests verifying the existence of unit root can be found in Green (2008), Levin et al. (2002), De Blander et al. (2007), Harris et al. (1999).

The previous relation (2) can be transformed to the equation with no incremental form:

$$cpl_{ij,t} = \beta_{ij,t} + (1-\beta)\cdot cpl_{ij,t-1} + \varepsilon_{ij,t}, \tag{4}$$

where regression parameter β indicates the estimation of the convergence/divergence process.

The speed of the convergence determines (in the percentage terms), how is the gap between the actual level of catching up economy and the stable state reduced in a single period. The regression parameter β is used to calculate the speed of the price convergence (λ) through the following relation:

$$\lambda = -\ln(1-\beta) \tag{5}$$

The equation symbolism corresponds to the symbolism used in the previous sections of the paper. Coefficient λ helps to calculate the half-life of the convergence, i.e. the time period during which the gap between the price levels of studied economies declines to half. Conditions needed for the convergence half-life calculation are a stable rate of price increase and the normalized value of the price level. The half-life can be calculated by the following relation:

$$t_{\frac{1}{2}} = \frac{\ln(2)}{\lambda}. \tag{6}$$

4. MODEL OF THE BETA CONVERGENCE OF PRICE LEVEL: INPUT DATA

The input data of the comparative price levels of GDP (CPL) of the particular EA17 countries (Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain) and the economy of the Czech Republic were obtained in the Eurostat database. The data covered the time period from 1995 to 2010. Eurostat defines the comparative price level as a ratio of purchasing power parity (PPP) and the market exchange rate. This ratio is given in relation to the EU average (EU27=100 or EU15=100). If the value of the comparative price level of selected economy is higher/lower than 100, the costs of the final consumption, including the indirect taxes, are relatively higher/lower than the EU average. For the purposes of this paper the CPL (EU15=100) values were obtained and subsequently they were recalculated to the EA17=100 basis. The development of

the CPL values of studied economies is captured in the following free figures (Fig. 1, 2, 3).

Figure 1 shows the comparative price levels of the Czech Republic and new Euro zone member countries (Cyprus, Malta, Estonia, Slovakia and Slovenia). At the beginning of the time period (1995) the price level of all selected economies was below the Euro zone average price level (EA17=100). The lowest values were reported in Slovakia, Estonia and Czech Republic (approximately 35–37 % of the Euro zone price level). In these countries there was the biggest increase of CPL values observed till the year 2010. In 1995 Cyprus and Slovenia had significantly higher initial level of CPL values compared to the other countries of the group, thus the increase of the price levels was not so strong.

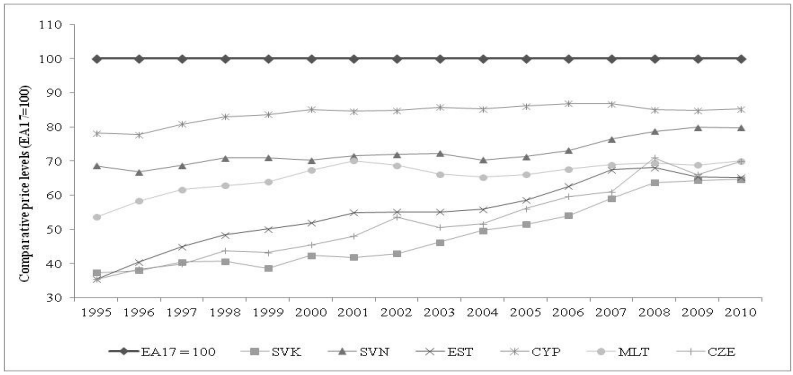

Fig. 1 - Comparative price levels of the CR and the new Euro zone countries in 1995–2010. Source: Eurostat (2011), self–elaboration.

The second graph is similar to Figure 1 but captures the development of the comparative price levels of the Euro zone member states, which were at the beginning of studied time period below the average EA17 price level. The specific development of CPL was observed in Ireland. In 1997 this country reached the Euro zone average price level and subsequently the significant increase of the CPL values was reported. The turnover of this development was in years 2009 and 2010, when the comparative price values started to decrease. The other economy, which reached the EA17 average price level, was Italy in the year 2004. Since then the country has maintained a stable price level on the level of the Euro zone. The last free observed economies: Greece, Spain and Portugal did not reached the average price level of EA17 in the studied time period and they reported slight increase of CPL values.

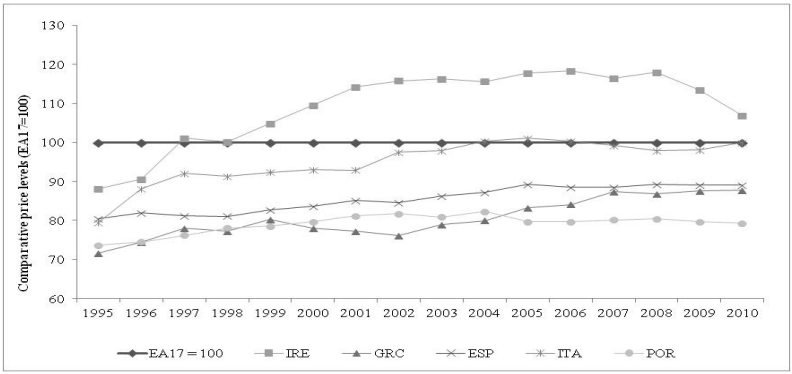

Fig. 2 - Comparative price levels of the old Euro zone countries in 1995–2010 (below the average Euro zone price level in 1995). Source: Eurostat (2011), self–elaboration.

Figure 3 represents the last group of selected economies. The old Euro zone member countries, which reported higher CPL values compared to the EA17 average price level in 1995. The highest price level is observed in Finland (approximately 115 % of the Euro zone price level in average in the period 1995-2010). The selected countries did not showed the significant changes in the price trends, with exception of Germany, which comparative price levels reported decline from 116 % in 1995 to current 100 % (average price level of the Euro zone).

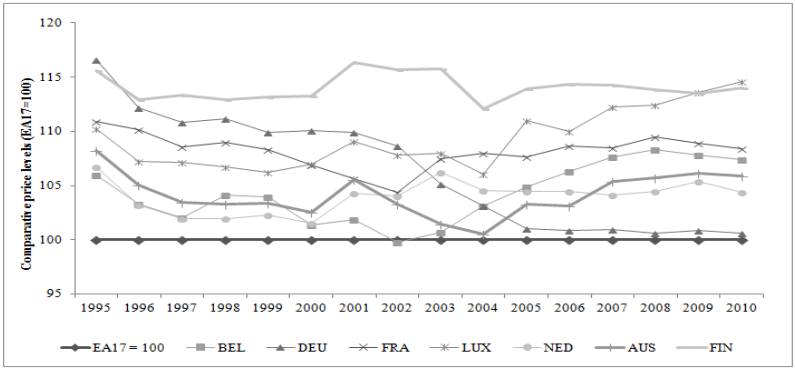

Fig. 3 - Comparative price levels of the old Euro zone countries in 1995–2010 (above the average Euro zone price level in 1995). Source: Eurostat (2011), self–elaboration.

5. MODEL OF THE BETA CONVERGENCE OF PRICE LEVEL: METHODOLOGY

To confirm defined hypothesis (the Czech price level converged to the average price level of Euro zone in period 1995–2010) the theoretical approach of measuring the beta convergence of Barro and Sala-i-Martin (1996) is used:

$$\frac{1}{T}\log\left(\frac{y_{i,T}}{y_{i,0}}\right)=\alpha+\beta\log y_{i,0}+\varepsilon_i, \tag{7}$$

where the left side of the regression equation of the β-convergence expresses the average GDP p. c. growth in the PPP in time 0 (beginning of the period) and T (the end of the period), which is dependent on the initial economic level $y_{i,0}$. Variable T is the number of years in the analyzed period, α is the absolute term, β is the regression coefficient, εi is a random component. The β-convergence of economic levels occurs when the β parameter is negative.

Because the price level convergence is studied, the equation (7) is modified in the following form: instead of an indicator of the economic level an indicator of the comparative price level of GDP (CPL) is used. The resulting relation is in the following form:

$$\frac{1}{T}\log\left(\frac{CPL_{i,T}}{CPL_{i,0}}\right)=\alpha+\beta\log CPL_{i,0}+\varepsilon_i, \tag{8}$$

where the left side of the regression equation of the β-convergence expresses the average increase of the price level for the given country in time 0 (beginning of the period) and T (the end of the period), which is dependent on the initial price level $CPL_{i,0}$. Variables T, α, β and εi represent the same characteristics as is described in the equation (7). The regression model defined by equation (8) verifies the price levels convergence/divergence of Euro zone countries and the Czech Republic to the Euro zone average in the time period 1995–2010. As mentioned above if the parameter $\beta < 0$ – is a negative number - the price levels of the EA17 countries and the Czech Republic converge to the Euro zone average price level.

Assuming that, in the model there are initial levels, regression equation can be modified as follows:

$$\log\left(\frac{CPL_{i,t}}{CPL_{i,t-1}}\right)=\alpha+\beta\log CPL_{i,t-1}+\varepsilon_i, \tag{9}$$

where $CPL_{i,t}$ is the comparative price level in the year t, $CPL_{i,\,t-1}$ is the CPL in the year *t-1*, α is the intercept, β is the regression coefficient and εi is the random effect. The left side of the regression equation shows an inter-annual price growth, which is dependent on the previous price level ($CPL_{i,\,t-1}$).

To test the defined regression model the method of panel data analysis is used, especially the Fixed Effects Model (FEM). In this model the individual effects are unobservable but correlated with the explanatory variables and a specific constant αi exists for each cross-sectional unit (Greene, 2003).

This model can be estimated in two basic ways. In the first one the model is estimated without intercept. In the second method a one cross-sectional unit is selected as the basic unit. Its value becomes an absolute member of the model and then only n-1 dummy variables are used in the model. To explore the price convergence the latter way was chosen. The selected cross-sectional unit is the average price level of the Euro area (EA17). The results of fixed effects for each cross-sectional unit are obtained by the following equation by Lukáčiková and Lukáčik (2008):

$$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \alpha_1 + \begin{bmatrix} 0 & \cdots & 0 \\ i & & 0 \\ \vdots & & \vdots \\ 0 & \cdots & i \end{bmatrix} \begin{bmatrix} \alpha_2 - \alpha_1 \\ \alpha_3 - \alpha_1 \\ \vdots \\ \alpha_n - \alpha_1 \end{bmatrix} + \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \beta + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{bmatrix}. \quad (10)$$

The first aim defined in the paper is to identify, whether the Euro zone countries and the Czech Republic converge/diverge to the Euro zone average price level in the time period 1995–2010. For these purposes the equation (9) is amended by dummy variables, which determines the selected countries (spatial aspect). The modified relation is following:

$$\log\left(\frac{CPL_{i,t}}{CPL_{i,t-1}}\right) = \alpha + \beta \log CPL_{i,t-1} + \delta D_i + \varepsilon_i, \quad (11)$$

where the Di represents dummy variables, i denotes the Euro zone countries and the Czech Republic, δ is the regression parameter.

The second goal of this article is to analyze the price convergence/divergence process of the Euro zone countries and the Czech Republic in the light of the financial and economic crisis, i.e. to conclude, whether the convergence or divergence prevailed in the years affected by these crises: 2008–2010 (time aspect). In order to examine the level of the price convergence in individual years, defined equation (9) is modified as follows:

$$\log\left(\frac{CPL_{i,t}}{CPL_{i,t-1}}\right) = \alpha + \beta \log CPL_{i,t-1} + \delta D_t + \varepsilon_i, \quad (12)$$

where the left side of the equitation represents inter-annual price growth, α is the absolute term, β is the regression parameter, δD_t is the time effect and εi is the random effect.

Created panel models of the beta convergence of price levels are tested using statistical-econometric software Eviews7. To estimate the model parameters the method of ordinary least squares (OLS) is used. Given regression models are tested on the 5% level of significance ($\alpha = 0.05$).

6. REGRESSION MODEL ESTIMATION – SPATIAL ASPECT

The first panel regression model, defined by the equitation (11), determines which of the selected countries converge/diverge to the average price level of the Euro zone in the period 1995–2010. Table 1 represents the results of model estimation.

Tab. 1 - The estimation of the panel regression model in the time period 1995–2010. Source: self-elaboration in Eviews 7.

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/25/12 Time: 17:15
Sample: 1996 2010
Periods included: 15
Cross-sections included: 19
Total panel (balanced) observations: 285

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.119374	0.017700	-6.744435	0.0000
D1	0.240140	0.035813	6.705432	0.0000
D2	0.241184	0.035815	6.734127	0.0000
D3	0.232088	0.034160	6.794136	0.0000
D4	0.222386	0.030189	7.366379	0.0000
D5	0.223947	0.030708	7.292797	0.0000
D6	0.245174	0.036520	6.713472	0.0000
D7	0.242137	0.036112	6.705193	0.0000
D8	0.237828	0.036006	6.605266	0.0000
D9	0.232998	0.033796	6.894338	0.0000
D10	0.248742	0.036163	6.878284	0.0000
D11	0.242463	0.035087	6.910403	0.0000
D12	0.244328	0.036169	6.755201	0.0000
D13	0.224215	0.032222	6.958342	0.0000
D14	0.240104	0.035810	6.704987	0.0000
D15	0.228739	0.033712	6.785073	0.0000
D16	0.215016	0.029656	7.250240	0.0000
D17	0.226056	0.032996	6.851093	0.0000
D18	0.233395	0.034283	6.807849	0.0000
D19	0.238749	0.035512	6.723106	0.0000

R-squared	0.353910	Mean dependent var	0.004520
Adjusted R-squared	0.307586	S.D. dependent var	0.013134
S.E. of regression	0.010929	Akaike info criterion	-6.127130
Sum squared resid	0.031655	Schwarz criterion	-5.870815
Log likelihood	893.1160	Hannan-Quinn criter.	-6.024379
Durbin-Watson stat	1.945396		

As above mentioned, a one cross-sectional unit is selected as the basic unit for the model. Its value becomes an absolute member and then only n-1 dummy variables are used in the model. The selected basic cross-sectional unit is the average price level of the Euro area (EA17). Consequently, the model is re-estimated with the n-1 dummy variables. The results are shown in the Table 2:

Tab. 2 - The re-estimation of the panel regression model in the time period 1995–2010. Source: self-elaboration in Eviews 7.

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/25/12 Time: 17:17
Sample: 1996 2010
Periods included: 15
Cross-sections included: 18
Total panel (balanced) observations: 270

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.119374	0.018187	-6.563863	0.0000
D1	0.240140	0.036798	6.525904	0.0000
D2	0.241184	0.036800	6.553831	0.0000
D3	0.232088	0.035100	6.612234	0.0000
D4	0.222386	0.031020	7.169155	0.0000
D5	0.223947	0.031553	7.097543	0.0000
D6	0.245174	0.037524	6.533729	0.0000
D7	0.242137	0.037105	6.525672	0.0000
D8	0.237828	0.036996	6.428420	0.0000
D9	0.232998	0.034725	6.709752	0.0000
D10	0.248742	0.037158	6.694129	0.0000
D11	0.242463	0.036052	6.725387	0.0000
D12	0.244328	0.037164	6.574341	0.0000
D13	0.224215	0.033109	6.772043	0.0000
D14	0.240104	0.036795	6.525471	0.0000
D15	0.228739	0.034639	6.603413	0.0000
D16	0.215016	0.030472	7.056125	0.0000
D17	0.226056	0.033903	6.667665	0.0000
D18	0.233395	0.035226	6.625579	0.0000

R-squared	0.349616	Mean dependent var	0.004771
Adjusted R-squared	0.302975	S.D. dependent var	0.013451
S.E. of regression	0.011230	Akaike info criterion	-6.072673
Sum squared resid	0.031655	Schwarz criterion	-5.819450
Log likelihood	838.8108	Hannan-Quinn criter.	-5.970989
Durbin-Watson stat	1.944991		

The coefficient of determination (R–squared) is 0.35, i.e. that the initial price level (in the Table 1 denoted as the variable X explains about 35 % of the average price growth in the 1995–2010. The regression parameter β is –0.11; its negative value indicates that selected economies in average converge to the Euro zone price level in the studied time period. Smrčková (2008) understands the beta convergence concept as prevailing process of catching-up, i.e. even if there is a convergence in general there could be economies which diverge. The equations (5) and (6) define the speed and half–life of convergence/divergence. To calculate these characteristics for the Euro zone and Czech Republic the parameter β from equation 11 is used. The results for Euro zone countries and the Czech Republic speed and half-life of price convergence are summarized in Table 3.

Tab. 3 - The speed and half–life of the price convergence of the Czech Republic and Euro zone countries. Source: self-elaboration.

Euro zone countries and Czech Republic	Speed of the convergence (λ) in %	Half–life of the convergence ($t_{1/2}$) in years
	11.27	6.15

Variables D1 – D18 are dummy variables, which mark the selected economies (EA17 countries and the CR). D19 is a dummy variable which denotes the Euro zone average price level. The final results of fixed effects for each cross-sectional unit (selected countries) are calculated according to equation (10) and are presented in the Table 4:

Tab. 4 - Final results of price convergence/divergence of selected economies to the Euro zone in the period 1995–2010. Source: self-elaboration.

Country	Dummy	Effect	Significance
Austria	D1	0.001391	0.000
Belgium	D2	0.002435	0.000
Cyprus	D3	-0.006661	0.000
Czech Republic	D4	-0.016363	0.000
Estonia	D5	-0.014802	0.000
Finland	D6	0.006425	0.000
France	D7	0.003388	0.000
Germany	D8	-0.000921	0.000
Greece	D9	-0.005751	0.000
Ireland	D10	0.009993	0.000
Italy	D11	0.003714	0.000
Luxemburg	D12	0.005579	0.000
Malta	D13	-0.014535	0.000
Netherland	D14	0.001355	0.000
Portugal	D15	-0.010010	0.000
Slovakia	D16	-0.023733	0.000
Slovenia	D17	-0.012693	0.000
Spain	D18	-0.005354	0.000

According to the final results shown in the Table 4 there are 10 countries which converged to the Euro zone average price level in the studied time period. These are: Cyprus, Czech Republic, Estonia, Greece, Germany, Malta, Portugal, Slovakia, Slovenia and Spain. The rest of the countries diverged from the EA17 price level. These results confirm assumptions based on the graphical analysis of the price levels development in the selected economies.

7. REGRESSION MODEL ESTIMATION – TIME ASPECT

The second task of this paper is to analyze the price development of Euro zone countries and the Czech Republic in the recent years affected by the financial and economic crisis. The aim is to conclude, whether in years 2008, 2009 and 2010 the convergence or divergence prevailed in the group of the selected countries. To fulfill this goal the panel regression model based on the equation (12) is estimated. In this model there are 16 dummy variables added which represent the 15 individual years of studied time period and the average price level of Euro zone.

Similarly to the previous panel model there is the first estimation with 16 dummy variables. Subsequently the dummy variable for average Euro zone price level is chosen to be a basic unit and then the model is re–estimated with the n–1 dummy variables. The final results of convergence/divergence predomination in individual years are calculated in the way described in the equitation (10). Both estimations and final results are presented in the tables 5, 6 and 7.

Tab. 5 - The estimation of the panel regression model in the time period 1995–2010. Source: self-elaboration in Eviews 7.

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/25/12 Time: 17:14
Sample: 1996 2011
Periods included: 16
Cross-sections included: 18
Total panel (balanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.053281	0.005332	-9.991779	0.0000
D1	0.107446	0.010375	10.35624	0.0000
D2	0.112320	0.010412	10.78799	0.0000
D3	0.107610	0.010471	10.27654	0.0000
D4	0.104223	0.010504	9.922450	0.0000
D5	0.107597	0.010517	10.23100	0.0000
D6	0.109681	0.010547	10.39963	0.0000
D7	0.104812	0.010586	9.901301	0.0000
D8	0.103974	0.010597	9.811315	0.0000
D9	0.104005	0.010604	9.807891	0.0000
D10	0.110931	0.010611	10.45455	0.0000
D11	0.109312	0.010653	10.26121	0.0000
D12	0.111144	0.010684	10.40249	0.0000
D13	0.110592	0.010724	10.31290	0.0000
D14	0.101262	0.010758	9.412708	0.0000
D15	0.104677	0.010742	9.744481	0.0000
D16	0.106562	0.010977	9.707961	0.0000

R-squared	0.328998	Mean dependent var	0.004473
Adjusted R-squared	0.289382	S.D. dependent var	0.013074
S.E. of regression	0.011021	Akaike info criterion	-6.120827
Sum squared resid	0.032916	Schwarz criterion	-5.904611
Log likelihood	898.3991	Hannan-Quinn criter.	-6.034180
Durbin-Watson stat	1.891229		

Tab. 6 - The re-estimation of the panel regression model in the time period 1995–2010. Source: self-elaboration in Eviews 7.

Dependent Variable: Y
Method: Panel Least Squares
Date: 01/25/12 Time: 17:04
Sample: 1996 2010
Periods included: 15
Cross-sections included: 18
Total panel (balanced) observations: 270

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.053281	0.005508	-9.673309	0.0000
D1	0.107446	0.010717	10.02615	0.0000
D2	0.112320	0.010754	10.44414	0.0000
D3	0.107610	0.010816	9.948989	0.0000
D4	0.104223	0.010850	9.606189	0.0000
D5	0.107597	0.010863	9.904901	0.0000
D6	0.109681	0.010894	10.06816	0.0000
D7	0.104812	0.010934	9.585714	0.0000
D8	0.103974	0.010946	9.498596	0.0000
D9	0.104005	0.010953	9.495281	0.0000
D10	0.110931	0.010960	10.12133	0.0000
D11	0.109312	0.011004	9.934150	0.0000
D12	0.111144	0.011036	10.07093	0.0000
D13	0.110592	0.011077	9.984192	0.0000
D14	0.101262	0.011112	9.112694	0.0000
D15	0.104677	0.011096	9.433892	0.0000

R-squared	0.323703	Mean dependent var	0.004771
Adjusted R-squared	0.283764	S.D. dependent var	0.013451
S.E. of regression	0.011384	Akaike info criterion	-6.055825
Sum squared resid	0.032916	Schwarz criterion	-5.842586
Log likelihood	833.5364	Hannan-Quinn criter.	-5.970198
Durbin-Watson stat	1.863065		

Tab. 7 - Final result of price convergence/divergence to the Euro zone in the individual years of the time period 1995–2010. Source: self–elaboration.

Country	Dummy	Effect	Significance
1995 – 1996	D_1	0.001391	0.000
1996 – 1997	D_2	0.002435	0.000
1997 – 1998	D_3	-0.006661	0.000
1998 – 1999	D_4	-0.016363	0.000
1999 – 2000	D_5	-0.014802	0.000
2000 – 2001	D_6	0.006425	0.000
2001 – 2002	D_7	0.003388	0.000
2002 – 2003	D_8	-0.000921	0.000
2003 – 2004	D_9	-0.005751	0.000
2004 – 2005	D_{10}	0.009993	0.000
2005 – 2006	D_{11}	0.003714	0.000
2006 – 2007	D_{12}	0.005579	0.000
2007 – 2008	D_{13}	-0.014535	0.000
2008 – 2009	D_{14}	0.001355	0.000
2009 – 2010	D_{15}	-0.010010	0.000

According to the final effects of time analysis, the divergence prevailed ones in the years affected by financial and economic crisis. That is in the year 2009 when the effect δ is a positive value. In this year the selected economies in average diverged to the Euro zone price level, i.e. in average the difference between the price levels increased.

8. CONCLUSION

Vintrová and Žďárek (2007) included the price convergence to the nominal convergence which they understand also as the fulfillment of the Maastricht convergence criteria required for joining the Euro zone. As was mentioned in introduction the Czech Republic currently exceeds the criterion of public finance deficit and does not participate in the Exchange Rate Mechanism. From this perspective the Czech Republic does not fulfill conditions of the nominal convergence.

Nominal convergence can be also understood in the narrower sense as the convergence of nominal characteristics such as prices or wages. The narrow and wide understanding of price convergence might be in contrast. Specifically the catching–up economy should reach the higher rates of price convergence to approach to the level of other economy. On the other hand the economy is limited by the Maastricht convergence criteria of the price stability which secures the low and stable inflation rates in Euro zone respectively in the European Union.

The narrow understanding of nominal convergence predominates in this article because the price convergence of selected countries to the Euro zone average price level was studied. The price convergence was measured by the beta convergence concept and the comparative price

levels of GDP were used as the indicator of price development. The selected economies were current member states of Euro zone and the Czech Republic and the analysis covered the time period 1995–2010.

To confirm the hypothesis and to meet two defined goals of this paper the panel data analysis was used, specifically the fixed effect model was selected. The subject of this article – the price convergence - was studied in two aspects. The first was the spatial aspect when the price convergence of EA17 countries and CR to the Euro zone price level was researched. According the results of created regression model the price convergence of selected economies to the Euro zone average price level was confirmed (the beta parameter from equation 11 and table 1 was a negative value). Smrčková (2008) understands the beta convergence concept as prevailing process, i.e. even if there is a convergence in general there could be economies which diverge. In this case the economies which diverged from the Euro zone price level were Austria, Belgium, Netherland, Ireland, Italy, Luxemburg, Finland and France. The divergence rate was the highest in the Ireland, Finland and Luxemburg what is in compliance with the assumptions from the graphical analysis. For the rest of the countries the divergent trend was slight. The price convergence was confirmed in Cyprus, Czech Republic, Estonia, Greece, Germany, Malta, Portugal, Slovakia, Slovenia and Spain. Based on these results the defined hypothesis that the Czech Republic converged to the Euro zone price level in the period 1995–2010 was confirmed.

The most significant was the convergence process in Slovakia, Czech Republic and Estonia. These countries reached the lowest comparative price values of GDP (compared to the Euro zone level) at the beginning of the studied time period (1995). Malta also reported the significant increase of price level but it was not as strong as in the latter mentioned countries. Slovenia and Cyprus converged slightly because their initial CPL values were comparatively higher as in other new EU member states. The old EU member state which experienced a significant price convergence (approaching from above) was Germany. At the beginning of the studied period country was above the Euro zone average (approximately 117 % of Euro zone price level) but consequently its price level decreased and last few years reached the similar level as was in the Euro zone.

The second aspect of the price convergence study was a time aspect, i.e. it was examined whether the convergence or divergence prevailed in the individual years of time period 1995–2010. Specifically the analysis was focused on the years 2008, 2009 and 2010 when the financial and economic crises influenced the world economy. In the estimation of the second regression model the parameter beta was a negative value what suggested that the convergence of selected economies to the Euro zone average price level prevailed in the studied period. In the last free years of the analysis the divergence prevailed ones and it was in the year 2009 when the CPL values were influenced by the negative economic development. In some countries decrease of comparative price values was observed (for example Estonia and Czech Republic), in other economies the rate of price increase slowed down.

Ždárek (2011) in his study focused on the price convergence of new member states of the European Union meditates about the affect of these crises. He outlines the significant role of the price channel but also the influence of the fluctuations of the exchange rates in these coun-

tries. Because of the Euro zone membership the exchange rate channel is missing in the EA17 countries and the whole price adaptation takes place through the inflation channel. Author also points out the role of the real convergence which was affected by the significant decrease of the economic growth. In the Czech Republic the real and price convergence are not in compliance and the rate of the convergence of the economic level is significantly slower compared to the convergence of price levels. Nevertheless there is a persisting gap between the achieved price and economic level. Nowadays the price level convergence in the Czech Republic takes place primarily through the exchange rate channel which leads to strengthening of the nominal exchange rate of Czech Crown in relation to Euro. The average annual appreciation of the Czech Crown towards Euro in 2001-2006 was 3.9 %, while the inflation differential to the EU countries was in the annual average even negative, see Vintrová and Žďárek (2007). In this sense the delaying of the entry into ERM II can be recommended, until the closer alignment of the price levels of the CR and Euro zone. Otherwise, the Czech economy could be exposed to higher inflationary pressures.

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