

Price convergence and its determinants in the European Union after global financial crisis.

Aleksandra Hałka, Agnieszka Leszczyńska-Paczesna

Narodowy Bank Polski

Preliminary Working Draft

Please do not quote or cite without authors' permission

Abstract

The process of the nominal convergence in the recent years is questionable as in the CEE countries after the EU accession we observe permanently lower price level not followed by significantly higher inflation rates than in the old member states countries. In our paper, using disaggregated price level indices, we analyse the price convergence process in the CEE countries. In our research we check whether the beta and sigma convergence occurs and seek to find the main drivers of this process. The outcomes indicate that the outbreak of the global financial crisis stopped the price convergence process. Moreover, for some subaggregates in the consumption basket the statistically significant divergence materialized. We believe that the main factor contributing to the slowdown of the convergence process may be, as other authors indicate, observed decline of the real convergence after 2009 which was especially visible for the old member states. The second important factor affecting the weakening of the convergence process may be higher protection of the domestic markets in several European countries after the crisis.

Key words: price convergence, price dispersion, new EU member states, panel data analysis

JEL: C23, E31, F02, F31, F41

1. Introduction

The basic concept for the price convergence process is the law of one price (LOOP), which implies that in fully competitive markets the prices of the same goods should be equal (taking into account the exchange rate). It is assumed that due to the arbitrage LOOP should hold for the tradable goods (and also some selected services). The generalisation of the LOOP is Purchasing Power Parity (PPP) a concept, which compares reference baskets between the countries. The PPP theory entails that purchasing power of money in each country is the same, and changes of the exchange rate in a long term should lead to the adequate price adjustment (depreciation to the increase of the prices and appreciation to the decrease). However, in real world either LOOP or PPP is often violated due to trade barriers, different consumer preferences, monopolies, influence of the non-tradable components in tradable goods, price stickiness etc. (Engels 1993; Obstfeld and Rogoff, 1996; Rogoff, 1996; Obstfeld and Taylor, 1997). Certain price differentials between locations can be due to the transportation costs that prevent arbitrage transactions.

However, we should keep in mind that LOOP applies only to the tradable goods which can be exchanged internationally and which prices are set on the international markets. The prices of non-tradable goods are mainly determined by the domestic conditions, like domestic demand or supply. The empirical evidence both for the integrated European market or the US economy indicate that of law of one price does not always hold (Isard, 1977, Lutz, 2004, Parsley and Wei, 1996).

Another stream of the literature relates the diminishing dispersion of the price level to the real convergence. The real convergence means among others the catching-up of the of productivity and of the income levels. Higher productivity of the tradable sector in the economy will transmit into higher wages, but without the need of the prices' increase. In response, to keep the workforce in the non-tradable sector, non-tradable sector will have to rise the wages accordingly. However due to lower productivity of the non-tradable sector, the prices must also increase. As a result the economy will face higher inflation in the non-tradable sector and relatively lower in tradable. In the long term the convergence of the productivity and prices in the tradable sector will occur and due to the spillover effect on the wages the prices of non-tradables will also converge. This relation is known as a Balassa-Samuelson effect (Balassa, 1964, Samuelson, 1964). This theory, confirmed in the empirical research, implies that the increase of the income level leads to the increase of the price level. If this relation holds than it explains the inflation differentials between the non-euro area low income countries and EA high income countries. It is particularly important especially as the non-EA countries are supposed to enter euro area and sustainably fulfil the Maastricht criteria.

The aim of the foundation of the European Union is, among the others, to reduce the disparities of the development level between the countries¹. To achieve it the trade barriers as well as tariffs are eliminated, however there remain other factors: both structural and natural. The process of integration between EU countries should lead to real convergence and assuming that Balassa-Samuleson effect works, also to the price convergence.

¹ Article 174; Consolidated versions of The Treaty On European Union And The Treaty On The Functioning Of The European Union (2016/C 202/01); <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:C:2016:202:FULL&from=EN>

The process of price convergence materialise as a result of the opening of the country, among the other. Therefore often the literature concentrate mainly on the convergence in the context of the intensification of the integration of the EU countries. The literature focusing on this topic is extensive, however concentrate mainly on the period due to creation of EMU and after the EU enlargement with New Member States. However it does not mean that this literature is limited only to the European countries (e.g. Hoarau J.F., S. Blancard and P.Jean-Pierre, 2009)

There are two main streams of the convergence's literature. The first one analyses the process of nominal convergence, including its determinants, and the other real convergence. In addition, the term nominal convergence can be understood in a narrow perspective – price, wages convergence or in a wider context in connection with e.g. the fulfilment of the Maastrich criteria. In our paper we will concentrate on the convergence in a narrow meaning i.e. convergence of the prices. The literature focus' on disaggregated data and, when possible, on the individual goods' prices.

The research on the price convergence on the market without trade barriers and in the one currency world was conducted by Parsley and Wei (1996) for the US economy. The authors indicate that tradable goods converge faster than non-tradable. Additionally they spot some non-linearities in the price convergence process – convergence is faster when the initial price differences are larger and with the diminishing difference between the prices the speed declines. The differences in the prices between the US cities are the biggest for the services (non-tradable goods).

Engels and Rogers (2004) argue that there is no convergence after the introduction of the euro (1999), however they figure out that substantial reduction of the price differentials occurred in the decade before the EMU foundation. Similarly to the other papers they confirm stronger reduction of the price dispersion for the tradable goods than for the non-tradable ones. Sosvilla-Rivero and Fil-Pareja (2004) analysing convergence among 12 euro area countries find that convergence did not occur for the non-tradable goods as well as for the goods under special taxes or regulations. Similar outcomes are reached, to name only a few, by Allington, Kattuman and Waldman (2005), Rogers (2001) or Grauwe and Schnabl (2005).

The analysis of the convergence process in the Central and Eastern European countries (CEE countries) which jointed the EU in 2004 and 2007 was conducted, among others, by Wolszczak-Derlacz and De Blander (2009), Faber and Stockman (2007) and Dräger et al. (2007). The outcomes of their research confirm the ongoing process of the price convergence, especially for the tradable good.

On the other hand, there is a part of the literature that questions the ongoing price convergence. For example Lutz (2003) analyses the price convergence among the EMU countries using individual data on the prices of cars, "The Economist", Big Mac and from the USB data base². The outcomes show little evidence on price convergence in the first 3 years of the EMU. Buseti et al (2007) in their research show that common currency helps to stabilize country's inflation but some discrepancies on the price level remained.

² Data base provided by the UBS on the prices of selected goods and services (122) in 72 cities in the world.

Apart from the process of convergence the literature focuses also on its determinants. In general it is considered that the low income countries have lower price level. The economic developments and catching up process leads to the higher income and thus to higher price level (Figure 1).

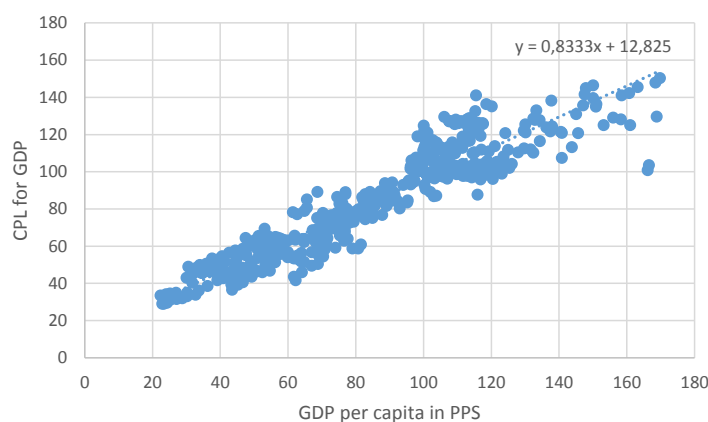


Figure 1 Relationship between comparative price level for GDP and GDP per capita in PPS (EU15=100) for EU countries in 1999-2016.
Source: Eurostat, own calculations.

This part of the literature is also substantial, however concentrates mainly on the period after EU enlargement. The authors use different determinants of the convergence process, like openness, level of the development, market competitiveness, role of the government sector, exchange rate regime, etc. Dreger et al. (2007) divide determinants of the convergence process into two groups – related to the catching-up process and to the competitiveness. The outcomes, according to the intuition, confirm that catching up positively influence the price level and higher competitiveness leads to lower price level. Their research indicate that countries with initial low price level experience higher inflation. Bauer (2014) concentrates on the influence of the relative level of development and exchange rate on prices. As his sample spans up to 2013 he also shows the influence of the global financial crisis on the price convergence. He finds that after 2009 the price convergence reversed and stagnated in the following years. He suggests that it may also be the result of the nominal exchange rate depreciation. Zdarek (2013) in the research on the convergence to avoid problem of model misspecification and problem of omitting factors influencing convergence process uses Bayesian Model Averaging to tests a bulk of different model's specification with different explanatory variables. His benchmark model supports the results of the previous research that labour costs, output gap (Čihák and Holub, 2005) or institutional factors (Dreger et al., 2007) are important determinants of the price convergence.

The process of the nominal convergence in the recent years is questionable as in the new member states after the accession to the EU we observed significantly lower price level not followed by significantly higher inflation rates than in the EA countries. In addition in the recent years some of the CEE countries experienced deflation which, on average, was not the case of the euro area.

There is a question whether the global financial crisis changed the process of price convergence. On the one hand after the GFC the globalization process as well as the international trade slowed down what can implicate the decrease of the convergence process speed. On the other hand much stronger crisis in the euro area than outside euro area countries could boost the process of real convergence and what follows also of the nominal one. Regardless of the changes in the speed of convergence the GFC could bring the changes of the determinants of this process. Thus, the aim of our paper is to analyse the process

of price convergence as well as its determinants in CEE countries with a focus on the years after the outbreak of the financial crisis. In the first step we analyse whether the nominal convergence in the European Union countries, which started before the EU enlargement, after the global financial crisis is still at work. In the second step we try to establish the factors behind the price's convergence, like the level of the country's development, openness of the economy or market's competitiveness among the European countries. In our research we focus on CEE countries as they are in the process of the catching up towards the old member states (the 12, core euro area countries).

The rest of the paper is structured as follows. In Section 2 we specify the method and the data used in the research. Section 3 describes the main findings, and finally, Section 4 concludes.

2. Method and data

a. Method

In our empirical analysis we look at price convergence from several different angles. First, we test whether the relative price levels (CPL_t) across countries are stationary:

$$CPL_t = p_i - p^*$$

Where: p_i is the logarithm of the price level in country i and p^* is the price level of the reference group of countries (in our case EU 27=100).

According to the purchasing power parity theory the prices in the long term converge to the same level (strong version of the PPP) or at least reach a point where they are proportional (weak version of the PPP). One way of looking at the price convergence is to check whether the relative prices are mean reverting, i.e. are stationary. To test it we use panel unit root test proposed by Harris and Tzavelis³ (Harris, and Tzavalis, 1999, Crucini and Shintani, 2008). The idea behind it is the following. First we assume that the series of prices in all countries are nonstationary, then we test whether the deviations from the group mean are stationary, which may be a sign of convergence. Due to relatively short sample period, the test is conducted for the whole period and it aims at answering the question whether the price levels in different product groups across 30 of the European economies have been converging during the period of 1999-2016.

Wolszczak-Derlacz and De Blander (2009) view panel unit root testing as a formal test of beta convergence. Following this procedure, in the next step we try to assess the degree of absolute beta convergence which assumes the negative relationship between the initial level of prices and their rate of change in the period under analysis (Barro and Sala-i-Martin (1992) design the concept of beta convergence for the cross-country levels of income, and we apply this concept directly to the price convergence). In order to measure the overall rate of absolute beta convergence in the selected groups of products we estimated beta parameter in the following cross sectional regression:

$$\ln\left(\frac{CPL_{i,T}}{CPL_{i,t0}}\right)\frac{1}{T} = \alpha + \beta \ln(CPL_{i,t0}) + \epsilon_i$$

³ We use Harris-Tzavalis (1999) test for panel unit root, corrected for short sample and cross-sectional mean.

In addition we can also calculate the speed of the convergence: $\lambda = -\ln(1 + \beta)$ and half life: $t^* = \frac{\ln(2)}{\lambda}$.

Assessing convergence basing only on the speed of mean reversion is often criticised. Quah, 1993 and Friedman, 1992, argue that the negative parameter β from the regression above may not be connected to the convergence process itself, but is a symptom of the mean reversion tendency of different samples from the same distribution (so called Galton's fallacy). What is more, mean reversion of relative price levels does not necessarily mean that price dispersion across countries diminishes (Young, Higgins and Levy, 2008). In the literature is often said that beta convergence is necessary but not sufficient condition for the sigma convergence.

A direct way of knowing whether the prices have lower dispersion across countries is to measure sigma convergence (Young, Higgins and Levy, 2008). In our empirical analysis we calculate standard deviations of disaggregated price indices across countries and test whether they are equal in different points in time. Two tests are employed: a non-conditional test of equal variances (Levene, 1960) and Carre-Klomp (1997) test.

After this detailed description of the price convergence in different product groups (both beta and sigma convergence), in the final part of the empirical exercise, we try to investigate the determinants of the convergence process using dynamic panel analysis.

b. Data

In the literature the analysis of the price convergence is conducted using either indicators (e.g. CPLs) or using individual price data. Both approaches have advantages and disadvantages. Using the CPL indicators (or PPP), which are aggregates does not allow us to determine whether the convergence occurred in all subaggregates or only in some components. In addition there is a problem of the weights used to calculate aggregates. Firstly they change year by year, what is especially visible for the developing countries⁴. Secondly each country has different weighting scheme as the consumption pattern differ among them. On the other hand, basing the analysis on the prices of individual products we can encounter the problem of comparability of the products between the countries, e.g. different quality of goods – products in the developing countries may be of inferior quality than in developed ones.

In our research we analyse the price convergence using comparative price level indices (CPL), which are calculated as part of the Eurostat-OECD Purchasing Power Parity Programme. They measure relative price level, which is the purchasing power parity index (PPP_t – a ratio of prices in national currencies for the same product in different countries) corrected for the nominal exchange rate (ER_t – exchange rate to the unit of PPP, which is 1 EUR in case of Eurostat calculations and USD for the comparisons calculated by the OECD):

$$CPL_t \equiv \frac{PPP_t}{ER_t};$$

Comparative price levels are available at different aggregation levels: starting at the GDP level (which indicates the total price level in the economy), through much narrow indices, such as 3 or 4 digit COICOPs and finally at the single product level. Overall, there are 61 aggregated indices ("analytical

⁴ E.g. the share of the food and non-alcoholic beverages in CEE on average declined by around 10 pp. since 2000, whereas for the old member states only by 2 pp.

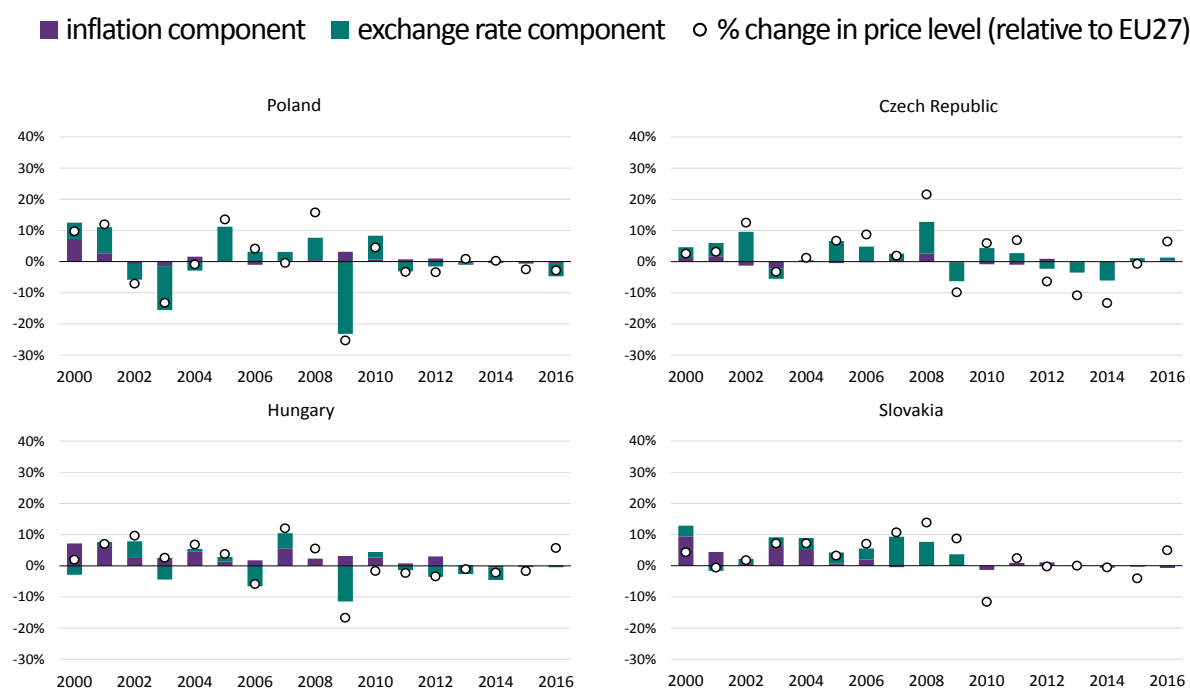
categories”) and 276 small, well-defined groups of products (“basic headings”). Due to the time series length and data availability we use only consumption analytical categories (see appendix 1 for the details).

The methodology of price collection for the purpose of PPP comparisons is similar to price collection, although some differences remain. The most substantial difference is the selection of the product which price is to be collected. In case of the CPI the decision on the product is dependent on the price collector and may differ from outlet to outlet unless it does not change over time. On the contrary such flexibility is not possible for the PPP purposes as the products must be spatially comparable. Therefore the collected products must be comparable between all countries and all outlets in which they are priced. Otherwise due to the quality differences the PPP estimates will be biased – either overestimated or underestimated. In addition they must be representative for the expenditures of the households in each country (Eurostat, 2012).

The dataset of the CPL indices is of annual frequency and available from 1999 up to 2016 for 31 European countries (members of EU and EEA). The base for comparison of PPP is European Union before the latest enlargement (i.e. EU15⁵).

The adjustment of the price level can occur through two channels: exchange rate and/or inflation. The importance of each channel depends on the exchange rate regime. In countries with a fixed exchange rate the adjustment are only through the inflation, whereas in countries with a floating exchange rate the CPL changes are done by both channels and the relative importance of each channel may vary in time and between countries (compare e.g. Romania and Bulgaria on Figure 2).

Figure 2 Decomposition of the price convergence in CEE countries in 1999-2016 (in pp. EU15=100).



⁵ Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.



As for the determinants of the convergence, following the literature, we distinguish two main factors: catching up and competition. The catching up process manifest through GDP per capita, productivity gap between NMS and OMS or compensation of employees. The speed of convergence may be dampened by the administered prices whereas removal of the regulations can speed up the convergence process. Therefore in our analysis we also focus on the completion variables like sectoral openness (the share of total import and total export in the GDP), import penetration (share of the total import in the output on the sectoral level) or the level of regulations (tariffs, regulatory trade barriers from the Faser index and Heritage Foundation).

3. Results

a. Measuring and testing convergence

We start our empirical analysis with testing for both types of convergence: beta and sigma. From the theoretical perspective, beta convergence is considered as the necessary condition of sigma (Friedman (1992) and Quah (1993)), therefore we first test for the former type of convergence.

The results (Table 1) show that at 5% significance level convergence occurs for almost all of the main consumption groups, with the exception for education, housing and food and non-alcoholic beverages. For the first two components the hypothesis of nonstationarity was not rejected, for food and non-alcoholic beverages we can only reject it at 10% significance level. The results are not surprising, as the education and housing services (supplying water, electricity and gas) are mostly non-tradable as well as substantial part of their prices is administered, and as such, are less likely to converge in terms of prices.

Table 1 The results of a panel unit root test for comparative price levels

Product group:	z-stat (HT test)	p.val of HT test
COICOP aggregates:		
Actual individual consumption	-2,03	0,021 **
Food and non-alcoholic beverages	-1,50	0,067 *
Food	-1,59	0,056 *
Bread and cereals	-1,10	0,136
Meat	-1,84	0,033 **
Fish	-5,53	0,000 ***
Milk, cheese and eggs	-2,20	0,014 **
Oils and fats	-2,93	0,002 ***
Fruits, vegetables, potatoes	-2,72	0,003 ***
Other food	-3,32	0,000 ***
Non-alcoholic beverages	-1,58	0,057 *
Alcoholic beverages, tobacco, narcotics	-2,74	0,003 ***
Alcoholic beverages	-4,61	0,000 ***
Tobacco	-1,49	0,068 *
Clothing and footwear	-7,20	0,000 ***
Clothing	-6,81	0,000 ***
Footwear	-9,04	0,000 ***
Housing, water, electricity, gas and other fuels	-1,11	0,134
Electricity, gas and other fuels	-1,96	0,025 **
Household furnishings, equipment and maintenance	-4,51	0,000 ***
Furniture and furnishings, floor coverings	-6,83	0,000 ***
Households appliances	-9,01	0,000 ***
Health	-1,67	0,048 **
Transport	-3,84	0,000 ***
Personal transport equipment	-2,98	0,002 ***
Transport services	-6,13	0,000 ***
Communication	-4,79	0,000 ***
Recreation and culture	-6,41	0,000 ***
Audio-visual, photographic and info. proc. equipment	-19,60	0,000 ***
Education	1,44	0,925
Restaurants and hotels	-2,68	0,004 ***
Miscellaneous goods and services	-1,73	0,042 **
Goods/services aggregates:		
Consumer goods	-3,35	0,000 ***
Non-durable goods	-2,03	0,021 **
Semi-durable goods	-6,20	0,000 ***
Durable goods	-5,62	0,000 ***
Consumer services	-1,62	0,053 *

In order to measure the overall rate of beta convergence in these product groups we estimated beta parameter in the following cross sectional regression:

$$\ln\left(\frac{PLI_{i,T}}{PLI_{i,t0}}\right) = \alpha + \beta \ln(PLI_{i,t0}) + \epsilon_i$$

The results (Table 2) indicate that if we measure convergence in the period 1999-2008 ($T = 2008$ and $t_0 = 1999$) the beta parameter is negative and significant for all of the product groups⁶, including total individual consumption. However, if we look at the whole sample (i.e. set $T = 2016$ and $t_0 = 1999$), we can see that for a few components we cannot reject the hypothesis of $\beta = 0$. Those components are: housing, household appliances, health, recreation and culture, restaurants and hotels, miscellaneous goods and services, total consumer services and total consumption. First of all it shows that for a substantial part of the consumption basket the process of beta convergence stopped. In addition ample part of these components are services for which the process of the convergence is weaker and long-lasting. Therefore we can conclude that the prices of services are the main factor that reversed the convergence process. The confirmation may be that on an aggregated level goods (durable, semi-durable and non-durable) still undergo the process of price convergence, whereas for consumer service this process was present up to the outbreak of the global financial crisis (see the table 2, last five rows).

Therefore, in the following steps we evaluate sigma convergence. However, in doing so we also account for the possible break in the convergence process around year 2008.

First, we check whether the price dispersion has decreased since 1999. We measure the price dispersion of 37 product groups across 30 countries⁷ in three points in time: 1999, 2008 and 2016.

We apply Levene test (1960), which is a type of test based on the F distribution, but is less sensitive to non normal distribution of the underlying data. The null hypothesis of equal variances is rejected for most of the product categories when comparing the distribution of prices in 2008 with the distribution in 1999. On the other hand, if we look at the most recent changes in price dispersion (between years 2008 and 2016), we observe constant variance or statistically significant increase in the dispersion of three groups: household equipment, semi-durable goods and consumer services.

⁶ the only exception is Fish

⁷ EU28 together with Iceland, Norway, Switzerland, excluding Croatia for which the data is available from 2004 only.

Table 2 Estimates of the beta convergence

Product group:	beta estimates:		
	t0=1999; T=2008	t0=2009; T=2016	t0=1999; T=2016
COICOP aggregates:			
Actual individual consumption	-0,031 ***	0,018	-0,004
Food and non-alcoholic beverages	-0,049 ***	0,010	-0,015 ***
Food	-0,049 ***	0,012	-0,014 ***
Bread and cereals	-0,050 ***	0,005	-0,019 ***
Meat	-0,035 ***	0,021	-0,008 **
Fish	-0,023 *	-0,033 **	-0,014 **
Milk, cheese and eggs	-0,067 ***	-0,019	-0,017 ***
Oils and fats	-0,067 ***	-0,022 **	-0,028 ***
Fruits, vegetables, potatoes	-0,047 ***	0,001	-0,017 ***
Other food	-0,057 ***	0,028	-0,014 ***
Non-alcoholic beverages	-0,043 ***	-0,011	-0,016 ***
Alcoholic beverages, tobacco, narcotics	-0,031 ***	0,013	-0,010 ***
Alcoholic beverages	-0,045 ***	0,040	-0,007 **
Tobacco	-0,019 ***	-0,008	-0,013 ***
Clothing and footwear	-0,081 ***	0,019	-0,027 ***
Clothing	-0,088 ***	0,016	-0,030 ***
Footwear	-0,078 ***	0,004	-0,026 ***
Housing, water, electricity, gas and other fuels	-0,031 ***	0,025	-0,007 *
Electricity, gas and other fuels	-0,063 ***	-0,029 **	-0,033 ***
Household furnishings, equipment and maintenance	-0,054 ***	0,018	-0,011 **
Furniture and furnishings, floor coverings	-0,063 ***	-0,011	-0,013 **
Households appliances	-0,041 **	-0,011	0,000
Health	-0,026 ***	0,017	0,000
Transport	-0,040 ***	-0,001	-0,016 ***
Personal transport equipment	-0,043 ***	-0,038 **	-0,027 ***
Transport services	-0,049 ***	-0,004	-0,020 ***
Communication	-0,110 ***	-0,066 ***	-0,044 ***
Recreation and culture	-0,025 ***	0,013	-0,001
Audio-visual, photographic and info. proc. equipment	-0,074 ***	-0,013	-0,019 ***
Education	-0,022 ***	0,004	-0,005 *
Restaurants and hotels	-0,033 ***	0,004	-0,005
Miscellaneous goods and services	-0,024 ***	0,017	-0,001
Goods/services aggregates:			
Consumer goods	-0,051 ***	0,010	-0,017 ***
Non-durable goods	-0,048 ***	0,005	-0,018 ***
Semi-durable goods	-0,076 ***	0,027	-0,021 ***
Durable goods	-0,052 ***	-0,004	-0,018 ***
Consumer services	-0,025 ***	0,023	0,000

The significance was tested using t-stats, stars denote 1-sided significance levels: * - 0.01; ** - 0.05 *** - 0.001.

If the convergence is defined as the decline in the dispersion of a distribution over time, it is necessary that the process is mean reverting to the long run steady state and that the initial level of dispersion is higher than the steady state distribution. In such a case, simply comparing the variance in two points in time may lead to underestimating or even rejecting sigma convergence. Therefore, Carree and Klomp

(1997) propose a test for sigma convergence that takes into account the mean reversion (beta convergence) which results in higher power of the test. Mean reversion parameters are taken from the regressions of the PLI from the end period ($T1$) on the PLI from the first period ($T0$) for each of 37 product groups (i) across countries (c):

$$PLI_{i,c,T1} = \alpha_i + (1 - \beta_i)PLI_{i,c,T0} + \epsilon_{i,c}$$

The estimates of β_i indicate the speed of mean reversion (i.e. beta convergence), with $\beta_i = 1$ indicating complete convergence and $\beta_i = 0$ no convergence. Taking the parameter estimates into account, we calculated Carre, Klomp (1997) statistic, which is only available if the mean reversion occurs therefore for some of the components in the period 2008-2016 the convergence could not be tested (“n/a” in the table).

The results show that in 2016 the prices of most of the product groups had significantly lower dispersion than in 1999 (i.e the convergence occurred). The components for which the hypothesis of constant price dispersion could not be rejected have either a significant component of services (education, health, restaurants, recreation – the latter shows significant divergence) or are administered to large extent (housing, health, education).

If we break down the period of analysis into two subperiods, we can observe a considerable change in the convergence process. In the first subperiod (1999-2008) in all of the product groups we observed mean reversion (beta convergence) and almost all of the prices converged significantly in terms of price dispersion⁸. From 2008 to 2016 the process stopped for all of the component except for personal transport equipment⁹ and in 7 components a significant divergence can be observed. Most of the prices aggregated to product groups did not even present mean reversion.

⁸ There are five exceptions: Fish, Meat, non-alcoholic beverages, tobacco and household appliances.

⁹ Which include motor cars; motor cycles and bicycles and excludes maintenance and repair of personal transport equipment, spare parts and fuels; http://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services

Table 3 The mean reversion parameter (sigma convergence)

Product group:	1999-2016		1999-2008		2008-2016	
	mean reversion param.	p.val of Carree,Klomp (1997)	mean reversion param.	p.val of Carree,Klomp (1997)	mean reversion param.	p.val of Carree,Klomp (1997)
COICOP aggregates:						
Actual individual consumption	0,07	0,385	0,28	0,002 ***	-0,20	n/a
Food and non-alcoholic beverages	0,25	0,008 ***	0,44	0,000 ***	-0,13	n/a
Food	0,24	0,008 ***	0,44	0,000 ***	-0,15	n/a
Bread and cereals	0,32	0,001 ***	0,45	0,000 ***	-0,09	n/a
Meat	0,14	0,200	0,31	0,001 ***	-0,15	n/a
Fish	0,23	0,358	0,21	0,546	0,22	0,309
Milk, cheese and eggs	0,29	0,012 **	0,60	0,000 ***	0,01	<u>0,000</u> ***
Oils and fats	0,48	0,015 **	0,60	0,000 ***	0,00	n/a
Fruits, vegetables, potatoes	0,29	0,010 ***	0,42	0,000 ***	-0,01	n/a
Other food	0,25	0,073 *	0,51	0,000 ***	-0,29	n/a
Non-alcoholic beverages	0,27	0,178	0,38	0,114	0,09	0,281
Alcoholic beverages, tobacco, narcotics	0,17	0,044 **	0,28	0,003 ***	-0,03	n/a
Alcoholic beverages	0,11	0,167	0,40	0,000 ***	-0,27	n/a
Tobacco	0,23	0,038 **	0,17	0,098 *	0,12	0,249
Clothing and footwear	0,46	0,003 ***	0,73	0,000 ***	0,11	<u>0,002</u> ***
Clothing	0,51	0,001 ***	0,79	0,000 ***	0,23	<u>0,021</u> **
Footwear	0,44	0,023 **	0,70	0,000 ***	0,12	<u>0,001</u> ***
Housing, water, electricity, gas and other fuels	0,11	0,312	0,28	0,002 ***	-0,22	n/a
Electricity, gas and other fuels	0,56	0,000 ***	0,56	0,000 ***	0,21	0,653
Household furnishings, equipment and maintenance	0,18	0,175	0,48	0,000 ***	-0,15	n/a
Furniture and furnishings, floor coverings	0,21	0,432	0,57	0,001 ***	0,03	<u>0,000</u> ***
Households appliances	-0,01	n/a	0,37	0,790	0,18	0,178
Health	0,00	n/a	0,23	0,022 **	-0,19	n/a
Transport	0,27	0,003 ***	0,36	0,000 ***	0,05	<u>0,031</u> **
Personal transport equipment	0,46	0,000 ***	0,39	0,063 **	0,35	0,072 *
Transport services	0,35	0,003 ***	0,44	0,000 ***	0,05	<u>0,029</u> **
Communication	0,74	0,046 **	0,99	0,000 ***	0,42	0,153
Recreation and culture	0,02	<u>0,027</u> **	0,23	0,031 **	-0,17	n/a
Audio-visual, photographic and info. proc. equipment	0,33	0,063 *	0,66	0,000 ***	0,44	0,133
Education	0,08	0,322	0,20	0,017 **	-0,09	n/a
Restaurants and hotels	0,08	0,498	0,30	0,013 **	-0,14	n/a
Miscellaneous goods and services	0,02	0,763	0,21	0,017 **	-0,16	n/a
Goods/services aggregates:						
Consumer goods	0,28	0,001 ***	0,46	0,000 ***	-0,05	n/a
Non-durable goods	0,31	0,000 ***	0,43	0,000 ***	-0,02	n/a
Semi-durable goods	0,36	0,018 **	0,69	0,000 ***	-0,05	n/a
Durable goods	0,31	0,020 **	0,47	0,003 ***	0,23	0,231
Consumer services	0,00	n/a	0,23	0,009 ***	-0,23	n/a

The stars: *, ** and *** denote significance level: 0.1; 0.05 and 0.01, respectively. In cases where the null was rejected and there was an increase in price dispersion we can conclude that we observe statistically significant divergence. These few cases in the table are underlined.

4. Conclusion

In our paper we analyse the price convergence process in the CEE countries with emphasis on the period after the outbreak of the global financial crisis. We deal with disaggregated price level indices to investigate the convergence process of prices in the respective (subsequent) groups of goods and services. To do it we conduct the panel data analysis.

- For the whole sample we find statistically significant beta convergence for most subaggregates in the consumption basket. However by splitting the sample into two subsamples: before and after global financial crisis we document that the price convergence process was present up to 2008 and stopped after the outbreak of the global financial crisis.
- The outbreak of the financial crisis stopped the price convergence process measured by the sigma parameter as well. Moreover in some cases we find statistically significant price divergence.
- We believe that the main factor contributing to the slowdown of the convergence process may be the decline of the real convergence after 2009 which was especially visible for the old member states (cf. Grela et al., 2017). The second important factor affecting the weakening of the convergence process may be higher protection of the domestic markets in several European countries after the crisis.

Bibliography

Allington, Nigel FB, Kattuman, Paul A and Waldmann, Florian A, (2005), One Market, One Money, One Price?, MPRA Paper, University Library of Munich, Germany.

Balassa B., 1964, The Purchasing Power Parity Doctrine: A Re-Appraisal, *Journal of Political Economy*, 72(6), 584-596.

Bauer P., 2015., Factors of price convergence and its estimated level in Hungary, MNB Occasional Papers 2015/119, Magyar Nemzeti Bank (Central Bank of Hungary).

Bliss, C., 1999, Galton's Fallacy and Economic Convergence. *Oxford Economic Papers*, 51(1), 4-14.

Busetti F., L. Forni, A. Harvey, F. Venditti, 2007, Inflation Convergence and Divergence within the European Monetary Union, *International Journal of Central Banking*, *International Journal of Central Banking*, vol. 3(2), pages 95-121, June.

Čihák, M., Holub, T., 2005, Price convergence in EU-accession countries: Evidence from the international comparison, *Économie internationale*, vol. 102, 2005, No. 2, pp. 59–82.

Crucini M.J., Shintani M., 2008, Persistence in Law-of-One-Price Deviations: Evidence from Micro-data, *Journal of Monetary Economics*, Volume 55, Issue 3, p. 629-644

Dreger C., K. Kholodilin, K. Lommatzsch, J. Slacalek, P. Wozniak, 2007., Price Convergence in the Enlarged Internal Market, Discussion Papers of DIW Berlin 730, DIW Berlin, German Institute for Economic Research.

Engel C., 1993, Real exchange rates and relative prices : An empirical investigation, *Journal of Monetary Economics*, Elsevier, vol. 32(1), pages 35-50, August.

Engel C., J. H. Rogers, 2004, European product market integration after the euro, *Economic Policy*, CEPR; CES; MSH, vol. 19(39), pages 347-384, 07.

Eurostat, 2012, Eurostat-OECD Methodological Manual on Purchasing Power Parities, Methodologies and Working papers, Luxembourg 2012.

Faber P.R., AD C.J. Stokman, (2009). A Short History of Price Level Convergence in Europe. *Journal of Money, Credit and Banking*. 41. 461-477. 10.1111/j.1538-4616.2009.00215.x.

Friedman M., 1992, Do Old Fallacies Ever Die?, *Journal of Economic Literature*, American Economic Association, vol. 30(4), pages 2129-2132, December.

Grauwe P., G. Schnabl, 2005, Nominal Versus Real Convergence - EMU Entry Scenarios for the New Member States, *Kyklos*, Wiley Blackwell, vol. 58(4), pages 537-555, November.

Grela M., A. Majchrowska, T. Michałek, J. Mućk, A. Stążka-Gawrysiak, G. Tchorek, M. Wagner, 2017, Is Central and Eastern Europe converging towards the EU-15?, NBP Working Papers 264, Narodowy Bank Polski, Economic Research Department.

Harris, R.D.F., Tzavalis, E., 1999, Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of Econometrics* 91 (2), 201–226.

Hoarau J.F., S. Blancard, P.Jean-Pierre, 2009, Testing for nominal convergence in the Central American area: evidence from panel data unit-root tests, *Applied Economics Letters*, Taylor & Francis Journals, vol. 16(11), pages 1171-1174.

Isard P., 1977, How Far Can We Push the "Law of One Price"?, *American Economic Review*, 67, issue 5, p. 942-48

Lutz M., 2003, Price Convergence under EMU? First Estimates, *Royal Economic Society Annual Conference 2003* 143, Royal Economic Society.

Lutz M., 2004, Pricing in Segmented Markets, Arbitrage Barriers, and the Law of One Price: Evidence from the European Car Market. *Review of International Economics*, Vol. 12, No. 3, pp. 456-475, August 2004.

Obstfeld M., K. S. Rogoff, 1996, *Foundations of International Macroeconomics*, MIT Press Books, The MIT Press, edition 1, volume 1, number 0262150476, January.

Obstfeld, M., A.M. Taylor, 1997, Nonlinear Aspects of Goods-Market Arbitrage and Adjustment: Heckscher's Commodity Points Revisited, *Journal of the Japanese and International Economies*, Elsevier, vol. 11(4), pages 441-479, December.

Parsley D.C., S-J. Wei, 1996, Convergence to the Law of One Price Without Trade Barriers or Currency Fluctuations, *The Quarterly Journal of Economics*, Oxford University Press, vol. 111(4), pages 1211-1236.

Quah D., 1993, Galton's Fallacy and Tests of the Convergence Hypothesis, *Scandinavian Journal of Economics*, Wiley Blackwell, vol. 95(4), pages 427-443, December.

Rogers J.H., 2001, Price level convergence, relative prices, and inflation in Europe, *International Finance Discussion Papers* 699, Board of Governors of the Federal Reserve System (U.S.).

Rogoff K., 1996, The Purchasing Power Parity Puzzle, *Journal of Economic Literature*, American Economic Association, vol. 34(2), pages 647-668, June.

Samuelson, P. 1964, Theoretical Notes on Trade Problems. *Review of Economics and Statistics* 46(2), 145-164.

Sosvilla-Rivero S., S. Gil-Pareja, 2004, Price convergence in the European Union, *Applied Economics Letters*, Taylor & Francis Journals, vol. 11(1), pages 39-47.

Wolszczak-Derlacz, J., R. De Blander, (2009), Price convergence in the European Union and in the New Member States, *Bank i Kredyt*, 40, issue 2, p. 37-59.

Zdarek, V., (2015), A Robust Search for Determinants of Price Convergence in European Union – Known “Suspects” or New “Villains”?, *ACTA VSFS*, 9, issue 1, p. 7-41.

Appendix A.

Table 4 Standard deviation of CPL across countries in three points in time: 1999, 2008 and 2016 together with the p-values of the sigma

Product group:	st.dev. in 1999	significance of 2008-1999 change (p.val)	st.dev. in 2008	significance of 2016-2008 change (p.val)	st.dev. in 2016
COICOP aggregates:					
Actual individual consumption	0,35	0,056 *	0,27	0,125	0,34
Food and non-alcoholic beverages	0,33	0,031 **	0,21	0,385	0,26
Food	0,34	0,029 **	0,21	0,353	0,27
Bread and cereals	0,40	0,016 **	0,24	0,482	0,29
Meat	0,44	0,119	0,32	0,529	0,41
Fish	0,23	0,990	0,23	0,509	0,22
Milk, cheese and eggs	0,32	0,020 **	0,19	0,118	0,25
Oils and fats	0,27	0,012 **	0,17	0,430	0,21
Fruits, vegetables, potatoes	0,35	0,126	0,24	0,679	0,28
Other food	0,31	0,026 **	0,19	0,167	0,27
Non-alcoholic beverages	0,26	0,263	0,22	0,875	0,23
Alcoholic beverages, tobacco, narcotics	0,46	0,198	0,35	0,558	0,39
Alcoholic beverages	0,49	0,057 *	0,33	0,211	0,46
Tobacco	0,53	0,424	0,47	0,805	0,45
Clothing and footwear	0,25	0,000 ***	0,13	0,144	0,18
Clothing	0,25	0,000 ***	0,13	0,196	0,18
Footwear	0,22	0,000 ***	0,12	0,122	0,17
Housing, water, electricity, gas and other fuels	0,44	0,168	0,34	0,121	0,43
Electricity, gas and other fuels	0,37	0,017 **	0,22	0,950	0,21
Household furnishings, equipment and maintenance	0,22	0,002 ***	0,14	0,057 *	0,20
Furniture and furnishings, floor coverings	0,20	0,052 *	0,14	0,103	0,20
Households appliances	0,12	0,505	0,14	0,539	0,16
Health	0,45	0,127	0,37	0,188	0,48
Transport	0,27	0,014 **	0,19	0,256	0,21
Personal transport equipment	0,23	0,144	0,19	0,729	0,16
Transport services	0,42	0,008 ***	0,28	0,567	0,31
Communication	0,32	0,037 **	0,21	0,321	0,25
Recreation and culture	0,28	0,206	0,23	0,170	0,30
Audio-visual, photographic and info. proc. equipment	0,13	0,137	0,09	0,757	0,11
Education	0,70	0,264	0,58	0,559	0,68
Restaurants and hotels	0,33	0,205	0,27	0,169	0,33
Miscellaneous goods and services	0,34	0,147	0,28	0,226	0,35
Goods/services aggregates:					
Consumer goods	0,26	0,006 ***	0,16	0,301	0,20
Non-durable goods	0,31	0,007 ***	0,19	0,531	0,22
Semi-durable goods	0,22	0,000 ***	0,11	0,073 *	0,17
Durable goods	0,17	0,060 *	0,13	0,348	0,14
Consumer services	0,39	0,127	0,31	0,091 *	0,41

The test of equal variances is based on Levene (1960) statistic, which has an F distribution under the null hypothesis of equal variances. The stars: *, ** and *** denote significance level: 0.1; 0.05 and 0.01, respectively.