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Income Convergence and Inflation in Central and Eastern Europe: Does the Sun Always Rise in the East?

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Income Convergence and Inflation in Central and Eastern Europe: Does the Sun Always Rise in the East?

Karsten Staehr*

Abstract

This paper investigates the process of price convergence in the 10 new EU countries from Central and Eastern Europe. The analyses are based on panel data from 1995 to 2008 of the common currency price relative to the EU15 average. The lagged income level exhibit little explanatory power towards relative inflation, while the lagged price level has some explanatory power. In the long term the relative income and price levels are closely correlated implying concurrent nominal and real convergence. Deviations from the long-term relation between price and income levels are gradually closed by changes in relative inflation and GDP growth, but the process of convergence appears to be rather slow. In the short term the capital inflows associated with current account deficits put substantial upward pressure on the relative price inflation, while the Balassa-Samuelson effect appears to be subdued.

JEL Code: E31, O57, P24

Keywords: real convergence, nominal convergence, real exchange rate, inflation, transition economies

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Non-technical summary

This paper examines the process of price convergence in the 10 countries from Central and Eastern Europe that joined the European Union in either May 2004 or January 2007. During the period 1995–2008 all 10 countries have seen their domestic price levels converge towards the average EU15 level through nominal exchange rate appreciation and/or high domestic inflation.

The paper investigates to which extent the process of nominal convergence is tied to the income level or the process of income convergence having taken place in period 1995–2008. One question is thus if relative price increases can be considered an "inevitable" result of income convergence. This question has inspired the subtitle of the paper. Another, related, issue concerns the importance of different factors that may affect the relative inflation in the short term. Selected supply and demand factors are considered.

No economic theory links trend growth and real appreciation ***directly***, but a number of theories propose ***indirect*** relations, where trend growth is associated with features such as differential productivity growth, changing expenditure patterns, tax changes etc., which then affect the real exchange rate. The lack of a direct link between income and price levels implies that the stylised fact of a close association between income and price levels is somewhat puzzling and makes the study of price convergence compelling.

The paper uses annual panel data estimations for 1995–2008 in order to investigate in some detail the ***extent*** and ***speed*** of price level convergence in the 10 new EU countries. The main conclusion of the empirical analyses in the paper is that relative income and price levels have been closely correlated in the new EU countries. Gaps in the long-term relation between price and income levels are gradually closed by relative inflation changes; the adjustment to the long-term convergence path is relatively slow and takes place through both price inflation and GDP growth. The long-term relationship between price and income levels only gradually affects the short-term developments of relative inflation.

Regarding the short-term development of GDP inflation relative to the EU15, a number of other results were obtained. First, the relative income level has little or no explanatory power on inflation, whereas the price level has more explanatory power. Second, although higher productivity growth in traded sectors than in non-traded sectors is likely to affect relative inflation, the Balassa-Samuelson effect is difficult to estimate precisely. Third, the current account balance seems to have a strong effect on inflation. Capital inflows are typically seen as a vehicle of real catch-up in the region and policymakers in the region have frequently sought to stimulate capital inflows

(Fabrizio, 2009a). The results suggest that the rapid capital inflows in the period 2003–2008 may have contributed to real appreciation *in excess of* what the expansion of output would have justified, possibly because of a lack of absorptive capacity.

Starting in 2008, the global financial crisis has fundamentally changed the macroeconomic landscape in which the new EU countries from Central and Eastern Europe operate. The results are lower growth, sectoral reallocations of output and consumption as well as reduced capital inflows. The analyses in this paper suggest that these factors will markedly affect inflation developments in the new EU countries, notwithstanding the long-term co-movement of prices and income.

Contents

1. Introduction

This paper examines the process of price level convergence in the 10 countries from Central and Eastern Europe that joined the European Union in either May 2004 or January 2007.[1] All 10 countries have experienced rapid real exchange rate appreciation during the period from 1995 to 2008 and have seen their domestic prices converge towards Western European levels through nominal exchange rate appreciation and/or high domestic inflation.

Figure 1 shows the unweighted averages of two different real exchange rate measures for the 10 new EU countries. The measures are based on the GDP price index and the household consumption price index, respectively, both of which are expressed in a common currency and as percent of the corresponding EU15 average. The relative prices of GDP and household consumption grew substantially during the sample period 1995–2008, and this is reasonably seen as a trend towards EU15 price levels. It is also noticeable that the average real appreciation gained momentum after 2004, the year in which most of the countries joined the EU.

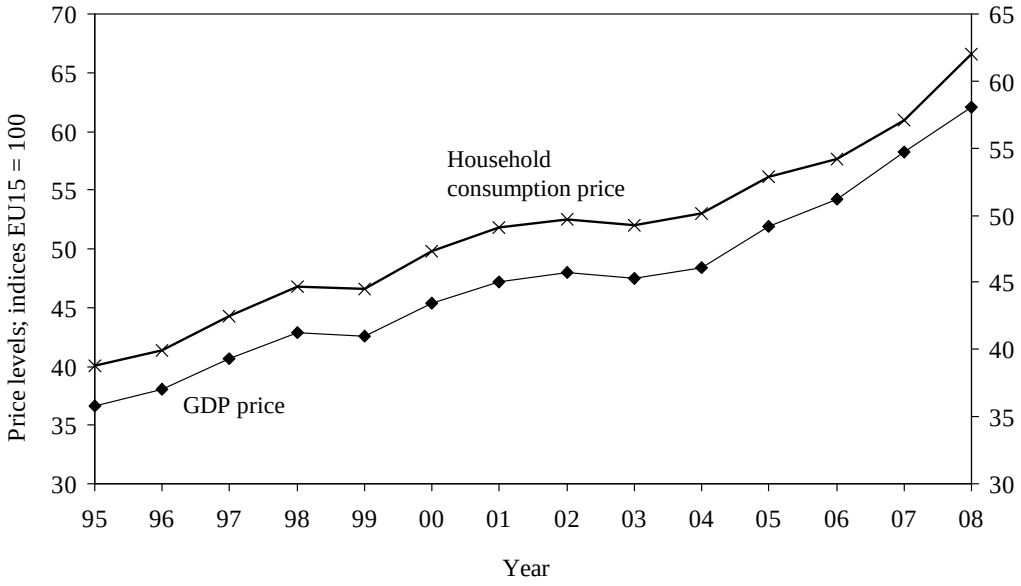

Figure 1: GDP price and household consumption price in common currency, unweighted averages for the 10 new EU countries; indices, EU15 = 100

Source: Eurostat (2010a, 2010b); author's calculations.

[1] Malta and Cyprus also joined the European Union in January 2004, but they will not be included in the analyses as their income levels and institutional background set them apart from the new EU members from Central and Eastern Europe.

Coinciding with the process of price level convergence, the new EU members experienced rapid income growth. The strong growth performance since the mid-1990s occurred amid low initial income levels reflecting the region's history of economic backwardness, decades of Soviet hegemony and the deep recessions after the dissolution of the command economies. The new market-based economies have exhibited high rates of economic growth, in particular in the period 2001–2007. As a consequence, the gap in per capita GDP between the new and the old EU15 members has narrowed. Financial crises and other shocks have led to temporary setbacks. The global financial crisis which started in 2008 has hit the region particularly hard, but the medium-term growth prospects are unlikely to have been fundamentally impaired.

Figure 2 shows indices of per capita GDP level (in purchasing power terms) and the GDP price level (measured in a common currency) for the 10 CEE countries from 1995 to 2008 relative to the EU15 averages.[2] The figure reveals a clear correlation between income and price levels over time, but it is also apparent that countries at various times have deviated substantially from that path. Most strikingly, the Czech Republic has for extended period had a lower price level than other new EU countries at comparable income levels. Another observation is that most of the data points are situated above the diagonal, signifying that the relative price level has generally been above the relative income level.

Figure 3 is a cross plot of the per capita GDP level and the GDP price level for all EU countries except Luxembourg. A close relationship between the income level and the price level is apparent, and although the new EU countries have comparatively low income levels, they clearly follow the same overall pattern as the rest of the EU countries.

The close correlation between the income and price levels depicted in Figures 2 and 3 suggests that the processes of real and nominal convergence are interrelated. A regression line through the data points of Figure 3 explains 87 percent of the cross-country variation of the GDP price level. On the other hand, it is clear that there is no one-to-one relation between income and price levels. There is still substantial variation around the regression line. For instance, among the countries with a price level in the region of 70 percent of the EU15 average, the range of GDP spans from less than 60 percent to almost 80 percent of the EU15 average.

[2] A similar picture emerges if the price level of household consumption is used instead of the GDP price level.

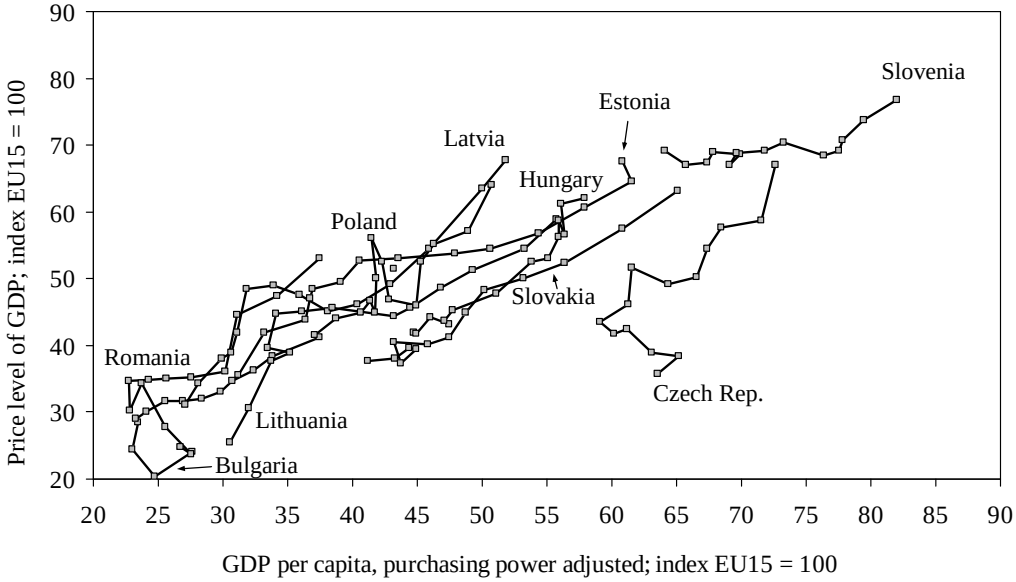

Figure 2: Relative per capita GDP and relative common currency GDP price level in the new EU countries; 1995–2008

Source: Eurostat (2010a, 2010c), WEO (2009); author's calculations

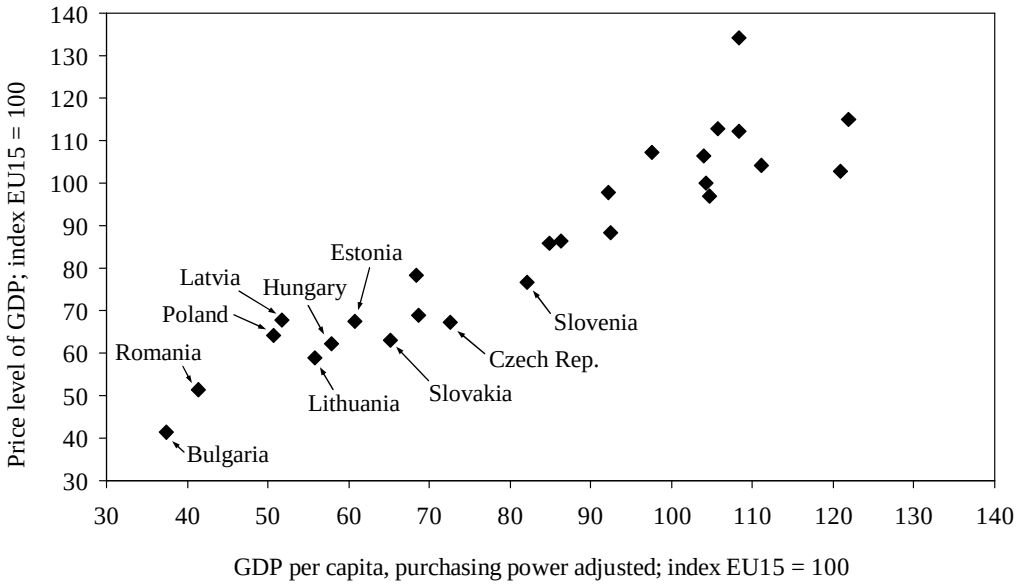

Figure 3: Relative per capita GDP and relative common currency GDP price level in 26 EU countries, 2008

Note: Luxembourg is not included.
Source: Eurostat (2010a, 2010b); author's calculations.

The discussion above has brought up two main points: First, the price level in the new EU countries (when measured in a common currency) has increased rapidly since 1995, having started from a low initial level. Second, the price and income levels have been tightly correlated, both across countries at a given time and across time for a given country. These findings are broadly congruent to the *stylised fact* — found across a large number of developed and developing countries — that income and price levels are closely correlated (Kravis and Lipsey, 1988; Wood, 1998; Ito et al., 1999).

This paper uses panel data estimations in order to investigate in some detail the *extent* and *speed* of price level convergence in the 10 new EU countries from 1995 to 2008. One of the main issues addressed is whether the income level has substantial explanatory power regarding the process of nominal convergence, i.e. whether relative price increases (real appreciation) can be considered an "inevitable" result of income (real) convergence? This question has inspired the subtitle of the paper. Another, related, issue concerns the importance of different factors that may affect the relative inflation in the short term. The two main factors relating, respectively, to selected supply and demand factors are considered. The main supply factor in the literature is the Balassa-Samuelson effect stemming from differential productivity growth in non-traded and traded sectors. The main demand factor is arguably capital inflows stimulating domestic demand.

An empirical analysis of these issues is important for several reasons. First, the price convergence process might lead to high inflation, which can disrupt the role of prices in signalling relative scarcities. Second, from the group of new EU members from Central and Eastern Europe, Slovenia and Slovakia had by 2009 joined the euro area, while the remaining eight countries were still under an obligation to join in the future. Membership is, however, conditional on an applicant country satisfying the convergence criteria set out in the Maastricht Treaty, including nominal exchange rate stability and stable low inflation. Nominal convergence entails real exchange rate appreciation, which emerges as nominal exchange rate appreciation or domestic inflation, and may thus jeopardise the prospect of fulfilling the two Maastricht criteria (Dobrinsky, 2006; Lewis, 2009). Finally, the process of price level convergence is linked to the external competitiveness of a country. In particular, excessive real appreciation may undermine the external competitiveness of the country affected, and possibly also make the country more vulnerable to financial instability (Lommatzsch and Tober, 2004; Fabrizio et al., 2009). These issues feature prominently in policy debates regarding exchange rate and other policies in Central and Eastern Europe (*The Economist,* 2009; Zoli, 2009).

The rest of the paper is organised as follows. Section 2 comprises a conceptual discussion of the factors behind the non-equalisation of prices across

borders. Section 3 provides a discussion of the price and income developments in the new EU member countries during the period 1995–2008. Section 4 produces estimates of "simple" price level convergence in the new EU countries. Section 5 is the main analytical section examining convergence within a co-integration framework. Finally, Section 6 concludes the paper.

2. Relative prices and relative income levels

The starting point for the analysis of price level convergence is usually the theorems of purchasing power parity, which in turn are based on the conception of arbitrage trade (Froot and Rogoff, 1995). Different countries having different price levels when measured in a common currency is tantamount to a rejection of ***absolute*** purchasing power parity. If the inflation rates measured in a common currency do not coincide, ***relative*** purchasing power parity does not hold. In other words, the issue of price level convergence and common currency inflation differentials is closely related to the reason for the purchasing power parity theorems not being satisfied.

The main building block of the purchasing power parity theorems is the law of one price, which states that the same traded product should be available at different locations at the same price (measured in common currency units). The underlying argument is that arbitrage will lead to equalisation of common currency prices given various assumptions regarding duties and taxes, transportation, information acquisition and other transaction issues. Evidently the law of one price can only be expected to hold for products that can be traded, i.e. where the transaction costs do not prevent trade. From this it follows that absolute PPP is more likely to hold when all items in the price index are traded products. However, even if all products are traded and transaction costs are small, absolute PPP may still fail to hold if different countries have different index baskets, so that the weights in the price index vary across countries.

Non-traded products comprise a substantial share of total production and consumption, also in the new EU member countries. The law of one price does not apply to these products and there is thus no ***direct*** mechanism linking the price of non-traded products to the price level abroad. Price equalisation of non-traded products across countries would require that the equalisation of the prices of traded products, inclusive of production factors, in some way affect non-traded prices. This all means that diverging price levels measured in common currency units can be due to non-equalisation of both traded prices and non-traded prices as well as to the different compositions of the price indices.

Price level convergence implies that the price of a basket increases faster than the common currency price of a corresponding basket in the reference area with an initial higher price level. In other words, price level convergence takes place through domestic prices increasing faster than in the reference area and/or through nominal appreciation of the exchange rate. If the price indices considered are broad indices, then the nominal convergence process amounts to an appreciating *real* exchange rate.[3]

In practice the distinction between traded and non-traded products can never be clear-cut. All traded products will include a share of non-traded inputs consisting of, *inter alia*, transportation, retail sale, advertisement and warranty repair, which in almost all cases are produced locally subject to only limited foreign competition. Thus, in practice a traded product will comprise both traded and non-traded elements. Likewise, most non-traded products will contain internationally traded inputs. Finally, the dividing line between traded and non-traded products will also change over time as means of transportation, information technology, product characteristics and consumer preferences change.

Empirical work confirms that the price inflation of traded products is higher in the new EU countries than in the euro area (Egert et al., 2003). The impracticality of making a clear distinction between traded and non-traded products may partly explain this result insofar as the prices of traded products include remuneration for the non-traded components of the traded good.

The discussion above points to two main sets of explanations for nominal convergence, namely, i) increased market opening and ii) factors affecting the prices of non-traded products (and the non-traded component of traded products). Regarding increased cross-border integration, the effect will depend on the price of the product prior to the market opening as market opening would be expected to increase prices of products with initially low prices.

The factors affecting non-traded prices might be grouped into supply-side and demand-side factors (for detailed discussions, see Egert, 2007, 2008 and Staehr, 2009). The supply-side explanation, which is most frequently considered, is the Balassa-Samuelson hypothesis according to which higher productivity growth in the traded than in the non-traded sector leads to real appreciation. The argument is that high productivity growth leads to high wage growth in that sector, which is carried over to the non-traded sector and leads to higher relative prices because of the lower productivity growth in that sector. Other supply-side explanations consider the effects of capital deepening

[3] Another way to state this point is that nominal convergence is associated with increasing prices measured in foreign currency units.

and overall productivity growth in economies with different sectoral labour intensities.

The demand side explanations include demands shifts toward higher priced products, tax changes because of changes in public consumption and the Phillips curve effect. The latter effect builds on the concept that the capacity utilisation in goods and labour markets affects the price setting in these markets and hence the rate of real appreciation. In open economies the current account balance may be an expedient measure of capacity utilisation to the extent that capital inflows augment domestic demand.

This brief overview of the literature on inflation in economies experiencing real convergence can be summed up in a few sentences. The theoretical starting point is purchasing power parity, which implies that inflation in common currency terms will move towards ensuring absolute purchasing power parity over time. There are, however, a host of theories explaining how income convergence may lead to real appreciation, i.e. domestic inflation in common currency terms exceeding the inflation abroad. None of these theories establishes a ***direct*** link from income convergence to price level convergence, but rather point to price convergence as a ***possible*** outcome that requires specific conditions to be satisfied.[4]

Turning to the empirical evidence for countries in Central and Eastern Europe, the literature on inflation and real exchange developments is voluminous, as could be expected given the recurrent exchange rate and inflation issues that have affected the region. The literature can be divided into two strands. One strand examines whether purchasing power parity is satisfied for different countries in the region, while the other strand seeks to pinpoint the factors driving inflation or real exchange rate developments.

A number of papers examining purchasing power parity in Central and Eastern Europe are summarised in Cuestas (2009). Most papers either reject or find only weak evidence for the hypothesis, although the results vary substantially. Choudhry (1999) finds some support for purchasing power parity in a sample of four high inflation countries in the 1990s. Christev and Noorbakhsh (2000) find that in a sample of six Central and East European countries domestic prices, foreign prices and the exchange rate are cointegrated, but not in such a way that the real exchange rate is constant even in the long term. Sideris (2006) reaches similar results on a larger and more recent sample of 17 transition countries. Saygili and Saygili (2009) find that for the new EU countries purchasing power parity only holds for traded

[4] The Balassa-Samuelson theory, for instance, presuppose asymmetries in the form of different productivity growth across sectors or different labour intensities across sectors. Theories relying on sectoral shifts in production and/or consumption similarly assume that economic catch-up will induce specific behavioural changes.

goods and not for non-traded goods. Finally, Cuestas (2009) shows that purchasing parity holds in eight Central and Eastern European countries, but only if non-linear deterministic trends with smooth transitions are included in the long-term specification. Overall, the empirical literature provides very limited support to standard models of purchasing power parity, which may not be a surprising result given the real exchange rate trends apparent in Figure 1.[5] Moreover, very few papers report results on the short-term dynamics of the real exchange rate or inflation.

The empirical literature seeking to pinpoint factors driving the process of real appreciation is summarised in Egert (2008). There is disagreement regarding the importance of the Balassa-Samuelson effect, but productivity growth differentials between the traded and non-traded sectors are unlikely to explain the bulk of the observed real appreciation (Egert et al., 2003; Miyakima, 2005; Egert, 2007). Others have stressed the importance of increased openness in trade (Lein et al., 2008) and higher taxes and administered prices (Stavrev, 2009). Egert (2007, 2008) have argued that the price increases often are over-estimated in fast-growing economies as the indices prices are not adequately adjusted for increased product quality, which may be a particular problem since demand for high quality products is increasing. Finally, measures of demand pressure, chief among which is the current account balance, have been shown to have a strong effect on the real exchange rate (Darvas and Szapary, 2008; Staehr, 2009; Saborowski, 2009). In spite of much progress within the field, it is reasonable to conclude that there is no consensus in academic literature regarding the relative importance of the different factors driving the process of real exchange rate appreciation in the new EU countries.

3. A look at price and income levels in the new EU countries

This section presents annual data from 1995 to 2008 on prices and incomes in the 10 new EU countries, relative to the EU15 average. The statistics are derived from the national accounts. Data have been retrieved from the web-based database of Eurostat. Data are collected using on a common methodology, which facilitates comparisons across countries.

Table 1 shows the *price* level of GDP or value added in the 10 new EU countries relative to the EU15 average. The methodology comprises the calculation of the domestic-currency price index for each country and its subse-

[5] The literature explaining real exchange rate changes is related to the work on equilibrium exchange rates. Egert and Halpern (2006) provide a survey on equilibrium exchange rates in the transition countries.

quent conversion into EUR (or ECU before 1999) using the average market exchange rate for the year. The price index is based on market prices and thus includes both direct and indirect taxes. The common currency prices have been indexed so that EU15 is 100 every year.

Table 1: GDP price levels measured in common currency; index, EU15 = 100

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	24.0	20.3	24.4	28.5	29.1	30.1	31.7	31.7	32.0	33.1	34.7	36.2	38.3	41.3
Czech Rep.	35.7	38.4	39.0	42.5	41.8	43.5	46.1	51.6	49.2	50.2	54.4	57.7	58.8	67.1
Estonia	35.5	42.0	43.9	47.0	48.4	49.6	52.7	53.0	53.7	54.4	56.8	60.6	64.5	67.6
Latvia	31.2	34.3	38.0	39.0	41.9	48.5	49.0	47.6	45.1	46.1	49.1	54.5	63.5	67.8
Lithuania	25.5	30.6	37.6	38.9	39.7	44.7	45.1	45.6	44.4	45.6	48.7	51.3	54.5	58.9
Hungary	41.9	41.8	44.2	43.2	43.6	45.2	47.7	52.5	53.1	56.2	58.7	56.6	61.2	62.1
Poland	41.5	44.0	45.0	46.7	44.9	50.0	56.0	52.6	46.8	46.0	52.6	55.1	57.2	64.1
Romania	24.8	23.7	27.7	34.3	30.3	34.6	34.9	35.1	35.2	36.0	44.5	47.4	53.1	51.5
Slovenia	69.1	67.1	67.3	68.9	68.6	67.1	68.7	69.2	70.4	68.5	69.2	70.8	73.7	76.8
Slovakia	37.6	38.0	39.6	39.5	37.3	40.5	40.1	41.3	45.0	48.2	50.0	52.3	57.4	63.1
Average[a]	36.7	38.0	40.7	42.9	42.6	45.4	47.2	48.0	47.5	48.4	51.9	54.3	58.2	62.0

Note: [a] *Unweighted average.*
Source: Eurostat (2010a).

A number of interesting results can be found in Table 1. First, the price level of domestic production is substantially below the EU15 average for all the new EU members.[6] Second, for most of the countries a clear trend towards convergence is apparent; the unweighted average price level for the 10 new EU countries increased from 36.7 percent of the EU15 price level in 1995 to 62.0 percent in 2008. Third, the convergence has not been monotonous for all countries. This is the case for Poland and, to a lesser degree, the other Visegrad countries, which all maintained floating exchange rates in most of the sample period. Finally, there are cases where the convergence is less pronounced. This applies particularly to Slovenia, whose GDP price level has hovered around 70 percent of the EU15 average throughout all the years until 2007. Slovenia has the highest per capita income in the sample of new EU countries and also in this respect constitutes a special case.

[6] Broadly similar results apply to the price level of household final consumption (Eurostat, 2010b). Data for the price level of household final consumption will therefore not be reported after this.

Table 2 shows annual per capita GDP adjusted for purchasing power, relative to the EU15 average.[7] The table depicts the output performance of the 10 new EU countries ***relative*** to the average of the EU15 countries during the time period 1995–2008.

Table 2: Per capita GDP adjusted for purchasing power differences; index, EU15 = 100

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	27.6	24.7	23.0	23.5	23.3	24.1	25.6	26.9	28.4	29.8	30.7	32.3	33.8	37.4
Czech Rep.	63.5	65.2	63.1	61.2	60.2	59.1	61.2	61.5	64.4	66.5	67.3	68.4	71.6	72.7
Estonia	31.2	33.1	36.4	36.7	36.9	39.1	40.5	43.6	47.9	50.6	54.3	57.9	61.5	60.8
Latvia	27.1	28.1	29.9	30.6	31.1	31.8	33.9	35.9	38.1	40.4	42.9	45.9	50.0	51.8
Lithuania	30.6	32.0	33.7	35.2	33.5	34.1	36.1	38.5	43.2	44.5	46.9	49.2	53.2	55.8
Hungary	44.7	44.9	46.0	47.4	47.1	47.7	51.1	53.8	55.1	55.9	55.9	56.4	56.1	57.9
Poland	37.1	38.8	40.6	41.3	41.7	41.8	41.4	42.3	42.8	44.9	45.3	46.2	48.9	50.7
Romania	26.7	27.6	25.6	23.7	22.8	22.7	24.2	25.6	27.5	30.2	31.1	34.2	37.4	43.2
Slovenia	64.1	65.7	67.4	67.9	69.9	69.1	69.6	71.8	73.3	76.3	77.6	77.8	79.5	82.0
Slovakia	41.2	43.3	44.4	44.9	43.7	43.2	45.8	47.4	48.7	50.2	53.1	56.4	60.8	65.1
Average[a]	39.4	40.3	41.0	41.2	41.0	41.3	43.0	44.7	46.9	48.9	50.5	52.5	55.3	57.7

Note: [a] *Unweighted average.*
Source: Eurostat (2010c), WEO (2009), own calculations.

Per capita GDP in the new EU countries has increased from 40 percent of the EU15 average in 1995 to 58 percent in 2008. From 1995 to 2008 the average catch-up, shown by the additional growth in the new EU countries, was 1.4 percentage-points per year. It is noticeable that the real convergence process progressed much faster in the second half of the sample period. The average per capita GDP in the new EU countries increased from 39.4 percent to 43.0 percent of the EU15 average during the period 1995–2001, while it increased from 43.0 percent to 57.7 percent during the period 2001–2008. The picture of the 1990s as relatively disappointing in terms of economic growth is common for most of the new EU countries.

To conclude this section, the results of tests for the time series properties of the price and output variables are reported. The following notation is used: the GDP price level relative to the EU15 average is denoted as PY, while per

[7] Eurostat does not report purchasing power adjusted income data for Romania 1995–1998 and these data have therefore been imputed using data from WEO (2009). The relative income level of Romania vs. France is computed using data from WEO (2009) and subsequently multiplied by the relative income level of France vs. the EU15. The resulting index is multiplied by a factor that ensures that the imputed GDP level based on WEO (2009) corresponds to the GDP level based on Eurostat (2010c) in 1999.

capita GDP relative to the EU15 average is denoted as Y. The prefix L signifies the natural logarithm of the variable and the prefix ΔL is the year-on-year change in the logarithmic value of the variable, which is approximately equal to the relative change of the variable.

The testing of the time series properties of panel data is complicated by the fact that different tests assume common or cross-sectional specific unit roots, and it is often a priory unclear which is the most meaningful assumption. Since this same issue will arise again in the estimations of the convergence process, the tests for both options are reported. Table 3 shows the results of four different unit root tests for the logarithms of the main variables LPY and LY and for their logarithmic differences ΔLPY and ΔLY.

Table 3: Tests of time series properties of logarithmic per capita GDP and logarithmic GDP price relative to the EU15, 1995–2008

	Levin, Lin and Chu *t*[a]	**Im, Pesaran and Shin *W*-statistic[b]**	**ADF – Fisher[b]**	**PP - Fisher[b]**
LPY	0.940 [0.826]	3.618 [0.999]	7.062 [0.997]	9.264 [0.985]
LY	3.336 [1.000]	5.355 [1.000]	1.397 [1.000]	1.040 [1.000]
ΔLPY	–5.506 [0.000]	–3.954 [0.000]	51.601 [0.000]	86.857 [0.000]
ΔLY	–2.710 [0.003]	–1.645 [0.050]	29.682 [0.075]	35.079 [0.020]

Notes: [a] *Test assumes a common unit root.* [b] *Test allows for different unit roots along the cross sections.*
The null hypothesis is in all cases that the variable has a unit root. The values in square brackets are p-values.

It follows from Table 3 that none of the four reported tests can reject the null hypothesis of a unit root for the logarithmic levels of the per capita GDP and the GDP price index. For the logarithmic changes the null hypothesis of a unit root is rejected in all cases, at least at the 10 percent level. These results are plausible in light of the data reported in Tables 1 and 2 (and Figures 1 and 2). There are clear trends in the per capita GDP level and in the GDP price level, but the trends are not explosive, implying that the two series LY and LPY are integrated of order one, while their first differences are stationary.

4. Income levels and real appreciation

The analysis of the time series properties reported in Table 3 showed that the difference in the logarithmic real exchange rate, i.e. the rate of real appreciation ΔLPY, is a stationary variable within the sample 1995–2008, and this applies whether a common intercept or country-specific intercepts are assumed. The stationarity of ΔLPY implies that a high (lagged) real exchange rate will lead to a lower rate of real appreciation, whereas a low (lagged) real exchange rate will lead to a higher rate of real appreciation.[8]

The relation between the rate of real appreciation and the lagged logarithmic real exchange rate can be expressed in algebraic form, where the subscript *i* denotes country and *t* time period:

$$\Delta LPY_{it} = \alpha_i + \beta \cdot LPY_{it-1} + \varepsilon_{it} \quad (1)$$

The term α_i is a constant, β is the coefficient of the lagged logarithmic GDP price level and ε_{it} is an error term. (A joint intercept implies that α_i is the same across all countries.) A statistically and economically significant negative estimate of β indicates stationarity.

It is not straightforward to implement the test for stationarity empirically, as under the null hypothesis the variable LPY is non-stationary and the distribution of the coefficient β will therefore be not be the standard *t*-distribution. The tests used in Table 3 have been developed to address this issue, usually by simulating the distribution of the β coefficient (see also Cuestas and Harrison, 2008).

The results when (1) is estimated may be compared with the results when the lagged price level is replaced by the lagged *income* level. The purpose of this exercise is to assess whether the lagged price level or the lagged income level holds more explanatory power. The relationship to be estimated is then:

$$\Delta LPY_{it} = \gamma_i + \delta \cdot LY_{it-1} + \varepsilon_{it} \quad (2)$$

The only difference between (1) and (2) is that the log relative price level is replaced by the log relative income level. A negative and statistically significant estimate of the coefficient δ implies that the increase in the common currency price relative to the EU15 average is larger for low income countries than for high income countries. In this case low income levels would be associated with upward pressure on the price level in the short term. Again,

[8] In the literature on economic growth such negative feedback from the logarithmic income level to its relative change is referred to as β-convergence (Barro and Sala-i-Martin, 1995, Ch. 13).

the non-stationarity of the residuals will imply that standard inference procedures cannot be used.

Table 4 shows in column (4.1) the results when (1) is estimated using OLS and assuming a common intercept. Notice that significance levels are not indicated since the distribution of the standard errors is non-standard. The estimated coefficient of the lagged price level is negative and (in numeral terms) relatively large relative to the standard error. In this respect there is no conflict with the result obtained in Section 3 that the relative inflation rate is a stationary series.

Table 4: Explaining ΔLPY, the rate of real appreciation against the EU15 average

	(4.1)	**(4.2)**	**(4.3)**[a]	**(4.4)**[a]	**(4.5)**	**(4.6)**[a]	**(4.7)**	**(4.8)**[a]
LPY(-1)	–0.055 (0.020)	..	–0.074 (0.035)	..	–0.092 (0.035)	–0.201 (0.053)	–0.151 (0.039)	–0.324 (0.058)
LY(-1)	..	–0.024 (0.017)	..	0.011 (0.042)	0.035 (0.028)	0.195 (0.062)	0.069 (0.028)	0.334 (0.061)
ΔLPY(-1)	..	..	..	..	..	..	0.060 (0.083)	0.104 (0.082)
ΔLY(-1)	..	..	..	..	..	..	0.164 (0.147)	0.182 (0.147)
Constant	0.254 (0.078)	0.135 (0.063)	..	..	0.258 (0.077)	..	0.355 (0.081)	..
R^2	0.055	0.017	0.097	0.063	0.066	0.165	0.134	0.081
DW	1.843	1.877	1.893	1.970	1.798	1.813	1.868	1.984
Countries	10	10	10	10	10	10	10	10
Time	96–08	96–08	96–08	96–08	96–08	96–08	97–08	97–08
Obs.	130	130	130	130	130	130	120	120

Notes: [a] *Country fixed effects are included in estimation.*
Standard errors are shown in brackets.

The estimated size of the coefficient of LPY(–1) in (4.1) implies that the common currency GDP price inflation is 3.8 percentage points higher than in the EU15 for a country which initially has half of the EU15 GDP price level and 1.6 percentage points higher for a country which initially has three-quarters of the EU15 GDP price level. The implied long-term price level is exp(0.255/0.055) = 103.2, which is very close to 100, the average level of the EU15 countries. Overall these results appear plausible and suggest the presence of long-term convergence of the price level in the new EU countries to the EU15 average.

Column (4.2) shows the results when (2) is estimated with a common intercept using OLS. The sign for the coefficient of the lagged income level is

negative, but the (numerical) value is much smaller than the corresponding estimate to the lagged price index. The share explained of the variance of the dependent variable is also lower. Overall, it is clear that the lagged income level has little explanatory power for short-term changes in the common currency price level.

The results in (4.1) and (4.2) were based on estimations with a common constant. The choice of whether or not to include individual fixed effects for each country has important economic implications. A common constant only allows convergence to a common long-term price level across all new EU countries, a level which may or may not be different from the average EU15 price level. With country-specific constants, the price level in different countries may converge to different levels.[9] The results of estimating (1) and (2) with fixed effects are reported in Columns (4.3)–(4.4). Overall the main finding remain the same as the lagged price level exhibits more explanatory power for the development of common currency prices than does the lagged income level.

The next step is to include the lagged logarithmic price and income levels ***simultaneously***. The results in column (4.5), where a common constant is used, are revealing: the coefficient of the lagged price level retains its negative sign from (4.1), but the coefficient of the lagged income level gains a positive sign unlike the result in (4.2). This finding arguably confirms that the price level has more explanatory power than does the income level. In (4.6) individual fixed effects are included. It is noticeable that the estimated coefficients of LPY(–1) and LY(–1) change markedly although they retain the signs from (4.5). The change in the estimated coefficients may suggest that there is substantial heterogeneity across the 10 new EU countries.[10]

Columns (4.7)–(4.8) repeat the estimations from Columns (4.5)–(4.6), but now the lagged ***changes*** in logarithmic price and income, ΔLPY(–1) and ΔLY(–1), are also included. These variable might "mop up" autocorrelation which may otherwise bias the results. The estimated coefficients of the lagged price and income levels become larger in numerical terms. Furthermore, there are substantial differences between the estimated coefficients with and without fixed effects. Overall, the results in (4.5)–(4.8) show that when both lagged level variables are included, then the estimated coefficient

[9] The panel structure implies that the convergence speed — the β coefficient — is the same for all countries.

[10] The estimations in (4.4)–(4.5) have been repeated with the sample divided along the cross-sectional dimension, namely a "core group" comprising the four Visegrad countries and Slovenia and a lower-income "periphery group" comprising the Baltic countries, Romania and Bulgaria. The estimated coefficients for each of the two groups are broadly in line those for the full sample, but it seems that the convergence speed is lower for the core countries than for the periphery countries (results not shown).

of the lagged price is consistently negative, while the estimated coefficient of the lagged income level is consistently positive. This points in the same direction as Figure 2, namely that the two variables are closely correlated and there may exist a co-integrating relationship between the two variables. This line of reasoning is developed further in Section 5.

The inference of the estimations in Table 4 was complicated by the problem that the distribution of the standard errors is non-standard since the LPY and LY variables are non-stationary. To address this problem, the estimations in Table 4 have been repeated using variables that are expressed as deviations from the group average of the 10 new EU countries. In this way all variables are stationary and standard inference procedures should be applicable. The detailed results are given in the appendix. The overall results from Table 4 remain. The price level seems to exhibit more explanatory power than the income level with regard to common currency inflation. When both variables are included, the coefficient of the lagged price level is negative while the coefficient of the lagged income level is positive. The inclusion of country dummies affects the results markedly, suggesting that country specific factors are of importance.

5. Co-integration and convergence

This section comprises the core of the paper, the estimation of Vector Error Correction Models (VECM) in which the long-term relationship between the GDP price level and the income level is modelled alongside the short-term dynamics of these variables. Deviations from the estimated long-term relationship are interpreted as signifying a "disequilibrium" and it is examined how and to what extent such deviations are corrected over time.

A specification is used in which only the log GDP price level and the log GDP level are included in the long term specification. The tests reported in Table 3 showed that both LPY and LY are integrated of order 1. Using these two variables, the Johansen Fisher Panel Cointegration test cannot reject the hypothesis that there is at most one cointegrating vector. This result is reasonable in light of the close correlation between the two variables revealed in Figure 2. Having specified the variables of the long-term relationship, the entire VECM (both the long-term relationship and the short-term dynamics) is estimated simultaneously using Full Information Maximum Likelihood.

Table 5 presents a number of simple VECM specifications; the upper panel shows the long-term co-integrating relationship and the lower panel the short-term adjustment. The variable EC denotes deviations from the co-integrating relationship and enters in lagged form in the short-term relation as an explanatory variable. The sample starts in all cases in 1998 (giving 11 years

along the time dimension), since data for labour productivity, which will be used later, are only available from 1998.

Table 5: Explaining LPY and LY in Vector Error Correction Model

	(5.1)		**(5.2)**		**(5.3)**		**(5.4)**[a]	
Co-integration								
LPY(–1)	1.000		1.000		1.000		1.000	
LY(–1)	–0.700*** (0.076)		–0.706*** (0.099)		–1.000		–1.000	
Constant	–1.197		–1.178		–0.066		–0.066	
Error correction								
Dependent ►	ΔLPY	ΔLY	ΔLPY	ΔLY	ΔLPY	ΔLY	ΔLPY	ΔLY
EC(–1)	–0.089** (0.041)	0.110*** (0.023)	–0.115*** (0.044)	0.064*** (0.022)	–0.048 (0.031)	0.047*** (0.015)	–0.352*** (0.069)	0.124*** (0.037)
ΔLPY(–1)	..	..	0.117 (0.092)	0.062 (0.046)	0.103 (0.095)	0.053 (0.047)	0.103 (0.091)	0.020 (0.049)
ΔLY(–1)	..	..	0.211 (0.157)	0.470*** (0.079)	0.130 (0.156)	0.490*** (0.076)	0.008 (0.154)	0.501*** (0.082)
Constant	0.040*** (0.005)	0.035*** (0.002)	0.029*** (0.008)	0.017*** (0.004)	0.032*** (0.009)	0.018*** (0.005)	..	..
R^2	0.042	0.169	0.066	0.377	0.027	0.382	0.249	0.437
Countries	10		10		10		10	
Time	98–08		98–08		98–08		98–08	
Obs.	110		110		106		106	

Notes: [a] *Country fixed effects are included in the error correction specification.*
The dependent variables are indicated in the table. Standard errors are shown in brackets. Superscripts ***, **, * *denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent levels of significance respectively.*

The specification in Column (5.1) is very parsimonious with only the lagged error correction term and a constant in the short-term specification. The estimated coefficient of the logarithmic income level in the long-term relation is –0.700, which implies that a 1 percent higher income level increases the price level by around 0.7 percentage point relative to the EU15 average in the long term.

The coefficients of the error correction term EC(–1) are statistically significant in both the short-term adjustment equations for ΔLPY and ΔLY. Deviations from the estimated long-term relation affect short-term changes in different ways. A high price level relative to the income level lowers price inflation, but increases GDP growth in the short term. These results indicate that that the system is dynamically stable; it convergences to the long-term "equilibrium" relationship between price and income levels. The estimated error-correction coefficients are relatively small, implying that it takes 5 years for a

"disequilibrium" stemming from a sudden price jump to be halved via changes in GDP price inflation and GDP growth.

The positive sign to the lagged error correction term in the ΔLY equation may be surprising. However, a positive error correction term may be the result of a negative income shock; the positive coefficient implies that the initial income fall is reversed subsequently. Grafe and Wyplosz (1997) present a theoretical model, in which a high price level is correlated with income *growth* in transition countries where high prices signal that restructuring is required.

Column (5.2) shows the results when the lagged values of ΔLPY and ΔLY are included. The fit improves somewhat and the estimated coefficients in the long-term and the short-term relationships are largely unchanged. The coefficient of the lagged GDP growth rate is statistically and economically significant, suggesting substantial inertia in the growth process.

It was tested whether the coefficient of LY in the long-term specification was statistically different from –1, which would imply one-to-one convergence of the price and income levels. The hypothesis that the coefficient is 1 could not be rejected (*p*-value = 0.071). Column (5.3) shows the results when the VECM is estimated with the constraint that the coefficient of LY is –1. The short-term results are largely unchanged, although the coefficient of the lagged error correction terms is now statistically insignificant.

The VECM estimation in Column (5.3) was subsequently augmented by the inclusion of country fixed effects in the short-term specification. The results are shown in Column (5.4). The coefficients of the error correction terms change markedly although the signs remain unchanged. However, the estimated fixed effects range from –0.149 for Romania to 0.128 for Latvia and these values are unreasonably large in numeral terms. The estimation results might thus be an artefact stemming from inter alia the limited number of data points, although they arguably also reflect some heterogeneity in the inflation and incomes processes across the new EU countries.

Table 6 shows the results after inclusion of variables which may capture (part of) the cross country heterogeneity. The additional variables signify, respectively, demand side and supply side shocks to the process governing relative inflation (real appreciation). In Column (6.1) a variable, which captures the Balassa-Samuelson effect discussed in Section 2, is included. The variable is calculated as the difference between productivity growth in the manufacturing (traded) sector and productivity growth in the service (non-traded) sector (Eurostat, 2010e, 2010f; author's calculations). The purpose is to investigate two issues: whether a direct proxy of the Balassa-Samuelson effect would explain a substantial part of the GDP price inflation relative to the

EU15; and whether the inclusion would render the adjustment to the long-term relationship statistically insignificant.

Table 6: Explaining LPY and LY in the Vector Error Correction Model with additional explanatory variables

	(6.1)		**(6.2)**		**(6.3)**	
Co-integration						
LPY(–1)	1.000		1.000		1.000	
LY(–1)	–0.803*** (0.149)		–0.851*** (0.160)		–1.000	
Constant	-0.797		-0.613		-0.040	
Error correction						
Dependent ►	ΔLPY	ΔLY	ΔLPY	ΔLY	ΔLPY	ΔLY
EC(–1)	–0.076* (0.039)	0.058*** (0.021)	–0.071* (0.036)	0.056*** (0.019)	–0.056* (0.031)	0.048*** (0.017)
ΔLPY(–1)	0.172* (0.100)	0.091* (0.053)	0.103 (0.099)	0.083 (0.054)	0.097 (0.099)	0.084 (0.054)
ΔLY(–1)	0.471*** (0.173)	0.357*** (0.091)	0.247 (0.149)	0.332*** (0.100)	0.233 (0.183)	0.336*** (0.100)
Productivity growth differential (–1)	0.069 (0.080)	0.042 (0.042)	0.106 (0.078)	0.047 (0.042)	0.108 (0.078)	0.047 (0.043)
Current account balance (–1)	..	..	–0.357*** (0.122)	–0.036 (0.067)	–0.369*** (0.123)	–0.025 (0.067)
Constant	0.016* (0.009)	0.017*** (0.005)	0.000 (0.010)	0.015*** (0.006)	–0.000 (0.010)	0.016*** (0.006)
R^2	0.112	0.314	0.185	0.380	0.179	0.319
Countries	10		10		10	
Time	98–08		97–08		98–08	
Obs.	97		116		106	

*Notes: The dependent variables are indicated in the table. Standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent levels of significance respectively.*

The estimated coefficient of the lagged productivity growth differential in the ΔLPY equation is reasonable and broadly in line with the findings in the literature, but the coefficient is far from being statistically significant.[11] The coefficients of the error correction terms are comparable to those found in (5.2) although their size in numerical terms is somewhat smaller. It is also noticeable that the coefficient of the lagged income growth ΔLY(–1) in the ΔLPY equation become statistically significant and of substantial size.

[11] Qualitatively similar results are obtained if the productivity growth differential is entered contemporaneously, i.e. without the one year lag.

Column (6.2) shows the results when the one-year lagged current account balance is included in the short-term specification along with the productivity growth differential. The current account balance is expressed as a share of GDP and a negative value signifies a current account deficit (Eurostat, 2010g). Most of the new EU countries experienced a marked increase in capital imports (current account deficits) in the years after accession to the EU.

The current account variable enters with a negative and statistically significant coefficient estimate in the equation for GDP price inflation, thus confirming results in Darvas and Szapary (2008) and Staehr (2009). If taken at face value, a current account surplus amounting to 10 percent of GDP would increase inflation relative to the EU15 by 3–4 percentage points in the short term. This sizeable effect gradually diminishes via the error correction from the long-term relationship. It seems safe to conclude that current account deficits may have played a major role in the rapid real appreciation seen in many new EU countries in the period 2004–2008.[12] There seems to be no discernible link between the lagged current account balance and GDP growth.

Finally, Column (6.3) shows the results when the estimated coefficient of LY(–1) in the long-term relation is restricted to –1, a hypothesis which cannot be rejected statistically (*p*-value = 0.488). The results are broadly similar to those found in (6.2). The estimated coefficients of the error correction term are of relatively small magnitude implying a relatively slow convergence process where disturbances such as current account balance shocks will relatively long-lasting effects on inflation and GDP growth.

6. Final comments

This paper has considered an important aspect of the convergence process in the new EU member countries from Central and Eastern Europe, namely the effect on inflation relative to the EU15. A process of relative price growth turns into high domestic inflation if changes in the nominal exchange rate do not fully absorb the real appreciation.

No economic theory links trend growth and real appreciation *directly*, but a number of theories propose *indirect* relations, where trend growth is associated with features such as differential productivity growth, changing expendi-

[12] Experiments were done with specifications in which the net foreign asset position (i.e. the sum of the current account balance adjusted for capital gains) was included into the long-term relation along with LPY and LY. The results are not reported since the specification becomes relatively complicated. There appear to be two co-integrating vectors and both the derived error correction terms enter significantly in the short-term specifications. Impulse-response analyses suggested that there is also in this specification a substantial effect from current account deficits on GDP price inflation.

ture patterns, tax changes etc., which then affect the real exchange rate. The lack of a direct link between income and price levels implies that the stylised fact of a close association between income and price levels is somewhat puzzling and makes the study of price convergence particularly compelling.

The main conclusion of the empirical analyses in the paper is that relative income and price levels have been closely correlated in the new EU countries. Gaps in the long-term relation between price and income levels are gradually closed by relative inflation changes; the adjustment to the long-term convergence path is relatively slow and takes place through both price inflation and GDP growth. The long-term relationship between price and income levels only gradually affects the short-term developments of relative inflation.

Regarding the short-term development of GDP inflation relative to the EU15, a number of other results were obtained. First, the relative income level has little or no explanatory power on inflation, whereas the price level has more explanatory power. Second, although higher productivity growth in traded sectors than in non-traded sectors is likely to affect relative inflation, the Balassa-Samuelson effect is difficult to estimate precisely. Third, the current account balance seems to have a strong effect on inflation. Capital inflows are typically seen as a vehicle of real catch-up in the region and policymakers in the region have frequently sought to stimulate capital inflows (Fabrizio, 2009a). The results suggest that the rapid capital inflows in the period 2003–2008 may have contributed to real appreciation ***in excess of*** what the expansion of output would have justified, possibly because of a lack of absorptive capacity (see also Saborowski, 2009).

Starting in 2008, the global financial crisis has fundamentally changed the macroeconomic landscape in which the new EU countries from Central and Eastern Europe operate. The results are lower growth, sectoral reallocations of output and consumption as well as reduced capital inflows. The analyses in this paper suggest that these factors will markedly affect inflation developments in the new EU countries, notwithstanding the long-term co-movement of prices and income.

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Appendix 1. Estimations using deviation variables

The variables PY and Y are transformed by subtracting the average for the 10 new EU countries in any given year. The transformed variables, labelled deviation variables, are underlined. For instance, the variable PY is found as:

$$\underline{PY}_{it} = PY_{it} - \frac{1}{10}\sum_{i} PY_{it} \qquad (A.1)$$

The deviation variable Y is found in an analogous way. The variables have subsequently been transformed using the natural logarithm and the difference operator. By subtracting the group average, the trend growth is removed and the deviation variables LPY and LY are both stationary.

The results of the estimations using the deviation variables are shown in Table A.1. It should be underlined that the contents of the estimations have altered as the trends have been removed; the estimated coefficients only reflect the effect of deviations from the group average at any given time on the deviation of real appreciation from the group average. Possible effects from the group averages have been removed.

Table A.1: Explaining ΔLPY, the deviation from the new EU countries' average of the real appreciation against the EU15 average

	(6.1)	**(6.2)**	**(6.3)**[a]	**(6.4)**[a]	**(6.5)**	**(6.6)**	**(6.7)**	**(6.8)**
LPY(–1)	–0.079*** (0.021)	..	–0.361*** (0.058)	..	–0.149*** (0.044)	–0.430*** (0.085)	–0.154*** (0.036)	–0.468*** (0.069)
LY(–1)	..	–0.036** (0.015)	..	–0.147* (0.074)	0.048 (0.031)	0.137 (0.093)	0.053** (0.026)	0.142** (0.069)
ΔLPY(–1)	..	..	..	..	..	..	0.020 (0.078)	0.126 (0.078)
ΔLY(–1)	..	..	..	..	..	..	0.113 (0.141)	0.149 (0.149)
Constant	0.001 (0.005)	0.001 (0.005)	..	..	0.004 (0.006)	..	0.002 (0.004)	..
R^2	0.102	0.041	0.306	0.109	0.120	0.237	0.190	0.377
DW	1.843	1.881	1.748	2.022	2.297	2.303	1.905	1.952
Countries	10	10	10	10	10	10	10	10
Time	96–08	96–08	96–08	96–08	96–08	96–08	97–08	97–08
Obs.	130	130	130	130	130	130	120	120

Notes: [a] *Fixed effect estimation; the constant term denotes the average value of the country fixed effects.*
Standard errors are shown in brackets. Superscripts ***, **, * *denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent levels of significance respectively.*

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