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Balázs Égert

Investigating the Balassa-Samuelson hypothesis in transition: Do we understand what we see?

Bank of Finland
Institute for Economies in Transition, BOFIT

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Contents

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Balázs Égert [1]

Investigating the Balassa-Samuelson hypothesis in transition: Do we understand what we see?

Abstract

This paper studies the Balassa-Samuelson effect in the Czech Republic, Hungary, Poland, Slovakia and Slovenia. Time series and panel cointegration techniques are used to show that the BS effect works reasonably well in these transition economies during the period 1991:Q1 to 2001:Q2. However, productivity growth does not fully translate into price increases due to the structure of CPI indexes. We thus argue that productivity growth will not hinder the ability of the five EU accession candidates to meet the Maastricht criterion on inflation in the medium term. Moreover, the observed appreciation of the CPI-deflated real exchange rate is found to be systematically higher compared to the real appreciation justified by the Balassa-Samuelson effect, particularly in the cases of the Czech Republic and Slovakia. This may be partly explained by the trend appreciation of the tradable-goods-price-based real exchange rate, increases in non-tradable sector prices due to price liberalisation and demand-side pressures, and the evolution of the nominal exchange rate due to the exchange rate regime and magnitude of capital inflows.

JEL: E31, F31, O11, P17

Keywords: Balassa-Samuelson effect, Productivity, Real Exchange Rate, Transition, Panel Cointegration

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Balázs Égert

Investigating the Balassa-Samuelson hypothesis in transition: Do we understand what we see?

Tiivistelmä

Tutkimus käsittelee Balassa-Samuelsonin efektiä (BSE) Tšekin tasavallassa, Unkarissa, Puolassa, Slovakiassa ja Sloveniassa. Aikasarja- ja paneeliyhteisintegroituvuusmetodit osoittavat, että BSE oli olemassa näissä siirtymätalouksissa 1990-luvulla. On kuitenkin huomattava, että tuottavuuden muutos ei täysin näy hintojen nousussa kuluttajahintaindeksin rakenteen takia. Tuottavuuden kasvu ei siten estä EU-jäsenyyttä hakeneita maita saavuttamasta Maastrichtin inflaatiokriteeriä. Valuuttakurssin havaittu reaalinen vahvistuminen on suurempaa kuin BSE yksin antaisi odottaa. Tämä saattaa johtua esim. nimellisen valuuttakurssin vahvistumisesta, joka puolestaan saattaa aiheutua suurista pääomavirroista.

Asiasanat: Balassa-Samuelsonin efekti, tuottavuus, reaalinen valuuttakurssi, transitio, paneeliyhteisintegroituvuus

1 Introduction

Since beginning of the transformation process from centrally planned to market economies, Central Europe's transition countries have experienced relatively high inflation and marked real appreciation of their currencies. It has become something of a stylised fact coming under the heading of the Balassa-Samuelson hypothesis that these phenomena are in part a consequence of strong productivity growth in the traded sector. The occurrence of such price increases naturally has repercussions for monetary policy. As EU accession candidates need to achieve nominal convergence as defined in the Maastricht criteria, inflation differentials stemming from productivity growth differentials have potential political consequences.

The Balassa-Samuelson effect in the transition countries has been examined in numerous studies.[1] As the sample data are limited to just over a decade of transition and as most useful time series are available only on an annual basis, studies typically use panel estimations for a large number of transition countries. Thus, a great degree of homogeneity across countries, ranging from the most advanced Central European countries to the CIS, had to be assumed in the investigations.

Here, we examine the empirical validity of the Balassa-Samuelson hypothesis using quarterly data for five advanced Central European countries: the Czech Republic, Hungary, Poland, Slovakia and Slovenia. Employing both time series and panel cointegration techniques, we allow for a high degree of heterogeneity across countries. In addition, we quantify the impact of the productivity growth differential on overall inflation and investigate the extent to which this accounts for the real appreciation of the exchange rate in each country. Although we establish the Balassa-Samuelson effect in every country, its importance is found to differ substantially. As regards EU accession and EMU run-up phase, we conclude that, despite marked productivity gains (especially in Hungary and Poland), the inflation differential associated with the Balassa-Samuelson effect is less of an issue than suggested in earlier research. Instead, we argue that stabilising the nominal exchange rate may be a more challenging task given liberalised capital accounts and large capital inflows.

In the next section, we present a brief exposition of the Balassa-Samuelson model. Section III describes our data set in detail and provides a preliminary data analysis. Section IV provides an overview of the time series and panel econometric techniques used in this paper. Section V presents the empirical results. In Section VI, we compute inflation rates and the real exchange rate appreciation consistent with the Balassa-Samuelson effect. Section VII discusses policy implications of our findings and Section VIII concludes.

2 The model

The Balassa-Samuelson effect, often labelled as the productivity bias hypothesis, is based on the model of a small open economy with two sectors: a sector producing tradable goods and one producing non-tradable goods. The model rests on two assumptions. On one hand, capital is perfectly mobile both across countries and across the two sectors of the economy, which implies that the interest rate is set in world markets and thus exogenous. On the

[1] Cf. e.g. Halpern-Wyplosz (1997), Halpern-Wyplosz (2001), Coricelli-Jazbec (2001) DeBroeck-Sløk (2001) and Golinelli-Orsi (2001).

other hand, while labour is internationally immobile, it is assumed to be perfectly mobile domestically between the open and sheltered sectors. Nominal wages are determined in the tradables sector and, due to the wage equalisation process, hold for the entire economy.

The supply side of the two sectors can be described with the aid of two different, constant returns to scale Cobb-Douglas production functions as:

$$Y^T = A^T \cdot (L^T)^{\gamma} (K^T)^{(1-\gamma)} \quad (1)$$

$$Y^{NT} = A^{NT} \cdot (L^{NT})^{\delta} (K^{NT})^{(1-\delta)} . \quad (2)$$

In these equations, A^T, A^{NT}, L^T, L^{NT}, K^T and K^{NT} denote the level of total factor productivity, labour and capital in the open and sheltered sectors, respectively. Profit maximisation implies that interest rates (i) and nominal wages (w) in both sectors equal the marginal products dY^T/dK^T, dY^{NT}/dK^{NT}, dY^T/dL^T and dY^{NT}/dL^{NT} , respectively, as shown in equations (3)-(6) expressed in logarithmic terms[2].

$$i^T = \log(1-\gamma) + a^T - \gamma (k^T - l^T) \quad (3)$$

$$i^{NT} = (p^{NT} - p^T) + \log(1-\delta) + a^{NT} - \delta (k^{NT} - l^{NT}) \quad (4)$$

$$w^T = \log(\gamma) + a^T + (1-\gamma)(k^T - l^T) \quad (5)$$

$$w^{NT} = (p^{NT} - p^T) + \log(\delta) + a^{NT} + (1-\delta)(k^{NT} - l^{NT}), \quad (6)$$

where p^{NT} and p^T stand for prices of non-tradables and tradables. Perfect competition in the traded sector means that the prices of traded goods are exogenous. First-order conditions (FOC) in the tradables sector determine the capital-labour ratio, as capital is assumed to be fixed in the short term, and the nominal wage. Due to the wage equalisation process in the economy, the wage level is exogenous for the non-tradables sector. The FOC of the non-tradables sector thus determine the capital-labour ratio in the non-tradables sector and the relative price of non-tradables. For this model, then, the relative price of non-tradables and tradables is fully determined by the supply side conditions. To establish the connection between changes in the relative price of non-tradables compared to that of tradables (relative prices) and the growth rate of productivity in the tradable sector relative to that in the non-tradable sector (dual productivity), equations (3) – (6) are totally differentiated and rearranged, leading to equation (7)[3]

$$\left(\hat{p}^{NT} - \hat{p}^T\right) = (\delta/\gamma) \cdot \hat{a}^T - \hat{a}^{NT} , \quad (7)$$

where circumflexes (ˆ) denote growth rates. Extending the model to a two-country framework and applying similar reasoning to the foreign country, equation (8) shows that the

[2] Lower case letters denote logarithms.
[3] For a detailed exposition, see e.g. Sarno/Taylor (2001).

difference between relative prices at home and abroad (relative price differential) is determined by the difference between dual productivity at home and abroad (dual productivity differential).[4]

$$\left(\hat{p}^{NT}-\hat{p}^{T}\right)-\left(\hat{p}^{NT}*-\hat{p}^{T}*\right)=\left((\delta/\gamma)\cdot\hat{a}^{T}-\hat{a}^{NT}\right)-\left((\delta*/\gamma*)\cdot\hat{a}^{T}*-\hat{a}^{NT}*\right) \quad (8)$$

To derive the relationship between the increase in the relative price of non-tradables and changes in the CPI deflated real exchange rate, we first decompose overall inflation into price increases for tradables and non-tradables in equation (9), where α and $(1-\alpha)$ stand for shares of the open and sheltered sectors of the economy. We then substitute this into the definition of the real exchange rate in equation (10). Substituting equation (9) into equation (10) yields equation (11):

$$\hat{p}=\alpha\cdot\hat{p}^{T}+(1-\alpha)\cdot\hat{p}^{NT} \quad (9)$$

$$\hat{r}=\hat{e}+\hat{p}*-\hat{p} \quad (10)$$

$$\hat{r}=\hat{e}+\hat{p}^{T}*-\hat{p}^{T}-(1-\alpha)\left(\hat{p}^{NT}-\hat{p}^{T}\right)+(1-\alpha*)\left(\hat{p}^{NT}*-\hat{p}^{T}*\right) \quad (11)$$

Real and nominal exchange rates are defined in domestic currency units per foreign currency. An increase (decrease) in the exchange rate reflects depreciation (appreciation) of the domestic currency. Assuming that α equals $\alpha*$ and that relative PPP holds for tradable goods, equation (11) can be further simplified to

$$\hat{r}=-(1-\alpha)\left(\left(\hat{p}^{NT}-\hat{p}^{T}\right)-\left(\hat{p}^{NT}*-\hat{p}^{T}*\right)\right). \quad (12)$$

Combining equations (7) and (12) provides the direct link between the dual productivity differential and the CPI-based real exchange rate.

$$\hat{r}=-(1-\alpha)\left(\left(\delta/\gamma\cdot\hat{a}^{T}-\hat{a}^{NT}\right)-\left(\delta*/\gamma*\cdot\hat{a}^{T}*-\hat{a}^{NT}*\right)\right) \quad (13)$$

Hence, to the extent that dual productivity at home exceeds that abroad, the domestic currency will appreciate in real terms.

[4] Asterisks denote foreign variables.

3 Description of the data

We consider the Czech Republic, Hungary, Poland, Slovakia and Slovenia, using quarterly labour productivity data, the relative price of non-tradables and real exchange rates. The sample period is 1991:Q1 to 2001:Q2. All data are seasonally adjusted and transformed by taking natural logarithms. Germany, the United States and a synthetic basket based on German and US data serve as the foreign country in this paper. Weights for the basket are derived from the currency settlement in foreign trade in 1999.[5]

Average labour productivity is used as a proxy for the marginal total factor productivity suggested by the theoretical model. Productivity is computed as the index of industrial production divided by the index of employment in that sector. Industrial production and the employment series are issued from the monthly database of the WIIW on transition economies.[6] As data at quarterly frequency are unavailable for labour productivity in the sheltered sector, we set it to zero. This seems a reasonable hypothesis as long as the non-tradable sector's productivity gains remain approximately equal across countries. The relative price of non-tradables is determined as changes in the price of services compared to the producer price index of final industrial goods. We assume services are the least likely to be traded, while industrial goods are likely to be traded and thus can be used as good proxies for non-tradable and tradables. The source of the price series is the OECD's MEI[7] and the WIIW monthly database. Nominal exchange rates are averages of average monthly rates vis-à-vis the German mark and the US dollar, and are obtained from the WIIW's database. They are expressed as domestic currency units per one foreign currency unit.

We conduct single-equation Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests both in levels and first differences to determine the order of integration of the series. Employing the standard testing strategy described in Bourbonnais-Terassa (1998), we first estimate the model including a trend and constant term, and then jointly test the null hypotheses of non-stationarity and the significance of the trend. If the tests reveal that the series is not trend-stationary, the model containing a constant is then estimated. When the series does not turn out to be stationary or non-stationary around a constant, the model without trend and constant is examined. The appropriate lag length is determined using the Schwarz information criterion. The results indicate that the variables are clearly I(1) processes. The exception is the Czech relative price of non-tradables compared to the US, as the PP test rejects the null of the unit root in level with a constant term.

4 Econometric techniques

Given the I(1) nature of the series, the cointegration analysis is employed to explore the long-run relationships developed in Section II. We then test the Balassa-Samuelson effect in two stages. In the first stage, we explore the internal transmission mechanism between dual productivity and relative prices according to equation (7). In the second stage, we investigate the external transmission mechanism of the Balassa-Samuelson effect in a two-

[5] As regards Germany, the weights we use are 80%, 82%, 62%, 74% and 89% for the Czech Republic, Hungary, Poland, Slovakia and Slovenia, respectively. The weights for the US are 20%, 18%, 38%, 26% and 11%, respectively.

[6] Vienna Institute for International Economic Studies, www.wiiw.ac.at

[7] Main Economic Indicators, www.sourceoecd.org

country framework. We test to determine, in accordance with equation (8), if the dual productivity differential and the relative price differential are related. We also test to see if the relative price differential is linked to real exchange rate movements (equation 12). Finally, we examine whether changes in real exchange rates are driven exclusively by differences in relative price developments. The Balassa-Samuelson model rests on the assumption that the strong version of relative PPP holds for tradables, which implies stationarity of the PPI-deflated real exchange rate, so we also perform ADF and PP tests for stationarity of the PPI-based exchange rate.

The above cointegration relationships are investigated using two types of cointegration techniques: the VAR-based multivariate cointegration methodology of Johansen (1988) developed for time series and the panel cointegration methodology proposed by Pedroni (1999, 2000).

For the time series cointegration analysis, we first specify a bivariate Vector Error Correction Model (VECM) for the internal transmission mechanism. We aim at establishing one cointegration relationship of the dual productivity and relative prices. Subsequently, we proceed to testing of the external transmission mechanism. The latter is implemented by specifying a trivariate VECM including the dual productivity differential, the relative price differential and changes in the CPI-deflated real exchange rate. We seek to detect two long-term cointegrating vectors between the dual productivity differential and the relative price differential on the one hand, and between the relative price differential and changes in the CPI-deflated real exchange rate, on the other hand. [8] The presence of statistically significant cointegrating vectors in both cases would imply a long-run relationship between productivity and the CPI-based real exchange rate. This is the reason why we estimate this cointegration vector as well. If only one long-run relationship can be established, we go on to estimate a bivariate VECM for the relationship of the dual productivity differential and the relative price differential. In the case we are able to detect cointegration, we found the long-term relationship. Otherwise, we specify another bivariate VECM for the relative price differential and changes in the real exchange rate so as to obtain the cointegrating vector detected in the three-variable VECM.

To obtain robust estimates of the cointegrating vectors, we implement a number of specification tests. The lag lengths are determined to ensure no auto-correlation and normality for the residuals. Further, we implement likelihood ratio tests to determine the trend polynomial in the cointegrating vector.[9] The cointegration rank is determined using the Johansen cointegration test.[10] The stability of the cointegration rank and space β are verified in line with suggestions in Hansen-Johansen (1993). Roots of the model and the autocorrelation and normality of the residuals are examined using correlograms and performing the Jarque-Bera multivariate test on single-equation residuals and the residual vector.

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[8] In this case, the rank of cointegration is equal to 2. It is worth noting that if the rank of cointegration (the number of cointegrating vectors) is equal to the number of variables (n), that is r=3 in this case, all variables are stationary with no exception. When r=3, a VAR in levels is appropriate for estimation, while with r=0 a VAR in first differences needs to be employed. In the latter case, no long-term relationship in levels can be established.

[9] We test for restrictions on deterministic trend coefficients. The following five models can be distinguished: model 1 (m1): the I(0) series have zero mean, the cointegrating vector does not have an intercept; model 2 (m2): the I(0) series have non-zero mean, the cointegrating vector contains an intercept; model 3 (m3): the I(0) series have linear trends, the cointegrating vector includes a constant; model 4 (m4): both the I(0) series and the cointegrating equation have a trend; model 5 (m5): I(0) series have a linear trend, and the I(1) component contains a quadratic trend.

[10] Only the trace test statistics are reported since the lambda-max test does not fit into a coherent testing strategy as noted in Johansen (1992).

Before turning to the panel cointegration technique, we ascertain that variables are I(1). To do this, we apply the panel unit root test proposed by Im, Pesaran and Shin (1997). To test the null of a unit root, we rely on t-bar statistics using the mean of individual ADF statistics. The advantage of this test is that it allows for heterogeneity in the autoregressive coefficient across the countries of the panel. Consider the following equation assuming a trend and a constant term:

$$\Delta y_{i,t} = \pi \cdot y_{i,t-1} + \sum_{t=1}^{n-1} b_i \cdot \Delta y_{i,t-1} + \mu_i + \gamma_i \cdot t + \varepsilon_{i,t}, i = 1,2,...,N; t = 1,2,...,T, \quad (14)$$

Thus, the null of $H_0 : \pi_i = 0$ for each i is tested against the alternative hypothesis of

$H_1 : \pi_i < 0, i = 1,2,...,N_1, \pi_i = 0, i = N_i + 1,...,N$.

As in the time series case, we start by investigating the internal transmission mechanism. While it is possible to test for the rank of cointegration in the time series context, the panel cointegration technique does not yet allow detecting the number of cointegrating vectors. For this reason, when investigating the Balassa-Samuelson effect in the two-country case, we have to proceed with pair-wise estimations between the dual productivity differential and the relative price differential and subsequently between the relative price differential and changes in the real exchange rate. If we find two cointegration relationships, we can establish the long-run relationship between the dual productivity differential and rate of growth of the real exchange rate as in the time series case.

Analogous to Engle and Granger, the Pedroni panel cointegration method tests the null of no cointegration against the alternative hypothesis of cointegration using the residuals obtained from the cointegrating regression:

$$\bar{y}_{i,t} = \alpha_i + \beta_i \cdot \bar{x}_{i,t} + \delta_i \cdot t + \varepsilon_{i,t}, i = 1,2,...,N; t = 1,2,...,T . \quad (15)$$

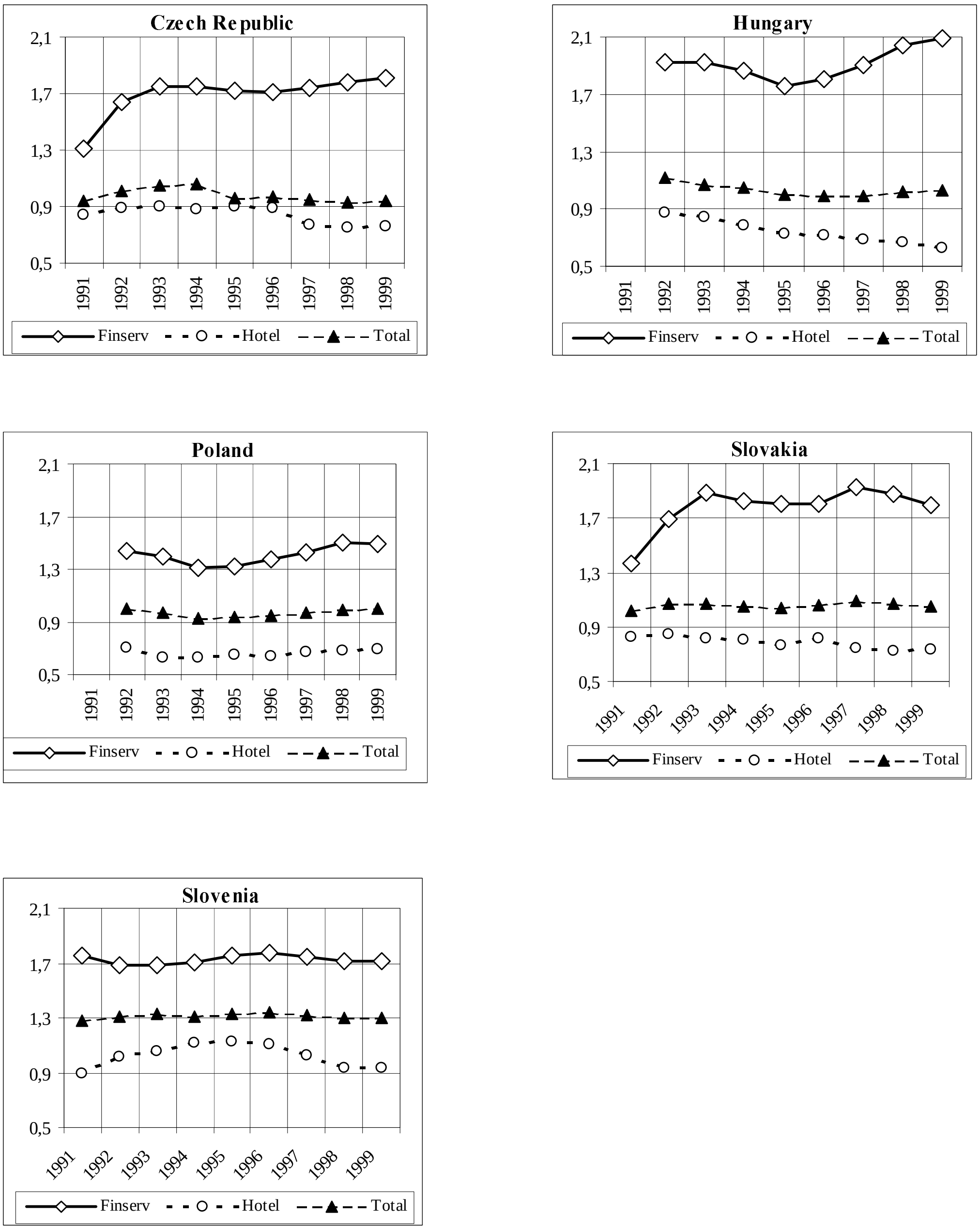
Out of the seven panel cointegration statistics developed by Pedroni, we choose those that best account for heterogeneity.[11] The group mean panel cointegration statistics test the null hypothesis of $H_0 : \pi_i = 0$ against the alternative hypothesis of $H_1 : \pi_i < 0, i = 1,2,...,N$ where π_i denotes the autoregressive coefficient of the residuals. Two of the tests are based on the non-parametric PP rho-statistic and t-statistic, while the third is an ADF-based t-statistic. To determine the coefficient of the cointegration vector, the panel fully modified ordinary least squares (FMOLS) estimator of Pedroni (2000) is employed. The lag length is allowed to differ across countries and is determined using the Newey-West method.

5 Empirical results

Before turning to the empirical results, the crucial assumption of wage equalisation between the tradable and non-tradable sectors needs to be verified. With regard to the dynamics of wage developments, relative wages ($w^{NT} - w^T$) should be mean reverting, which implies that even if there is a gap in levels between nominal wages across sectors, this gap would be stable over time. We therefore checked to see if nominal wage increases in the

[11] The employed statistics permit heterogeneity in the slope coefficients, the constant term and the trend, as well as allow for heterogeneous autoregressive coefficient in the residuals.

Figure 1. Relative wage developments, 1991-1999



Source: Countries in Transition 2000, WIIW Handbook of Statistics
Note: “Finserv,” “Hotel” and “Total” refer to the following ratios: nominal wages in financial services/nominal wages in industry, nominal wages in the hotel industry/nominal wages in industry and the average nominal wage of the economy/nominal wages in industry.

non-tradable sector are related to nominal wage developments in industry. Using annual data for sectoral nominal wages for the period of 1991 to 1999, we compare the evolution of average nominal wages in the economy as a whole with that of wages in industry.[12] Moreover, to reveal the dynamics on a more disaggregated level, we show the respective ratio for financial services and the hotel industry. In the case of Hungary and Poland (and possibly the Czech Republic), we encountered minor problems with wage equalisation, especially where wages in financial services to wages in industry were considered. However, based on the visual inspection of Figure 1, our conclusion is that, on the whole, the ratio between nominal wages in different sectors of the economy remains rather stable over time.

We now turn to the results of the cointegration tests reported in Tables 1–5 and 7. The cointegration relationships are summarised in four vectors X1, X2, X3 and X4, where X1=[relative prices, dual productivity], X2=[relative price differential, dual productivity differential], X3=[the CPI-deflated real exchange rate, the relative price differential] and X4=[changes in the CPI-deflated real exchange rate, dual productivity differential]. Theory suggests that dual productivity and the dual productivity differential should be positively correlated with relative prices and the relative price differential. At the same time, we expect a rise (fall) in the relative price differential and in the dual productivity differential to bring about an appreciation (depreciation) of the CPI-based real exchange rate. Technically, the estimated coefficients of X1 and X2 in the time-series cointegration analysis should bear a negative sign while the estimates of β_1 for X3 and X4 should be positively signed. Concerning panel cointegration, the estimate of β_1 of the X1 and X2 vectors should enter with a positive sign. At the same time, the β_1 of X3 and X4 should be negative.

Table 1 contains summary statistics for the Czech Republic. The cointegration tests reject the null of no cointegration for the internal linkage between dual productivity and relative prices. As can be seen from Table 1, the estimate of the coefficient is significant and has the correct sign. The stability tests also reveal that this relationship is stable over time as is space β. However, the coefficient is lower than one, indicating that productivity increases do not fully translate into increases in the relative price of non-tradables. Furthermore, we can establish statistically significant and correctly signed long-run relationships for the vectors X2, X3 and X4 when Germany and the trade-weighted basket are used as the benchmark. The estimated models are robust in terms of autocorrelation and normality. However, while space β seems to be stable, worries about the stability of the cointegration rank equal to 2 arise, especially in the case of the basket, where the cointegration rank becomes equal to 2 just at the very end of the period, casting doubt on the long-term connection between the relative price differential and the real exchange rate. The estimated coefficients suggest that increases in the relative price differential (X3) and the dual productivity differential (X4) are connected with a more than proportional appreciation of the real exchange rate. The results for the US as the foreign country clearly show that, even if we can find a long-run relationship between the dual productivity differential and the relative price differential, the tests fail to reject the null of one cointegration relationship against the alternative hypothesis of two cointegrating vectors. In addition, while the coefficient β_1 is significant and has the appropriate sign, the X2 vector is found rather unstable during the period studied and the size of the estimated coefficient varies between models.[13]

[12] The industrial sector includes manufacturing, mining and electricity.
[13] The results of the specification tests are not reported here, but are available on request from the author.

Table 1. Johansen cointegration tests, Czech Republic

Vector = X β'

X1 = [relative prices, dual productivity], β'= [1, β_1], expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], β'= [1, β_1], expected signs [1,-]

X3 = [changes in the CPI based real exchange rate, the relative price differential], β'= [1, β_1], expected signs [1,+]

X4 = [changes in the CPI based real exchange rate, the dual productivity differential], β'= [1, β_1], expected signs [1,+]

	k	H_0	λ_{trace}	Vector	1	β_1	Normality
Czech Republic							
	K=2, m3	R=0	24.32**	X1	1*	-0.643	4.427 (0.351)
		R=1	2.98			(-8.139)	
Germany							
Prod, RPrice, RER	K=1, m3	R=0	41.53**	X2	1*	-1.185	2.037 (0.916)
		R=1	14.82*			(-5.085)	
		R=2	1.53	X3	1*	1.441	
						(25.732)	
Prod, RER	K=1, m3	R=0	18.57**	X4	1*	1.884	1.275 (0.866)
		R=1	0.53			(5.037)	
Basket							
Prod, Rprice, RER	K=1, m3	R=0	40.48**	X2	1*	-1.007	2.655 (0.851)
		R=1	16.25**			(-5.009)	
		R=2	2.37	X3	1*	1.311	
						(24.736)	
Prod, RER	K=1, m3	R=0	21.00**	X3	1*	1.473	2.488 (0.647)
		R=1	1.45			(4.829)	
US							
Prod, RPrice, RER	K=1, m3	R=0	29.98**	X2	1*	-0.753	4.672 (0.587)
		R=1	9.33			(2.768)	
		R=2	1.31	2			
Prod, Rprice	K=1, m4	R=0	28.89**	X2	1	-0.342	4.320 (0.364)
		R=1	5.14			(2.408)	

Note. λ_{trace} is the Johansen statistics, critical values are those tabulated in Johansen(1996); * and ** indicate that H_0 is rejected at the 5% and 1% significance level, respectively;. the model tested for and the number of lags used in the model are in parenthesis below the Johansen statistics. Below β_1 values can be found the t-statistics of the CE in parenthesis. The asterisk above the 1 in column 5, (the beta to which the cointegrating vector is normalised) indicates that the variable is significant at the 5% level in another normalisation. As regards the Jarque-Bera normality test, p-values are in parenthesis beneath χ^2 statistics and refer to skewness and kurtosis: normality is accepted when the p-value is higher than 0.05. When we could establish one cointegration relationship, only the corresponding cointegrating vector is reported (e.g. X2, while X3and X4 are not displayed in the table). RPrice and RER stand for the relative price differential and changes in the CPI-deflated real exchange rate, respectively.

The Johansen test (Table 2) detects the presence of a cointegrating vector between the Hungarian dual productivity and Hungarian relative prices. This estimate, which is significant at the 5% level and has the correct negative sign, strongly corroborates the prediction of the theoretical model. The specification tests reveal the robustness of the model, as there is no problem in terms of auto-correlation, normality, stability of the cointegration rank or space β. In the two-country framework, Table 2 shows that a long-run relationship can be established between the dual productivity differential and the relative price differential no matter what benchmark country is chosen. These results are also quite robust as they passed all specification tests. The coefficients of the X2 cointegration vectors are highly significant and enter with the appropriate negative sign. Again, we find that increases in the productivity in the traded sector do not fully translate into increases in the prices of Hungarian non-tradables. The cointegration rank and space β are found to be very stable as the residuals satisfy the assumption of no auto-correlation and normal distribution. Even if normality is rejected at the 5% level for the two-variable model containing the dual productivity differential and the relative price differential with Germany as the foreign country, the cointegration vector is well specified in the three-variable VECM. We should emphasise here that, no matter which benchmark is chosen, the CPI-deflated real exchange rate does not seem to be related to either the relative price differential or the dual productivity differential.

Table 2. Johansen cointegration tests, Hungary

Vector = X β'

X1 = [relative prices, dual productivity], β'= [1, β_1], expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], β'= [1, β_1], expected signs [1,-]

X3 = [changes in the CPI based real exchange rate, the relative price differential], β'= [1, β_1], expected signs [1,+]

	K	H_0	λ_{trace}	Vector	1	β_1	Normality
Hungary							
	k=1, m3	R=0	37.22**	X1	1*	-0.694	6.073 (0.194)
		R=1	0.59			(-2.168)	
Germany							
Prod, Rprice, RER	k=1, m3	R=0	54.79**	X2	1*	-1.204	5.612 (0.468)
		R=1	9.88			(-16.722)	
		R=2	0.58				
Prod, Rprice	k=1, m3	R=0	37.22**	X2	1*	-1.200	11.788 (0.019)
		R=1	0.59			(-16.438)	
Basket							
Prod, Rprice, RER	k=1, m3	R=0	52.66**	X2	1*	-1.181	6.258 (0.395)
		R=1	12.41			(-16.634)	
		R=2	0.40				
Prod, Rprice	k=1, m3	R=0	36.43**	X2	1*	-1.183	8.788 (0.067)
		R=1	0.41			(-16.205)	
US							
Prod, Rprice, RER	k=1, m3	R=0	45.66**	X2	1*	-1.057	6.383 (0.382)
		R=1	9.15			(-2.890)	
		R=2	0.09				
Prod, Rprice	k=1, m3	R=0	29.34**	X2	1*	-1.109	6.572 (0.160)
		R=1	0.11			(13.202)	

Note: See Table 1.

Table 3 shows a broadly similar picture in the case of Poland. We detect the presence of a long-run cointegration relationship for the internal transmission mechanism between dual productivity and relative prices. The determined coefficients are the lowest for the internal relationship among the investigated countries. The test results also provide clear empirical evidence for the existence of statistically significant and correctly signed cointegration relationships between the dual productivity differential and the relative price differential, on one hand, and between the relative price differential and the real exchange rate, on the other, when Germany is chosen as the foreign country. As might be expected, the dual productivity differential is cointegrated with the real exchange rate, which is consistent with the Balassa-Samuelson model. We note that productivity gains are accompanied by a disproportionate change in the real exchange rate. Nevertheless, these results suggest that while the dual productivity differential and the relative price differential of non-tradables appear to be connected in the long run when we consider either the basket or the US as the benchmark, movements in the relative price differential do not seem to be related to changes in the real exchange rate. It should be noted here that the VECM models specified for Polish data are extremely robust for several reasons. Most importantly, for each cointegration vector, the estimate of the coefficient is found to be always correctly signed and the t-statistics are comfortably large. Moreover, the results of the specification tests attest to the absence of auto-correlation and indicate that normality is not violated. Finally, stability tests performed on the cointegration rank and the space β clearly reject instability for every cointegration relationship.

Table 3. Johansen cointegration tests, Poland

Vector = X β'

X1 = [relative prices, dual productivity], β'= [1, β_1], expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], β'= [1, β_1], expected signs [1,-]

X3 = [changes in the CPI based real exchange rate, the relative price differential], β'= [1, β_1], expected signs [1,+]

X4 = [changes in the CPI based real exchange rate, the dual productivity differential], β'= [1, β_1], expected signs [1,+]

	k	H_0	λ_{trace}	Vector	1	β_1	Normality
Poland							
	k=1, m3	R=0	83.73*	X1	1*	-0.488	3.095 (0.542)
		R=1	0.24			(-22.182)	
Germany							
Prod, Rprice, RER	k=1, m3	R=0	99.24**	X2	1*	-0.763	3.617 (0.728)
		R=1	23.99*			(17.744)	
		R=2	1.31	X3	1*	1.852	
						(21.046)	
Prod, RER	k=1, m3	R=0	36.18**	X4	1*	1.320	3.390 (0.495)
		R=1	3.71			(18.082)	
Basket							
Prod, Rprice, RER	k=1, m3	R=0	89.49**	X2	1*	-0.720	5.636 (0.465)
		R=1	8.91			(-14.327)	
		R=2	0.00				
Prod, Rprice	k=1, m3	R=0	76.55**	X2	1*	-0.702	4.447 (0.349)
		R=1	0.04			(-14.327)	
US							
Prod, Rprice, RER	k=1, m3	R=0	93.13**	X2	1*	-0.698	3.821 (0.701)
		R=1	5.71			(-16.233)	
		R=2	0.05				
Prod, Rprice	k=1, m3	R=0	84.99**	X2	1*	-0.698	3.487 (0.480)
		R=1	0.38			(-16.233)	

Note: See Table 1.

As reported in Table 4, in terms of the number of the detected cointegration relationships, the time-series cointegration analysis for Slovakia yields similar results as for Hungary. The Johansen tests provide a clear rejection of the null of no cointegration at the 1% level for the internal relationship between dual productivity and relative prices. In addition, we establish long-run cointegrating relationships between the dual productivity differential and the relative price differential, irrespective of the benchmark country. The tests fail, however, to detect a long-term relationship between the relative price differential and the real exchange rate, vis-à-vis our three benchmarks. A quick glance at the results initially seems to suggest that the estimated coefficients of the X2 vectors are statistically significant at the 1% level and bear the correct negative sign, but Jarque-Bera normality tests reveal that normality is rejected for four out of seven models. Moreover, while autocorrelation is not present in the residuals, we are unable to find a lag length that ensured normal distribution for the error terms for the estimates against the basket, the US and for the internal relationship. We should also note that according to the stability tests, the cointegration ranks we detected and space β turn out to be stable over time independent of the internal transmission mechanism.

Table 4. Johansen cointegration tests, Slovakia

Vector = X β'

X1 = [relative prices, dual productivity], β'= [1, β_1], expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], β'= [1, β_1], expected signs [1,-]

X3 = [changes in the CPI based real exchange rate, the relative price differential], β'= [1, β_1], expected signs [1,+]

	k	H_0	λ_{trace}	Vector	1	β_1	Normality
Slovakia							
	k=1, m3	R=0	24.34**	X1	1*	-0.614	23.602 (0.000)
		R=1	0.21			(-6.396)	
Germany							
Prod, RPrice, RER	k=1, m2	R=0	42.56**	X2	1*	-3.604	10.500 (0.105)
		R=1	8.12			(-5.112)	
		R=2	1.70				
Prod, Rprice	k=2, m2	R=0	25.21**	X2	1*	-3.905	6.033 (0.197)
		R=1	2.38			(-4.839)	
Basket							
Prod, RPrice, RER	k=2, m2	R=0	40.56**	X2	1*	-3.819	11.275 (0.080)
		R=1	12.63			(-4.992)	
		R=2	1.91				
Prod, Rprice	k=2, m2	R=0	24.17**	X2	1*	-3.377	15.967 (0.003)
		R=1	2.73			(-4.509)	
US							
Prod, RPrice, RER	k=1, m3	R=0	42.11**	X2	1*	-2.005	28.845 (0.000)
		R=1	10.04			(-3.755)	
		R=2	1.27				
Prod, Rprice	k=1, m3	R=0	28.57**	X2	1*	-2.157	21.553 (0.000)
		R=1	5.01			(-3.879)	

Note: See Table 1.

In the case of Slovenia (Table 5), the cointegration tests produce a clear rejection of the null of no cointegration at the 5% level for Slovenian dual productivity and relative prices. Despite the significant, correctly signed coefficient of the productivity variable and evidence of the stability of the detected cointegration relationship, the violation of the normality assumption deserves comment. The latter clearly affects the robustness of the established long-run relationship. The empirical evidence in favour of the Balassa-Samuelson effect is straightforward when Germany and the basket are taken as the benchmark; it is less clear when the US is considered as the foreign country. The results summarised in Table 5 uncover the presence of the cointegrating vectors X2, X3 and X4 for Germany and the trade-weighted basket. All estimated coefficients are significant and appropriately signed. The specification tests confirm the robustness of our estimates. Just as in the case of the four other transition countries, productivity and relative prices only seem to be related using US data, while tests fail to establish any meaningful linkage between relative prices and the real exchange rate.

Table 5. Johansen cointegration tests, Slovenia

Vector = X β'

X1 = [relative prices, dual productivity], $\beta' = [1, \beta_1]$, expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], $\beta' = [1, \beta_1]$, expected signs [1,-]

X3 = [changes in the CPI based real exchange rate, the relative price differential], $\beta' = [1, \beta_1]$, expected signs [1,+]

X4 = [changes in the CPI based real exchange rate, the dual productivity differential], $\beta' = [1, \beta_1]$, expected signs [1,+]

	K	H_0	λ_{trace}	Vector	1	β_1	Normality
Slovenia							
	k=1 m3	R=0	27.28*	X1	1*	-0.948	55.925 (0.000)
		R=1	3.19			(-10.478)	
Germany							
Prod, Rprice, RER	k=1, m2	R=0	74.99**	X2	1*	-3.537	2.037 (0.916)
		R=1	27.92**			(-10.685)	
		R=2	5.25	X3	1*	0.537	
						(8.391)	
Prod, RER	k=2, m2	R=0	22.59**	X4	1*	1.686	3.354 (0.500)
		R=1	5.01			(6.744)	
Basket							
Prod, Rprice, RER	k=1, m2	R=0	83.77**	X2	1*	-3.338	2.655 (0.851)
		R=1	30.91**			(-11.837)	
		R=2	4.91	X3	1*	0.431	
						(8.979)	
Prod, RER	k=2, m2	R=0	26.92**	X4	1*	1.105	2.980 (0.561)
		R=1	6.19			(6.538)	
US							
Prod, Rprice, RER	k=1, m2	R=0	62.49**	X2	1*	-2.797	7.012 (0.320)
		R=1	15.32			(-8.275)	
		R=2	2.78				
Prod, Rprice	k=1, m2	R=0	36.81**	X2	1*	-4.792	4.427 (0.351)
		R=1	6.77			(-6.573)	

Note: See Table 1.

Finally, we construct a panel including the five transition economies for the period used in the time-series analysis. The motivation for using panel data is to increase the power of the cointegration tests. The first step in the analysis is to test for unit root. As the single ADF and PP tests previously indicated that 49 series out of 50 are I(1), it is not surprising that the Im-Pesaran-Shin panel unit root test assuming an intercept and trend and only a constant term seems to confirm that all series are I(1) processes. Table 6 gives the results of the Pedroni panel cointegration tests. We note all three types of group mean statistics, since they allow for maximum heterogeneity across countries and give no indication that the residuals' autoregressive coefficient should be the same for all countries. Results in Table 6 indicate that the panel cointegration technique allows detection of more cointegration relationships than single-country analysis. Thus, we are now able to reject the null hypothesis of no cointegration against the alternative hypothesis of the existence of a cointegrating relationship for the vectors X3 and X4 for all countries when Germany or the basket serve as benchmark, i.e. also in the cases where time-series analysis could not detect such relationships (Poland vis-à-vis the basket and for Hungary and Slovakia vis-à-vis Germany and the basket). The panel cointegration analysis seems to confirm the results of the Johansen tests in cases where the US was used as a benchmark country: the relative price differential and the real exchange rate are not cointegrated for any countries.

Table 6. Panel Cointegration Statistics

	Internal		**Germany**			**Basket**			**US**	
	X1	X2	X3	X4	X2	X3	X4	X2	X3	X4
Group mean panel stat										
rho-stat	-2.607**	-1.271	-2.032*	-3.319*	-1.228	-2.099*	-2.959**	-1.335	1.421	1.047
pp-stat	-8.377**	-6.950**	-2.325*	-5.866**	-7.424**	-2.566**	-6.699**	-6.628**	0.965	-0.824
adf-stat	-1.612	-2.974**	-2.584**	-1.927*	-3.117**	-2.172*	-3.744**	-1.756	0.591	-0.638

Note: The Pedroni statistics (1999) are adjusted as proposed in Pedroni (2001). Critical values are based on the standard normal distribution; * and ** indicate that H_0 is rejected at the 5% and 1% significance level, respectively.

We use the panel FMOLS estimator to obtain the estimates for the coefficients of the cointegrating relationships we detected with the panel cointegration tests. As shown in Table 7, all coefficients are correctly signed.[14] For the Czech Republic, Hungary and Poland, each coefficient is similar to the value obtained from the time-series analysis and is significant at the 1% level. The case of Slovakia and Slovenia is somewhat puzzling in that the values of the coefficients are far lower than what we obtain from the Johansen tests. In addition, none of the coefficients for X2 is significant for Slovakia and the estimate of β_1 for the X3 against the basket is not significant for Slovenia.

[14] These coefficients are obtained from an Engle-Granger-style cointegration analysis.

Table 7. Panel FMOLS estimates of the cointegrating vectors' coefficients

Vector = X β'

X1 = [relative prices, dual productivity], β'= [1, β_1], expected signs [1,-]

X2 = [the relative price differential, the dual productivity differential], β'= [1, β_1], expected signs [1,-]

X3 = [CPI based real exchange rate, the relative price differential], β'= [1, β_1], expected signs [1,+]

X4 = [CPI based real exchange rate, the dual productivity differential], β'= [1, β_1], expected signs [1,+]

	Internal	**Germany**			**Basket**			**US**
	X1	X2	X3	X4	X2	X3	X4	X2
	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1
Czech Rep.	0.79	1.11	-1.31	-1.59	1.09	-1.15	-1.39	1.04
	(9.14)	(4.00)	(-23.99)	(-4.64)	(4.01)	(-22.47)	(-4.73)	(4.00)
Hungary	0.72	1.17	-0.50	-0.56	1.16	-0.34	-0.36	1.13
	(24.09)	(15.58)	(-10.24)	(-6.80)	(15.89)	(-9.21)	(-6.03)	(15.32)
Poland	0.53	0.73	-1.49	-1.29	0.73	-1.01	-0.88	0.74
	(12.84)	(9.70)	(-9.16)	(-16.61)	(10.02)	(-7.92)	(-11.50)	(9.85)
Slovakia	0.64	0.42	-1.31	-1.69	0.37	-0.96	-1.45	0.30
	(6.97)	(0.78)	(-3.86)	(-1.81)	(0.70)	(-3.10)	(-1.94)	(0.63)
Slovenia	0.91	1.38	-0.25	-1.13	1.39	-0.16	-0.92	1.37
	(7.73)	(2.03)	(-2.35)	(-4.82)	(2.09)	(-1.79)	(-4.74)	(2.40)
Panel	0.72	0.96	-0.97	-1.25	0.95	-0.72	-1.00	0.92
	(27.18)	(14.35)	(-22.18)	(-15.51)	(14.63)	(-19.89)	(-12.94)	(14.40)

Note: t-values in parenthesis.

As mentioned above, the final step of our analysis is to test if the relative PPP holds for tradables and thus whether our results fully accord with the Balassa-Samuelson model. To this end, we conduct both single equation ADF and PP tests and the Im-Pesaran-Shin panel unit root test for the real exchange rate calculated using the industrial producer price index. Surprisingly, the null hypothesis of a unit root cannot be rejected at the conventional 5% level, irrespective of the type of the unit root test employed. The fact that the strong version of the relative PPP cannot be verified for tradable goods provides us with a valuable insight about real exchange rate behaviour – in addition to changes in relative prices playing a role in real exchange rate determination, movements in the prices of tradable goods also appear to influence the evolution of the CPI-based real exchange rate.

6 Quantifying the linkage of productivity growth, inflation and appreciation of the real exchange rate

So far we have concentrated on the question of whether changes in productivity, relative prices and the real exchange rate are connected via a cointegrating vector. In the following section, we calculate the contribution of the Balassa-Samuelson effect to the inflation differential and the appreciation of the real exchange rate. In other words, our aim here is to quantify the impact of productivity gains on inflation and the real exchange rate.

We start by computing the inflation differential vis-à-vis Germany, assuming all five of these CEECs will eventually participate in the EMU. Meeting the Maastricht criterion on inflation implies that the inflation rate of an EMU aspirant will not exceed the average of the three lowest inflation rates of Euroland by more than 1.5% for at least one year before entering EMU. In this regard, Germany makes a good proxy for the inflation criterion thanks to its impressive inflation track record. Applying the theoretical assumptions presented in Section II, we derive the relationship between the dual productivity differential and the inflation differential between the home and the foreign country. Expressing the price of non-tradables in equation (7) and combining it with equation (9), we obtain the equation for overall inflation shown in equation (16):

$$\hat{p} = \hat{p}^{T} + (1-\alpha)\left(\delta/\gamma \cdot \hat{a}^{T} - \hat{a}^{NT}\right) \tag{16}$$

The inflation differential between countries is then related to the dual productivity differential so that

$$\hat{p} - \hat{p}^{*} = \hat{p}^{T} - \hat{p}^{T*} + (1-\alpha)\left[\left((\delta/\gamma)\cdot \hat{a}^{T} - \hat{a}^{NT}\right) - \left((\delta^{*}/\gamma^{*})\cdot \hat{a}^{T*} - \hat{a}^{NT*}\right)\right]. \tag{17}$$

We next use equation (18) to determine the extent to which productivity is likely to affect the inflation differential[15]

$$\hat{p} - \hat{p}^{*} = (1-\alpha)\beta_1\left[\left(\hat{a}^{T} - \hat{a}^{NT}\right) - \left(\hat{a}^{T*} - \hat{a}^{NT*}\right)\right], \tag{18}$$

where β_1 is the estimated coefficient of the X2 vector.

We use several methods to compute the inflation differential associated with the Balassa-Samuelson effect. We consider the productivity data used in the estimations, as well as the trend obtained by employing the Hodrick-Prescott filter on the series.[16] Next, the average yearly changes for three periods: the whole period and for two sub-periods, no-

[15] We set the tradable goods inflation differential to zero as we are interested in the inflation brought about by productivity gains. As equations (7) and (8) reveal, this inflation is always non-tradable inflation.

[16] The smoothing parameter is set equal to 1600 as proposed in Hodrick-Prescott (1997) for quarterly data. For a recent discussion on the appropriate value of the smoothing parameter for annual and quarterly data, see Ravn-Uhlig (2001).

tably for 1991:Q1 to 1995:Q4 and 1996:Q1 to 2001:Q2 are determined for the two types of series. We also determine the average annual change in productivity for each year.

Substituting these results into equation (18), we first only consider the (1-α) term[17] in the equation and ignore the estimates of the coefficient issued from the cointegrating vector. We then estimate the inflation differential using both (1-α) and β_1. We use estimates of β_1 coming both from the individual time-series analysis and the panel method.

Once we have quantified the inflation differential associated with the Balassa-Samuelson effect, we next attempt to determine how much real appreciation can be explained by productivity gains. Here, we employ a slightly modified version of equation (13):

$$\hat{r} = -(1-\alpha)\beta_1\left(\left(\hat{a}^{T} - \hat{a}^{NT}\right) - \left(\hat{a}^{T}* - \hat{a}^{NT}*\right)\right). \qquad (19)$$

The procedure is similar to that described above with the difference that we use the estimate of β_1 of the cointegration vector X4. The real appreciation associated with the dual productivity differential is then compared to the observed appreciation of the CPI-deflated real exchange rate. The results are reported in Tables 8, 9, 11 and 12.

Although results differ with regard to the countries and the time period studied (see Tables 8 and 9), the main features of the first results can be readily summarised. First, we observe sizeable productivity gains during the period studied – of the order of 2.7% to 3.6% for Hungary and 3.1% to 4.4% for Poland. Looking at the sub-periods suggests that the productivity growth relative to Germany has accelerated since the mid-1990, from 2.4% and 2.7% to as high as 5.5% and 5.8% for Hungary and Poland, respectively. As a result, in accordance with equation (18), the inflation differential vis-à-vis Germany due to the dual productivity differential amounts to between 2.2% and 3.1% for Hungary and 1.5% to 2.2% for Poland during the period 1991 to 2001. However, as productivity gains become greater over time, the inflation associated with the Balassa-Samuelson effect also rises to 4.3% or 4.6% in the case of Hungary, and 2.8% or 2.9% for Poland, depending on whether individual or panel estimates are used. Contrary to what we observe for the case of Hungary and Poland, the dual productivity differential compared to Germany is found to be slightly negative for Slovakia and Slovenia in the period 1991-2001. In the second half of that period, the dual productivity differential seems to accelerate in these countries taking positive values, but still averages below 1% a year. Table 8 shows the striking negative effect of productivity on inflation for the entire period and in the first half of the 1990s. With higher productivity growth after 1996, the inflation differential also becomes positive and ranges between 0.02% and 1.9% for Slovakia and between 0.6% and 2.1% for Slovenia. Note that the results differ substantially depending on whether panel or single-country estimates are used. On average, we can conclude that the dual-productivity-differential-driven inflation is rather modest in these two countries. The Czech Republic's situation is somewhat different because its dual productivity differential has always exceeded Germany's, although to a lesser extent than for Hungary or Poland. Hence, the impact of the

[17] The (1-α) term is the share of non-tradable goods in GDP. We determine it as the annual average for the period of 1992 to 1998 using nominal sectoral GDP data obtained from the WIIW database on transition economies. The industrial sector is taken as the tradable goods sector, while the non-tradable goods sector includes the rest. We note that agriculture is not taken into account. So, the non-tradable goods share amounts to 61.6% for the Czech Republic, 70.1% for Hungary, 65.5% for Poland, 65.1% for Slovakia and 64.4% for Slovenia.

dual productivity differential on the inflation differential remains modest, ranging from 0.06% to 1.1%, depending on the period and the source of the coefficient estimates.

Table 8. The contribution of the Balassa-Samuelson effect to the inflation against Germany (with the share of non-tradables as in GDP[a])

		Czech Rep	Hungary	Poland	Slovakia	Slovenia	Panel
The dual productivity differential against Germany (in %)							
Raw data	1991-2001	0.304	3.668	4.413	-0.696	-0.608	1.416
	1991-1995	0.418	1.543	2.251	-1.523	-1.940	0.150
	1996-2001	0.198	5.209	5.754	0.057	0.659	2.375
HP filter	1991-2001	0.083	2.730	3.082	-1.305	-0.450	0.828
	1991-1995	1.445	2.423	2.771	-1.089	-0.504	1.009
	1996-2001	1.229	5.484	5.815	0.805	0.904	2.847
The inflation differential due to the Balassa-Samuelson effect (%) using the 1-α term in equation (18)							
Raw data	1991-2001	0.187	2.571	2.890	-0.453	-0.391	0.967
	1991-1995	0.257	1.082	1.474	-0.992	-1.249	0.112
	1996-2001	0.122	3.651	3.769	0.037	0.424	1.607
HP filter	1991-2001	0.051	1.914	2.018	-0.850	-0.290	0.569
	1991-1995	0.890	1.698	1.815	-0.709	-0.325	0.674
	1996-2001	0.757	3.844	3.809	0.524	0.582	1.903
The inflation differential due to the Balassa-Samuelson effect (%), using the (1- α)β_1 term where betas are estimates from time-series analysis							
Raw data	1991-2001	0.222	3.096	2.205	-1.633	-1.384	
	1991-1995	0.305	1.303	1.125	-3.574	-4.419	
	1996-2001	0.144	4.396	2.875	0.133	1.501	
HP filter	1991-2001	0.061	2.304	1.540	-3.063	-1.026	
	1991-1995	1.055	2.045	1.385	-2.555	-1.149	
	1996-2001	0.897	4.629	2.906	1.888	2.060	
The inflation differential due to the Balassa-Samuelson effect (%), using the (1- α)β_1 term where betas are estimates from panel data							
Raw data	1991-2001	0.206	3.009	2.110	-0.190	-0.540	0.888
	1991-1995	0.283	1.266	1.076	-0.416	-1.724	0.094
	1996-2001	0.134	4.272	2.751	0.016	0.586	1.490
HP filter	1991-2001	0.056	2.239	1.473	-0.357	-0.400	0.519
	1991-1995	0.979	1.987	1.325	-0.298	-0.448	0.633
	1996-2001	0.833	4.498	2.781	0.220	0.804	1.786

[a] The (1-α) term is set equal to the share of non-tradables in GDP.

As far as the relationship between the dual productivity differential and the appreciation of the real exchange rate is concerned, the picture is broadly similar to what we obtain by analysing the extent to which the dual productivity differential may affect the overall consumer price index. In the case of Hungary and Poland, the national currency has experienced a real appreciation of 2.4%–3.2% and 4.3%–4.8%, respectively, for the whole period. As in the case of the dual productivity differential, real appreciation was higher in the second sub-period. Assessing the result obtained in accordance with equation (19), we observe that, with and without β_1, the observed real appreciation of the home currency is strongly related to the Balassa-Samuelson effect. Of the countries examined, Slovenia's currency had the lowest observed real appreciation – regardless of the period considered or the data used. This may be associated with the moderate fall in dual productivity during the period 1991–2001 and 1991–1995. The second sub-period provides evidence in favour of productivity-backed real appreciation, since the approximately 1.7% to 2.0% appreciation in real terms was accompanied by productivity gains exceeding German productivity growth by 0.6%–0.9%. Although Table 8 shows a large average yearly real appreciation of around 5% for both the Czech Republic and Slovakia, productivity progress remains quite low, and thus the associated real appreciation is also insignificant.[18]

Using weights based on national accounts as is usual practice, we assumed so far that the non-tradables' share in the CPI basket is equal to that in the GDP deflator. The examination of the officially published Czech and Hungarian consumer price basket reveals a strikingly different picture – non-tradables represent a mere 32.7% of the Czech basket between 1994 and 2000! Similarly, the average share of non-tradables was as low as 35% in Hungary over the period of 1993 to 2000, 33.9% for Slovakia for the period of 1997 to 1999 and 41% for Poland in 2000.[19] Using these weights, we proceed to recalculate the contribution of the dual productivity differential to the inflation differential and the real appreciation of the home currency.

Tables 11 and 12 summarise the new results. The conclusion for the Czech Republic, Slovakia and Slovenia shows little change. The inflation differential vis-à-vis Germany due to the dual productivity differential remains quite low. More importantly, we see a dramatic decrease in the inflation differential attributable to the Balassa-Samuelson effect for Hungary and Poland. Figures drop under the critical value of 1.5% in the periods 1991–1995 and 1991–2001. Examining the second period 1996–2001 yields figures for the inflation differential slightly above 1.5%.

[18] We also report results for the whole panel where possible. Although it is enticing to reason in terms of a panel of countries, we refrain for two reasons. First, in panel estimations, the same weight is attributed to every country. It is clear that Poland and Slovenia should not be treated with the same weights. Second, as the reported results make it clear, the countries are rather heterogeneous and therefore the same estimated coefficient should not be applied to all of them.

[19] As we lack data on Slovenia, we assume the average weight of the other countries. Figures obtained from central bank statistics.

Table 9. The contribution of the Balassa-Samuelson effect to the appreciation of the real exchange rate against Germany (share of non-tradables in GDP[a])

		Czech Rep	Hungary	Poland	Slovakia	Slovenia	Panel
Real appreciation justified by the Balassa-Samuelson effect (%) using only the 1-α term in equation (19)							
Raw data	1991-2001	0.187	2.571	2.890	-0.453	-0.391	0.967
	1991-1995	0.257	1.082	1.474	-0.992	-1.249	0.112
	1996-2001	0.122	3.651	3.769	0.037	0.424	1.607
HP filter	1991-2001	0.051	1.914	2.018	-0.850	-0.290	0.569
	1991-1995	0.890	1.698	1.815	-0.709	-0.325	0.674
	1996-2001	0.757	3.844	3.809	0.524	0.582	1.903
Real appreciation justified by the Balassa-Samuelson effect (%) using the (1- α)β_1 term where betas are estimates from time series							
Raw data	1991-2001	0.353	NA[20]	3.815	NA	-0.660	
	1991-1995	0.485	NA	1.946	NA	-2.107	
	1996-2001	0.229	NA	4.975	NA	0.715	
HP	1991-2001	0.096	NA	2.664	NA	-0.489	
	1991-1995	1.677	NA	2.396	NA	-0.548	
	1996-2001	1.426	NA	5.028	NA	0.982	
Real appreciation justified by the Balassa-Samuelson effect (%), using the (1- α)β_1 term where betas are estimates from panel data							
Raw data	1991-2001	0.298	1.440	3.728	-0.766	-0.442	1.157
	1991-1995	0.409	0.606	1.902	-1.676	-1.412	0.122
	1996-2001	0.193	2.045	4.862	0.062	0.479	1.940
HP	1991-2001	0.081	1.072	2.604	-1.436	-0.328	0.676
	1991-1995	1.415	0.951	2.342	-1.198	-0.367	0.824
	1996-2001	1.204	2.153	4.913	0.885	0.658	2.326
Observed appreciation of the CPI-based real exchange rate							
Raw data	1991-2001	4.611	2.436	4.267	4.109	0.500	3.185
	1991-1995	5.908	0.643	3.306	4.873	-1.022	2.741
	1996-2001	4.780	4.185	6.094	4.448	1.791	4.259
HP filter	1991-2001	4.892	3.153	4.868	4.495	1.552	3.792
	1991-1995	6.172	1.617	3.475	4.998	-0.029	3.247
	1996-2001	4.562	3.074	5.510	4.292	2.088	3.905

[a] The (1-α) term is set equal to the share of non-tradables in GDP

We also note that the share of regulated prices in the CPI remains high, even if it has generally declined over the past decade. During the period 1991–1999, administered prices represented, on average, 15-20% of the CPI basket (see Table 10). Typically, administered prices apply extensively to services. At stake here is the transmission between productivity

[20] Because of the missing cointegration vector, we could not compute the respective figures for Hungary and Slovenia.

growth and inflation. Consequently, the share of market-based services in the CPI, which provides the pass-through from productivity growth to overall inflation, is in fact lower that suggested above and may in fact drop below 30%. Hence, the figures presented in Table 11 and 12 should be revised downwards. The point here is that increases in administered prices likely exacerbate the increase in the relative price of non-tradables. Thus, there is a danger that the impact of non-tradables inflation on overall inflation may be wrongly interpreted as productivity growth.

Table 10. The share of administered prices in the CPI basket, 1991–1999 (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Czech Republic	27.9	18.3	17.9	18.1	17.4	17.4	13.3	13.3	13.3	13.3
Hungary	11.0	10.9	10.8	11.8	12.9	12.8	15.9	n.a.	n.a.	n.a.
Poland	11.0	14.0	16.0	17.0	17.0	15.0	12.0	10.0	9.0	9.0
Slovakia	n.a.	n.a.	21.8	21.8	21.8	21.8	15.1	14.7	15.2	n.a.
Slovenia	n.a.	23.7	19.8	18.4	22.5	22.4	20.4	17.0	14.3	13.7

Source: EBRD, Transition Report 2001

Based on Szapáry (2000), a growing body of literature calls for modifying the Maastricht inflation criterion since advanced transition countries will be unable to satisfy the criterion on price stability due to of the Balassa-Samuelson effect.[21] Our results, conversely, provide hope that even Poland and Hungary will meet the Maastricht criterion on price stability because the structural inflation differential explained by the Balassa-Samuelson effect does not present an insurmountable obstacle for these two countries. Both can bring their inflation into line with the Maastricht criterion on price stability. That said, as these economies catch up in terms of per capita GDP, consumption is likely to shift towards non-tradables. This shift will be explicit when the composition of the CPI is modified to give more weight to non-tradable items. An automatic consequence of this change will be the increased impact of the dual productivity differential on the overall inflation differential vis-à-vis the rest of the world. Of course, playing catching-up in terms of productivity is a game with diminishing returns: the closer a country approaches the targeted EU average productivity level, the lower the dual productivity differential. Indeed, in the long term, lower dual productivity could counterbalance the evolution of CPI weights in favour of non-tradables.

[21] Also see Begg et al (2001) and Coricelli-Jazbec (2001).

Table 11. The inflation differential against Germany associated with the Balassa-Samuelson effect (share of non-tradables in CPI[a])

		Czech Rep	Hungary	Poland	Slovakia	Slovenia	Panel
The inflation differential due to the Balassa-Samuelson effect (%), using only the (1-α) term in equation (18)							
Raw data	1991-2001	0.100	1.284	1.809	-0.237	-0.213	0.549
	1991-1995	0.137	0.540	0.923	-0.518	-0.679	0.081
	1996-2001	0.065	1.823	2.359	0.019	0.231	0.899
HP filter	1991-2001	0.027	0.956	1.263	-0.444	-0.158	0.329
	1991-1995	0.473	0.848	1.136	-0.370	-0.177	0.382
	1996-2001	0.402	1.919	2.384	0.274	0.317	1.059
The inflation differential due to the Balassa-Samuelson effect (%), using the (1-α)β_1 term where betas are estimates from time-series analysis							
Raw data	1991-2001	0.118	1.546	1.380	-0.853	-0.752	
	1991-1995	0.162	0.650	0.704	-1.866	-2.402	
	1996-2001	0.077	2.195	1.800	0.070	0.816	
HP filter	1991-2001	0.032	1.151	0.964	-1.600	-0.557	
	1991-1995	0.560	1.021	0.867	-1.335	-0.624	
	1996-2001	0.476	2.311	1.819	0.986	1.120	
The inflation differential due to the Balassa-Samuelson effect (%), using the (1-α)β_1 term where betas are estimates from panel data							
Raw data	1991-2001	0.109	1.502	1.321	-0.099	-0.293	0.483
	1991-1995	0.150	0.632	0.674	-0.218	-0.937	0.051
	1996-2001	0.071	2.133	1.722	0.008	0.318	0.810
HP filter	1991-2001	0.030	1.118	0.922	-0.186	-0.217	0.282
	1991-1995	0.520	0.992	0.829	-0.156	-0.244	0.344
	1996-2001	0.442	2.246	1.740	0.115	0.437	0.972

[a] The (1-α) term is set equal to the share of non-tradables in the consumer price index.

Next, we study the real appreciation associated with productivity gains. Results for the Czech Republic, Slovakia and Slovenia support the view that the appreciation of the real exchange rate referred to as sustainable in terms of the Balassa-Samuelson effect was essentially zero (or negative in the case of Slovenia during the first half of the 1990s). This finding may be somewhat embarrassing for the Czech Republic and Slovakia given that their currency appreciated at an annual pace of 4.5–6.8% and 4.1–4.9% during the whole period and the two sub-periods. For Slovenia, the observed real appreciation of the tolar vis-à-vis the German mark is low indeed, ranging from -1.02% to 2.1%, as can be seen in Table 12.

Table 12 provides an interesting insight as to the nature of the real appreciation in Hungary and Poland. Despite dual productivity differentials as high as 4–5%, the appreciation of the real exchange rate justified by the Balassa-Samuelson effect shrinks to just 1% in Hungary and 2% in Poland. This in turn means that only a fraction of the observed real appreciation of the Hungarian forint can be explained by the Balassa-Samuelson effect. An exception is the period 1991–1995, when real appreciation was also limited. Approximately half of the de facto appreciation of Poland's real exchange rate can be attributed to the Balassa-Samuelson effect. At least part of the reason for this is the poorly working transmission mechanism based on relative prices that connects the dual productivity differential to changes in the real exchange rate.

Table 12. Real appreciation associated with the Balassa-Samuelson effect (share of non-tradables in CPI[a])

		Czech Rep	Hungary	Poland	Slovakia	Slovenia	Panel
Real appreciation justified by the Balassa-Samuelson effect (%) using only the 1-α term in equation (19)							
Raw data	1991-2001	0.100	1.284	1.809	-0.237	-0.213	0.549
	1991-1995	0.137	0.540	0.923	-0.518	-0.679	0.081
	1996-2001	0.065	1.823	2.359	0.019	0.231	0.899
HP filter	1991-2001	0.027	0.956	1.263	-0.444	-0.158	0.329
	1991-1995	0.473	0.848	1.136	-0.370	-0.177	0.382
	1996-2001	0.402	1.919	2.384	0.274	0.317	1.059
Real appreciation justified by the Balassa-Samuelson effect (%) using the (1- α)β_1 term where betas are estimates from time series							
Raw data	1991-2001	0.187	NA	2.388	NA	-0.359	
	1991-1995	0.258	NA	1.218	NA	-1.145	
	1996-2001	0.122	NA	3.114	NA	0.389	
HP	1991-2001	0.051	NA	1.668	NA	-0.266	
	1991-1995	0.890	NA	1.500	NA	-0.298	
	1996-2001	0.757	NA	3.147	NA	0.534	
Real appreciation justified by the Balassa-Samuelson effect (in %), using the (1- α)β_1 term where betas are estimates from panel data							
Raw data	1991-2001	0.158	0.719	2.334	-0.400	-0.240	0.629
	1991-1995	0.217	0.303	1.190	-0.875	-0.767	0.067
	1996-2001	0.103	1.021	3.043	0.033	0.261	1.055
HP	1991-2001	0.043	0.535	1.630	-0.750	-0.178	0.368
	1991-1995	0.751	0.475	1.466	-0.626	-0.199	0.448
	1996-2001	0.639	1.075	3.076	0.462	0.358	1.265
Observed appreciation of the CPI-based real exchange rate							
Raw data	1991-2001	4.611	2.436	4.267	4.109	0.500	3.185
	1991-1995	5.908	0.643	3.306	4.873	-1.022	2.741
	1996-2001	4.780	4.185	6.094	4.448	1.791	4.259
HP filter	1991-2001	4.892	3.153	4.868	4.495	1.552	3.792
	1991-1995	6.172	1.617	3.475	4.998	-0.029	3.247
	1996-2001	4.562	3.074	5.510	4.292	2.088	3.905

[a] The (1-α) term is set equal to the share of non-tradables in the consumer price index.

The results for Hungary are somewhat lower than those of Simon and Kovács (1998), who estimated productivity-backed real appreciation between 1% and 3%. Our results also contrast with those of Rother (2000) who argues that 2.6% of Slovenian inflation is due to the dual productivity differential in the period 1993–1998. Moreover, according to Rother (2000), the dual productivity differential fully account for the long-term real appreciation of the Slovenian currency for the same period. According to the estimations of Golinelli and Orsi (2001), the contribution of the Balassa-Samuelson effect to inflation is 4.3%, 2.1% and 5.1% for the Czech Republic, Hungary and Poland when the euro zone is taken as a benchmark over the period of 1991 to 2000. Sinn and Reutter (2001) calculate the excess inflation relative to Germany that can be attributed to the dual productivity differential as high as 2.88%, 3.38%, 4.16% and 6.86% for the Czech Republic, Slovenia, Poland and Hungary, respectively.[22] Using panel data, De Broeck and Sløk (2001) conclude that the Balassa-Samuelson effect accounted for an average 1% of inflation in 1999.[23] In a recent panel study, Halpern and Wyplosz (2001) determine that, on average, the "equilibrium" real appreciation is around 3% per annum. [24] Coricelli and Jazbec (2001)[25] suggest sustainable real appreciation to be about 1% a year.[26]

Again, our results contrast with the results of previous studies, and indicate meeting the Maastricht criterion on inflation may not be a problem, even for Hungary or Poland. On the other hand, we also can also infer that the currencies of the transition countries discussed may have also experienced excessive appreciation of their real exchange rates the past ten years.

7 Looking behind the scenes

A. While the Balassa-Samuelson effect seems to be at work …

Summarising the results of our estimations, we conclude first and foremost that our empirical results support the view that relative price developments are related to relative productivity developments in all countries. In other words, we find cointegration relationships for the internal transmission mechanism for all countries, both in the time series and the panel estimations.

[22] They consider different periods for these countries: e.g. 1984-1996 for Germany, 1994-1998 for Hungary and Poland, 1995-1998 for the Czech Republic and 1996-1999 for Slovenia. The fact that the periods are different and do not cover each other cast doubt on the results.

[23] Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Mongolia, Poland, Romania, Russia, Ukraine and Uzbekistan are included in the panel covering the period 1991–1998.

[24] The unbalanced panel is constructed using data for the Czech Republic, Estonia, Hungary, Kyrgyzstan, Latvia, Lithuania, Poland, Romania, Russia, Slovakia and Slovenia.

[25] The study includes Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia, Ukraine, and Uzbekistan. The panel is unbalanced.

[26] A general criticism of these panel studies is that interpreting common coefficients for countries as different as Poland and Kyrgyzstan may be rather meaningless.

Second, the extent to which productivity increases in the tradables sector are translated into price increases of non-tradables sector varies among countries, as do productivity advances.

Third, regarding real exchange rate developments and the dual productivity differential vis-à-vis Germany as the benchmark country, stable cointegration relationships could be established only for some countries when using time series techniques, but for all countries within the panel estimation. In contrast, the real exchange rate in relation to the US dollar did not appear to be driven by productivity developments.

Fourth, in those cases where cointegration relationships between the dual productivity differential and the relative price differential, on one hand, and movements in the real exchange rate, on the other, could be established, we found that the extent to which the real appreciation of the currencies is connected to productivity increases varies among countries. In Slovenia and Slovakia these coefficients were to close to 3, a bit over 1 for the Czech Republic and Poland, and close to 0.5 in the case of Hungary (panel estimation).

When quantifying the inflation differential and real exchange rate appreciation associated with dual productivity differentials, once again, we find that these differ considerably among countries. While virtually nonexistent in the case of Slovenia and Slovakia (if the whole period is examined), Hungary and Poland show productivity differentials that could justify inflation differentials of up to 4% when we use weights obtained from national accounts for non-tradables. In practice, of course, weights derived from the national accounts and used in the CPI differ considerably. However, weights employed for non-tradables are much lower in the CPI. As a result, even for Poland and Hungary, the appreciation of the real exchange rate against the German mark may be just partly brought about the dual productivity differential as productivity-driven inflation (equation (18)) is considerably lower.

As a consequence, when comparing the observed real appreciation of the currencies with that explained by productivity developments, we conclude that, for each country, the observed real appreciation markedly exceeds that suggested by the Balassa-Samuelson theory. Thus, while productivity differentials exist, we cannot unequivocally support the notion that relative price developments – and specifically real exchange rate developments – are exclusively dominated by these productivity gains. The Balassa-Samuelson theory does not explain the real exchange rate developments in the countries studied here and suggests that the currency of the countries under consideration might have experienced excessive real appreciation over the last ten years.

B. … it does not fully explain movements in real exchange rates

Relative PPP has long been a yardstick for policy purposes as regards real exchange rate movements. Since Balassa and Samuelson, however, we have come to understand that developing countries in the catch-up process may experience a trend appreciation of their CPI-based real exchange rate. Although relative PPP holds for tradable goods, there seems to be a significant gap between price inflation of non-tradables in favour of the developing countries that leads to higher overall inflation. If we assume nominal exchange rate stability, this will bring about real appreciation. In addition to the Balassa-Samuelson effect and correction of any excessive devaluation at the start of transition (Halpern and Wyplosz, 1997), we can identify a number of factors that may exacerbate the Balassa-Samuelson effect by contributing to the trend appreciation of the real exchange rate.

First, we can observe a trend appreciation in the real exchange rate of tradables, albeit to a lesser extent than in the case of the CPI-deflated real exchange rate. As the export structure of these countries changes, with agricultural products losing weight and machinery and higher value-added goods gaining importance, the terms of trade shift dramatically. This phenomenon is echoed in the experience of Asian countries also engaged in the catch-up process.[27]

Second, the price of non-tradable items increases not only due to the wage increases transmitted from the tradable sector, but also because of higher demand for services as real incomes rise. Further, the correction of relative prices implies that prices of highly subsidised goods have to increase no matter whether productivity rises. External trade liberalisation and market determination of prices has consequences for both the efficiency of factor allocation and thus supply, and for price developments. Domestic producers of tradable goods need to set prices in accordance with world market developments, while the ability of producers of non-tradables to charge high mark-ups should be reduced when market entry is liberalised and supply is widened. However, it has been noticed that the large investments needed for upgrading the capital stock could increase the price of the corresponding non-tradables (Coorey et al., 1997).

The third reason is related to the nominal exchange rate and the ability of the countries to raise credits and attract foreign investment. In the early stage of the transition, inherited debts and balance of payments problems, as well as the high risk associated with investment in unstable environments reduces access to foreign capital and imposes high-risk premia. While direct investments were generally possible from the start of the reform process (and in some countries part of the privatisation strategy), capital account transactions remained regulated for years. Eventually, as establishing full convertibility of the currencies was part of the reform programs, restrictions were gradually reduced. This induced strong capital inflows, due to e.g. privatisation and more stable macroeconomic environments. Not surprisingly, higher capital inflows led to real appreciation, either directly through the nominal exchange rate, or indirectly through higher money supply. The real appreciation connected to capital inflows can be interpreted as increases in the equilibrium exchange rate where the growth performance of the economy secures that the repayment of these debts will not require adjustments in the real exchange rate. However, it can turn out that expected growth rates will not materialise and adjustments in the real exchange rate will be needed. To this day, it remains a challenge to assess the extent to which the appreciation of a currency due to capital inflows can be regarded as equilibrium appreciation.

C. The role of the exchange rate regime

Real exchange rate developments have also been influenced by the exchange rate regime. Clearly, if a fixed exchange rate is adopted, adjustment after shocks will require changes in price levels. Flexible exchange rates, however, do not prevent deviations from the equilibrium real exchange rate. The short event horizon on which most capital transactions are conducted mean that real exchange rates can be driven by nominal exchange rate development.

As seen earlier in the case of Hungary and Poland, de facto real appreciation may be partly explained by productivity gains, at least over the long run. One reason for this is that the early implementation of reforms resulted in rapid economic restructuring and productivity gains (Figure 2). Moreover, both Hungary and Poland implemented crawling peg exchange rate regimes. In this system, the authorities determined the rate of crawl by ex-

[27] "Tradable prices may appear to rise when the composition of domestic products as well as exports move to higher-value-added goods" Ito-Isard-Symansky (1997).

plicitly taking into account the expected productivity growth of the traded sector. As a consequence, the real exchange rate appreciated in tandem with the dual productivity differential.

In Poland, increasing convertibility of capital transactions required an early widening of the band. With the nominal exchange rate increasingly driven by capital movements, the Polish zloty experienced a huge real appreciation towards the end of the 1990s. Similarly, the widening of the band of the forint in early 2001 combined with the progressive abolition of capital controls in the second half of the 1990s drove nominal (and real) appreciation of the forint. Thus, the link between productivity and real exchange rate is likely to loosen in the future.

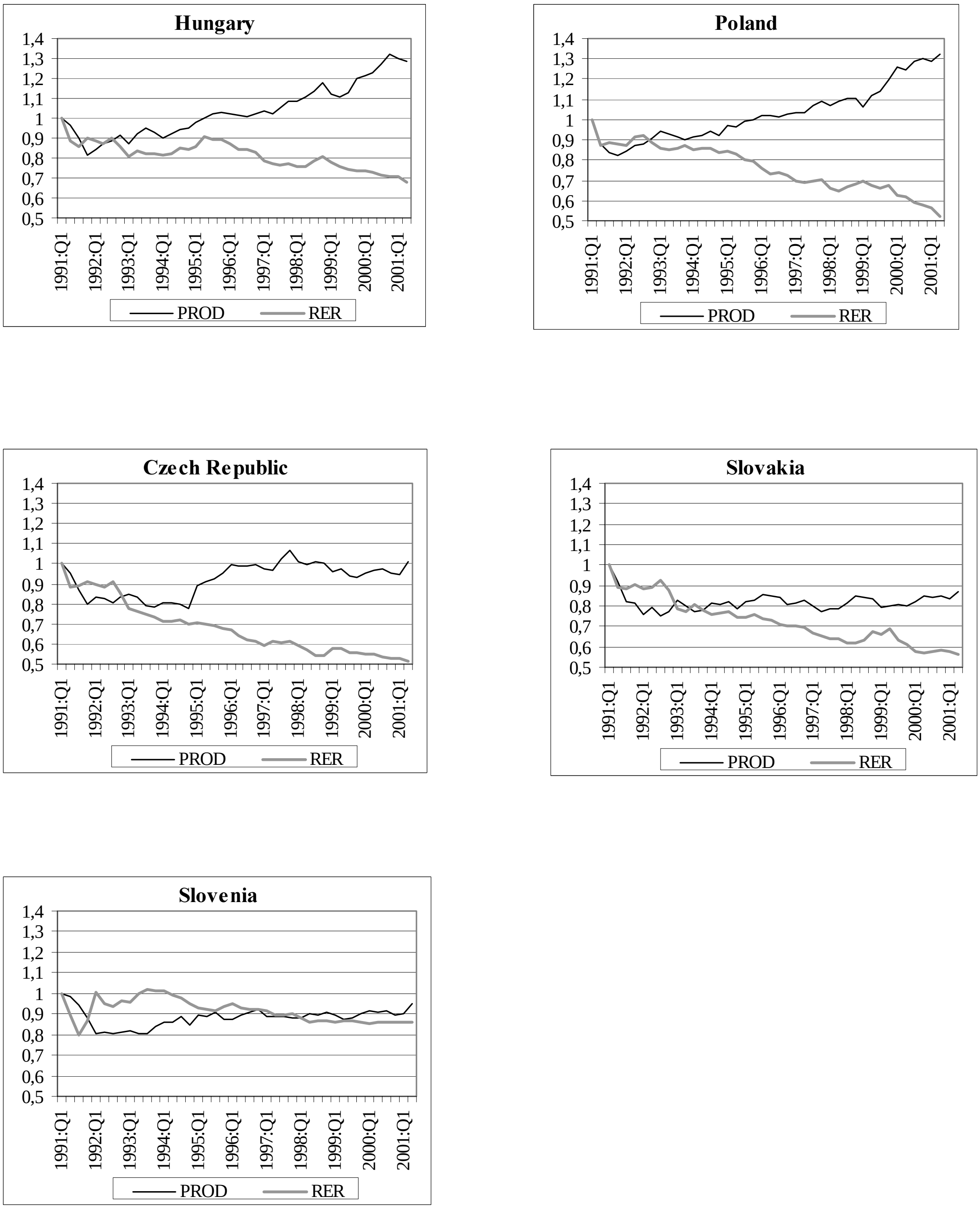
In contrast to Hungary and Poland, the nominal depreciation of the Czech and the Slovak currencies has been relatively low[28] given that their exchange rate policy has long consisted in pegging the currency to a basket based upon the German mark and the US dollar with virtually no devaluation until the end of the system in 1997 and 1998, respectively. Even if annual inflation was quickly brought down into single-digit territory, the inflation differential vis-à-vis the rest of the world coupled with the hard peg remained high enough to bring about substantial real appreciations. Simultaneously, both countries tended to drag their feet when it came to efficient firm-level restructuring, The result was sluggish progress in productivity (Figure 2). In the late 1990s, the privatisation process based on direct sales to domestic and foreign investors moved into high gear, attracting sizeable capital inflows and subsequent appreciation of the nominal exchange rate. As a consequence, throughout the period under investigation, real appreciation has occurred in tandem with a low dual productivity differential as compared to Germany and the US.

Slovenia is the special case in this regard. Although its economic reforms have also been slowly implemented, the clever use of macroeconomic policy made it possible for Slovenia to counterbalance the effects of slow reforms.[29] As shown in Figure 2, the Slovenian dual productivity differential relative to Germany has been far lower than Poland's or Hungary's. At the same time, despite the officially declared floating exchange rate regime, the Bank of Slovenia intervened actively in the foreign exchange market against the German mark in a context of low capital mobility. Thus, the exchange rate behaved like a crawling peg as the nominal exchange rate held to a continuously depreciating path. The appreciation of the tolar in real terms is far less that what we saw in the Czech and Slovakian cases.

[28] While the nominal exchange rate has depreciated by approximately 300% in Hungary and Poland between 1991 and now, the depreciation has not exceeded 20% and 30% for the Czech and Slovakian currencies, respectively.

[29] In general, policy makers lacked the stomach to introduce painful economic reforms in countries that were in relatively well off at the beginning of the transition, e.g. the Czech Republic and Slovenia. Hungary and Poland, on the other hand, had no choice but to restructure their economies rapidly.

Figure 2. The dual productivity differential and the consumer price deflated real exchange rate against Germany, 1991-2001 (1991=100).



8 Concluding remarks

These results are relevant to current discussions on EU accession and the requirement that aspirants meet the Maastricht criteria for joining the euro area. A number of papers have recently argued the impossibility of countries experiencing high dual productivity differential simultaneously achieving low inflation and a stable exchange rate. The remedy prescribed by these authors is a relaxation of price stability criterion. In this paper, we found that achieving low inflation rates may be less of a problem than earlier suggested. The dual productivity differential has actually been low in the Czech Republic, Slovakia and Slovenia, implying low structural inflation. Moreover, while the dual productivity differential is substantial in Hungary and Poland, productivity increases do not fully translate into price increases in these countries due to the composition of the CPI index. Consequently, real exchange rate movements can just partly be explained by productivity developments.

As a model for equilibrium real exchange rate determination, the Balassa-Samuelson effect suggests the equilibrium real appreciation during the period studied may actually have been close to zero in the cases of the Czech Republic, Slovakia and Slovenia, and around 1% and 3% for Hungary and Poland, respectively. Compared with the observed real appreciation, especially the Czech and the Slovak corunas and to a lesser extent the Polish zloty and the Hungarian forint appear to have experienced excessive appreciation in real terms. However, it must be stressed that the "true" excessive appreciation of the real exchange rate may be less detected by the Balassa-Samuelson model as factors such as the trend appreciation of the tradable-good-based real exchange rate associated with a shift towards technology-intensive exports and long-term demand-side relative price adjustments related to the catch-up process in terms of per capita GDP also affect the path of the equilibrium real exchange rate.

It is worth noting that as capital movements are fully liberalised and the countries are moving towards more exchange rate flexibility, changes in the nominal exchange rate will presumably play an increased role in real exchange rate determination. If these countries continue to receive large capital inflows, the nominal exchange rate will be subject to continuous upward pressure and thus provoke the real exchange rate to appreciate to unsustainable levels.

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