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**The Balassa-Samuelson Effect in Central Europe:  
A Dissaggregated Analysis**

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**THE BALASSA-SAMUELSON EFFECT IN CENTRAL EUROPE:  
A DISAGGREGATED ANALYSIS**

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Dubravko Mihaljek<sup>1</sup>

## The Balassa-Samuelson effect in central Europe: a disaggregated analysis

### SUMMARY

This paper aims to explain inflation differentials observed between six central European economies – Croatia, the Czech Republic, Hungary, Poland, Slovakia and Slovenia – and the euro area in terms of differential productivity growth. The coverage of tradable and non-tradable industries is broader and more detailed than in previous studies, and the data samples are larger, as quarterly data for up to ten years are used.

The main conclusion is that differential productivity growth – ie, the Balassa-Samuelson effect – does not seem to have played a major role in determining either inflation differentials vis-à-vis the euro area, or overall CPI inflation in central Europe. The paper shows that one needs to distinguish carefully between empirical evidence that faster productivity growth in tradable sectors contributes to rising relative prices of non-tradables, and evidence that productivity differentials vis-à-vis the euro area contribute to higher inflation in central Europe compared to the euro area. Although the relative price of non-tradables is rising more or less in line with relative productivity of tradables in central Europe, the same phenomenon has been observed in the euro area. As a result, productivity differentials explain on average only between 0.2 and 2 percentage points of annual inflation differentials vis-à-vis the euro area. Moreover, productivity differentials in general explain only a small proportion of domestic inflation in central European economies. Earlier studies that estimated this “domestic” Balassa-Samuelson effect to be larger have often neglected productivity growth in non-tradable sectors, which has been quite high in many countries.

These results have important policy implications. If EU accession countries find it difficult to satisfy the Maastricht inflation criterion, they will probably have to look for reasons beyond differential productivity growth, at least based on the performance of their tradable and non-tradable industries to date.

Keywords: Balassa-Samuelson effect; Productivity; EU accession; Inflation; Transition.

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## 1. INTRODUCTION

Recent academic and policy discussions about monetary and exchange rate policies have noted a possible conflict between a significant trend appreciation of real exchange rates in EU accession countries and the inflation and exchange rate criteria for EMU membership (see eg Szapáry, 2000). If the productivity growth differential between the traded and non-traded goods sectors is larger in the accession countries than the euro area on account of faster productivity catch-up in the traded goods sector, the relative price of non-traded to traded goods will be rising faster in the accession countries than in the euro area. At a given exchange rate, the overall inflation can thus be expected to be higher in the accession countries than in the euro area. To prevent this Balassa-Samuelson effect from manifesting itself and to produce an inflation rate below the Maastricht ceiling, monetary policy may have to be kept very tight, which could result in a growth slowdown. If the accession countries return to full employment following EMU membership, the inflation rate would continue to exceed that of the older EMU members by the margin implied by the Balassa-Samuelson effect, for as long as these intersectoral productivity growth differentials have not converged (Buiters and Grafe, 2001).

These observations imply a dilemma for monetary policies pursued by EU accession countries with fixed exchange rates. The dilemma is less pronounced for those EU accession candidates whose exchange rates are floating: the Czech Republic, Hungary, Poland and Slovakia. If monetary policy in these countries were to keep inflation below the Maastricht ceiling but the inflation differential warranted by the Balassa-Samuelson effect was greater than the 1½ percentage point margin (at a given exchange rate and at full capacity), the equilibrium response of the nominal exchange rate would be to appreciate (Buiters and Grafe, 2002). The Balassa-Samuelson effect would have to be very large to exhaust the 15% bands of the ERM in two years, assuming that exchange rate starts in the middle of the band. However, a floating rate regime has drawbacks of its own, so these countries would not necessarily find it easier to join the EMU.

The available estimates of the Balassa-Samuelson effect in the transition economies range from zero to 4 percentage points per annum (see Table 1). However, most of the studies do not test the extent to which inflation differences between accession countries and the euro area can be explained by productivity differentials. Rather, they test a related hypothesis developed by Baumol and Bowen (1966), according to which prices of services grow faster than those of manufactured goods due to faster productivity growth in manufacturing industries. This effect in itself is not sufficient to lead to a rise in the general price level – prices of manufactured goods have tended to fall in many countries in recent years as a result of increased domestic and foreign competition. Moreover, the mere presence of faster productivity growth in manufacturing is not sufficient to “justify” a rate of inflation in the transition economies that is higher than in the EU. The inflation differential between countries can be explained in terms of underlying productivity developments only if the productivity growth differential (between traded and non-traded industries) is higher in accession countries than in the euro area.

Against this background, this paper aims at assessing, with some degree of accuracy, the empirical significance of the Balassa-Samuelson effect in six central European economies – Croatia, the Czech Republic, Hungary, Poland, Slovakia and Slovenia. The main conclusion is that, despite evidence of higher productivity growth, productivity differentials in central Europe explain only a small proportion of inflation differentials vis-à-vis the euro area. The next two sections lay out the analytical and empirical framework used in the paper. The remaining sections compare data on productivity growth in tradable and non-tradable industries, look at the Balassa-Samuelson effect in a simple accounting framework based on the historical data, and provide preliminary econometric estimates of “pure” and “domestic” Balassa-Samuelson effects.

## 2. ANALYTICAL FRAMEWORK

Balassa (1964) and Samuelson (1964) identified productivity growth differentials between the sectors producing tradable and non-tradable goods as a factor introducing systematic biases into the relationship between exchange rates and relative prices. Historically, productivity growth in the traded goods sector has been faster than in the non-traded goods sector. By the law of one price, the prices of tradables tend to get equalised across countries, while the prices of non-tradables do not. Higher productivity in the tradable goods sector will bid up wages in that sector and, with labour being mobile, wages in the entire economy will rise. Producers of non-tradables will be able to pay the higher wages only if the relative price of non-tradables rises. This will in general lead to an increase in the overall price level in the economy.<sup>2</sup>

To formalise this model, the aggregate price level is first decomposed into its traded and non-traded components, both at home and abroad:

$$(1) \quad p_t = \alpha p_t^T + (1 - \alpha) p_t^{NT}$$

$$(1') \quad p_t^* = \alpha^* p_t^{T*} + (1 - \alpha^*) p_t^{NT*}$$

where  $p_t^T$  denotes the price of traded goods,  $p_t^{NT}$  denotes the price of non-traded goods, and  $\alpha$  denotes the share of traded goods in each economy.

The real exchange rate  $q$  is defined as the relative price of goods produced abroad (measured in domestic currency) to domestically produced goods:

$$(2) \quad q_t = (e_t + p_t^*) - p_t$$

where  $e_t$  is the nominal exchange rate expressed in units of the domestic currency per unit of the foreign currency. Substituting (1) and (1') in (2) and expressing the result in terms of the differences, the following expression can be obtained:

$$(3) \quad \Delta q_t = (\Delta e_t + \Delta p_t^{T*} - \Delta p_t^T) + [(1 - \alpha^*)(\Delta p_t^{NT*} - \Delta p_t^{T*}) - (1 - \alpha)(\Delta p_t^{NT} - \Delta p_t^T)]$$

If the law of one price holds in the tradable sector, then:

$$(4) \quad \Delta p^T = \Delta e + \Delta p^{T*}$$

ie, the first term on the right hand side of (3) will be zero.

Next, an expression for the movements of relative prices in terms of the productivity differentials between traded and non-traded goods is derived. A model of a small open economy with the following sectoral production functions is assumed (time subscripts are omitted to simplify notation and since it is assumed that there are no adjustment costs):

$$Y^T = A^T (L^T)^\gamma (K^T)^{1-\gamma} \quad (5)$$

$$Y^{NT} = A^{NT} (L^{NT})^\delta (K^{NT})^{1-\delta} \quad (5')$$

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<sup>2</sup> Another consequence, which was the real focus of Balassa and Samuelson, is that the prices of a common basket of goods in two countries measured in a common currency will differ systematically in the presence of long-run productivity differentials.

where  $Y$  denotes output of traded and non-traded goods; and  $A$ ,  $K$ , and  $L$  are productivity, capital and labour inputs. Assuming perfect mobility of capital both internationally and across the two sectors internally, as well as perfect competition in both sectors, profit maximisation implies:

$$R = (1 - \gamma)A^T \left( \frac{K^T}{L^T} \right)^{-\gamma} \quad (6)$$

$$R = P^{NT} (1 - \delta)A^{NT} \left( \frac{K^{NT}}{L^{NT}} \right)^{-\delta} \quad (7)$$

$$W = \gamma A^T \left( \frac{K^T}{L^T} \right)^{1-\gamma} \quad (8) \quad W = P^{NT} \delta A^{NT} \left( \frac{K^{NT}}{L^{NT}} \right)^{1-\delta} \quad (9)$$

where  $R$  is the rental rate on capital (determined in world markets),  $W$  is the wage rate (measured in tradables) and  $P^N$  is the relative price of non-tradables.

A key insight of Balassa and Samuelson is that with perfect capital mobility, the relative price of non-tradables  $P^N$  is governed entirely by the production side of the economy. Equations (6)–(9) involve four equations in four variables,  $K^T/L^T$ ,  $K^{NT}/L^{NT}$ ,  $W$  and  $P^{NT}$ , which can be solved recursively.<sup>3</sup>

By log-differentiating equations (6)–(9), one can obtain the following (domestic) version of the Balassa-Samuelson hypothesis:

$$p = p^{NT} - p^T = c + \left( \frac{\delta}{\gamma} \right) a^T - a^{NT} \quad (10)$$

where lower-case letters denote logarithms,  $c$  is a constant term that includes the real interest rate and factor intensities (which are taken as given), and  $a^T$  and  $a^{NT}$  are productivity growth rates in the two sectors. One important point, which is generally overlooked in the literature and empirical work, is that if non-traded goods are more labour intensive (ie,  $\delta > \gamma$ ), then even a balanced growth of productivity ( $a^T = a^{NT}$ ) will lead to an appreciation of the relative price of traded goods.<sup>4</sup> The percentage change in the relative price of traded goods will be equal to the productivity growth differential only if both sectors have the same degree of labour intensity.

Another implication of equation (10) is that in the small open economy with perfect labour mobility, demand factors do not affect the relative price of non-tradables, they only affect a country's consumption basket. However, if capital is not fully mobile or the economy is large,  $R$  is no longer tied down by world markets. In this case, equations (6)–(9) have to be supplemented by the demand side of the model.

Substituting (10) into (3) and using definitions (2) and (4) one obtains:

$$\Delta p_t - \Delta p_t^* = \Delta e_t + (1 - \alpha_t) \left[ \left( \frac{\delta}{\gamma} \right) \Delta a_t^T - \Delta a_t^{NT} \right] - (1 - \alpha_t^*) \left[ \left( \frac{\delta^*}{\gamma^*} \right) \Delta a_t^{T*} - \Delta a_t^{NT*} \right] \quad (11)$$

<sup>3</sup> Given the constant returns to scale production functions, equation (6) implies a unique level of  $K^T/L^T$  consistent with the world rate of return on capital  $R$ . Given  $K^T/L^T$ , equation (8) determines the economy-wide wage rate  $W$ . The remaining two equations then determine  $K^{NT}/L^{NT}$  and  $P^{NT}$ .

<sup>4</sup> This point is emphasised by Froot and Rogoff (1995).

The difference between the rates of inflation in an accession country and the euro area can thus be expressed as a sum of the nominal exchange rate depreciation of the accession country's currency vis-à-vis the euro,  $\Delta e$ , and a weighted average of the productivity growth differentials between the traded and non-traded goods sectors in the accession country ( $\Delta a_T - \Delta a_{NT}$ ) and the euro area ( $\Delta a_T^* - \Delta a_{NT}^*$ ).<sup>5</sup>

A final analytical point to note is that the Balassa-Samuelson effect is closely related to – but distinct from – the so-called Baumol-Bowen effect. Baumol and Bowen (1966) argued that within a country there is a broad tendency for the prices of service intensive goods (education, health care, auto repair, banking, etc.) to rise over time as, historically, productivity growth in these activities has tended to be much slower than in the more capital intensive manufacturing industries. Although there is a considerable overlap between non-tradables and service-intensive goods, the presence of a rising relative price of services, established on the basis of equation (10) or its equivalent, is not necessarily sufficient to imply a Balassa-Samuelson effect. As noted above, a higher rate of inflation at home than abroad can be explained as an equilibrium phenomenon only if differential productivity growth between the sectors producing traded and non-traded goods is greater at home than abroad.

### 3. EMPIRICAL FRAMEWORK

Most studies investigating the Balassa-Samuelson effect in transition economies use as the dependent variable a measure of the relative price of non-tradables and estimate a version of equation (10) (see Table 1).<sup>6</sup> In fact, these studies estimate the Baumol-Bowen effect, so even when they establish a strong positive correlation between differential productivity growth and the relative price of non-tradables, this does not necessarily show that higher inflation in the accession countries relative to the euro area can be justified as an equilibrium phenomenon.

The remaining studies focus on the evolution of real effective exchange rates (REER).<sup>7</sup> One problem with this approach is that multilateral REER indices are based on constant weights, the use of which is inappropriate given that trade patterns have shifted significantly throughout the transition. Another problem is that REER indices include inflation differentials as well as nominal exchange rate changes vis-à-vis countries outside the euro area. As a result, this approach may lead to inaccurate measurement of the Balassa-Samuelson effect.<sup>8</sup>

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<sup>5</sup> An equivalent expression can be derived within the Scandinavian model of inflation (Aukrust, 1977), which explains the domestic rate of inflation ( $\pi$ ) and the increases in domestic money wages in the open (or “exposed”) and “sheltered” sectors through an exogenously given rate of increase in the foreign price level,  $\pi^*$ , and the development of labour productivity in the two sectors ( $a_E$  and  $a_S$ ):  $\pi = \pi^* + \alpha_S(a_E - a_S)$ .

<sup>6</sup> This is also true of many studies of the Balassa-Samuelson effect in other countries, eg, De Gregorio, Giovannini and Wolf (1994) and Swagel (1999). One exception is Alberola-Ila and Tyrväinen (1998).

<sup>7</sup> In a two-country model, the CPI-based real effective exchange rate corresponds to the real exchange rate in equation (2), which was used to derive the Balassa-Samuelson equation (11). Let  $p^T$  and  $p^N$  be traded goods price inflation at home,  $p^{T*}$  and  $p^{N*}$  abroad, and  $e$  the rate of nominal exchange rate depreciation, so that  $p^T = e + p^{T*}$ . Then the evolution of the real exchange rate is:  $e - [\alpha p^T + (1 - \alpha) p^N] + [\alpha p^{T*} + (1 - \alpha) p^{N*}]$ , where  $\alpha$  is the share of traded goods in consumption, assumed to be same at home and abroad. The real exchange rate then changes as:  $-(1 - \alpha) [(p^N - p^T) - (p^{N*} - p^{T*})]$ , ie it appreciates when  $p^N - p^T > p^{N*} - p^{T*}$ .

<sup>8</sup> Fischer (2002) points out that, in a model with investment demand, rising productivity in the export sector (which usually requires relatively large capital input and relatively small labour input) raises the equilibrium capital stock and thus investment demand, which in turn increases prices and, ceteris paribus, leads to real exchange rate appreciation. The estimated total effect of productivity on the real exchange rate may thus include not only the pure Balassa-Samuelson effect, but also the investment demand effect.



Only few studies so far have attempted to estimate to what extent *inflation differentials* can be explained by relative productivity differentials.<sup>9</sup> In particular, equation (11) has not been tested empirically, even though the policy interest in the Balassa-Samuelson effect is precisely the contribution of differential productivity growth to inflation differentials between EU accession countries and the euro area. This paper will attempt to fill this gap.

All empirical studies of the Balassa-Samuelson effect – including the present one – also suffer to varying degrees from data measurement problems. First, most studies use annual data for the 1990s and try to compensate for the short time series by pooling data from different countries. Such cross-country panels often include very heterogeneous economies, from advanced transition economies in central Europe, to poorly developed central Asian economies.<sup>10</sup>

Second, the sectoral data used are highly aggregated. The traded goods sector typically includes industry – usually only manufacturing, but often also construction as well as electricity, gas and water supply, industries whose output is only to a small extent traded. The non-traded sector is in some studies the residual (ie, GDP less industry) (see Table 1). In others, it covers all services irrespective of their traded content. Some studies do not even consider non-tradables, assuming that productivity growth in the sector is zero or equal across countries.<sup>11</sup> Another frequent problem is the use of industrial production indices, which measure gross output rather than value-added, in constructing labour productivity measures.

Some additional simplifying assumptions are worth noting. The shares of non-traded goods ( $1 - \alpha$ ) are typically assumed to be the same across countries. Finally, none of the studies (including this one) considers different factor intensities in non-traded and traded sectors ( $\delta/\gamma$ ).<sup>12</sup> The use of these assumptions in empirical work can significantly affect the size of estimated Balassa-Samuelson effects. In particular, productivity growth in non-tradable industries differs substantially across transition economies as well as between the euro area and these economies.

To overcome some of these shortcomings and obtain more reliable estimates, this paper focuses on the “full” specification of the Balassa-Samuelson hypothesis and uses a disaggregated analysis:

- The main goal of the paper is to see to what extent inflation differentials between central European economies and the euro area can be explained by productivity growth differentials. As argued above, this will be one of the key issues for monetary and exchange rate policies of central European economies in the run-up to EMU. To address this issue empirically, it is important to look at the “full” or “international” version of the Balassa-Samuelson hypothesis, ie, at equation (11).
- The coverage of traded and non-traded industries in this paper is broader and more detailed than in previous studies. In particular, the traded sector includes not only manufacturing, but also mining, transportation and communications, and tourism, while the non-traded sector includes energy, construction, wholesale and retail trade, real estate and business services, education, health, and personal services (see Appendix);

<sup>9</sup> Egert (2002a, 2002b) and Egert et al. (2002) estimate the inflation differential vis-à-vis Germany as a proxy for EU.

<sup>10</sup> See eg Coricelli and Jazbec (2001), De Broeck and Sløk (2001), and Jazbec (2001).

<sup>11</sup> See Egert (2002a and 2002b).

<sup>12</sup> Under the assumptions of same productivity growth in domestic and foreign non-tradable industries, same shares of non-tradables, and same factor intensities, equation (11) simplifies to:

$$\Delta p_t - \Delta p_t^* - \Delta e_t = (1 - \alpha_t)(\Delta a_t^T - \Delta a_t^{T*})$$
The left-hand side of this equation is then represented in empirical work by CPI-based real effective exchange rates.

- The data samples are larger, as quarterly data for up to ten years are used. This makes it possible to estimate the Balassa-Samuelson effect for individual countries rather than a panel of economies with different structural characteristics. The data series are nevertheless still very short and are of poor quality for some countries. This highlights the need to interpret the results of analysis cautiously.

The empirical analysis proceeds in three steps. First, a preliminary look at the data is taken. Second, inflation differentials between central European economies and the euro area are decomposed in a simple accounting framework, using the historical data, on the basis of equation (11), which provides a theoretical model of the long-run relationship between inflation and productivity differentials under given – admittedly, highly restrictive – assumptions.<sup>13</sup> Third, empirical counterparts of equations (10) and (11) are estimated using standard regression tools.

#### **4. PRELIMINARY LOOK AT THE DATA**

In order to get a first impression of the Balassa-Samuelson hypothesis, the sectoral data on productivity and prices in various countries are considered in Charts 1–4. To illustrate the data problem for some countries, most of the series are shown as unadjusted four-quarter percentage changes; in the econometric work, the “dented” series are smoothed using seasonal adjustment or a Hodrick-Prescott filter.

The first point to note is that, over the whole sample period, productivity in the traded goods sector has grown faster than in the non-tradable sector, as the first panel for each country shows. The exception is Slovakia, where the growth rate of labour productivity in non-traded industries was higher during 1996–97. According to the theoretical model, faster productivity growth in tradable industries should have implied faster growth of non-traded goods prices. The second panel for each country shows that this has in general been the case. One exception is again Slovakia in the mid-1990s; another is Slovenia in the early 1990s.

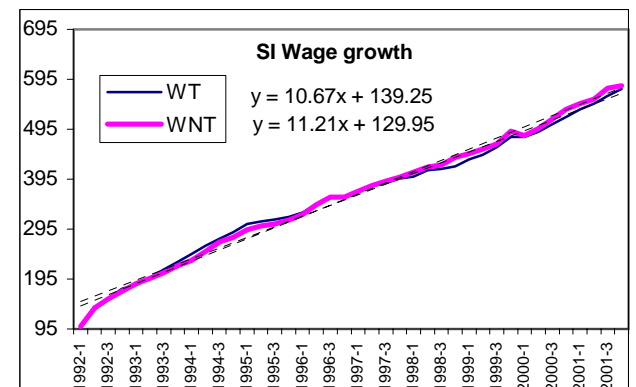
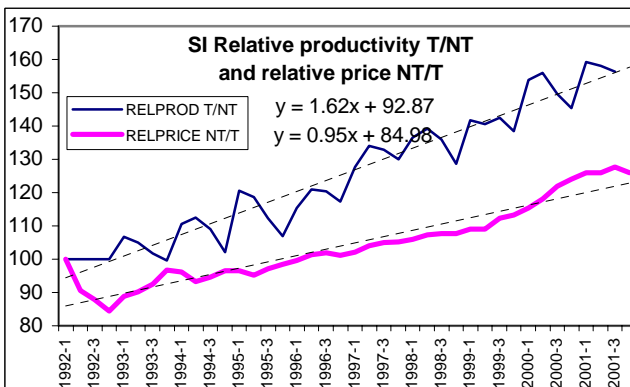
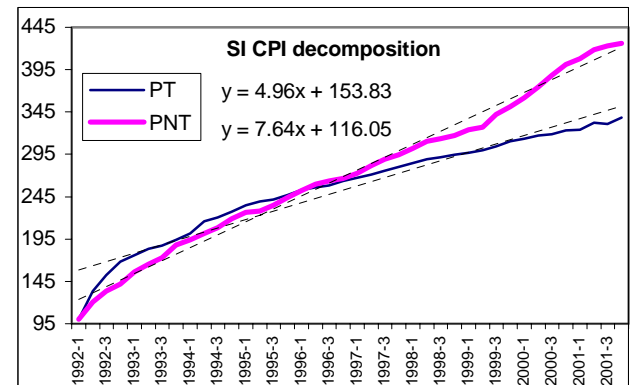
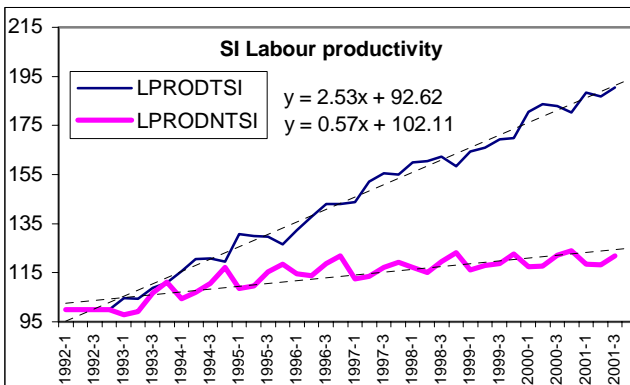
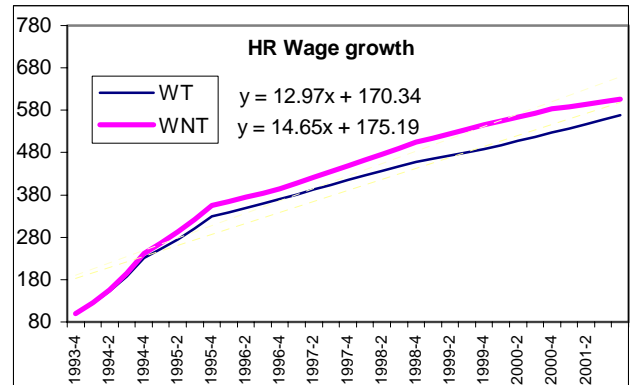
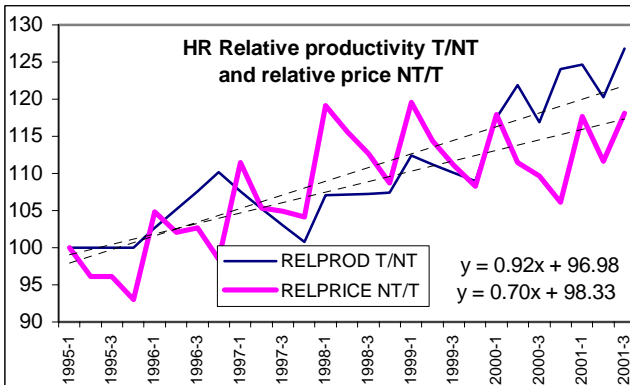
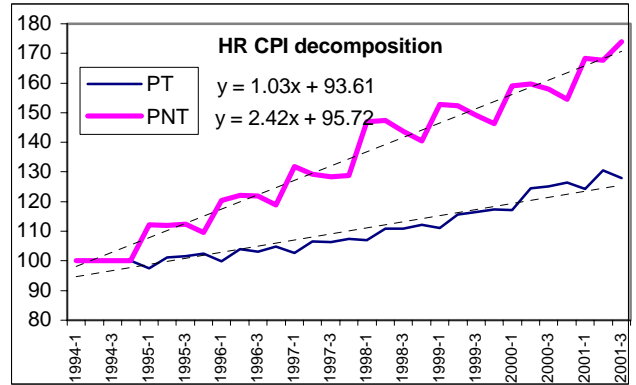
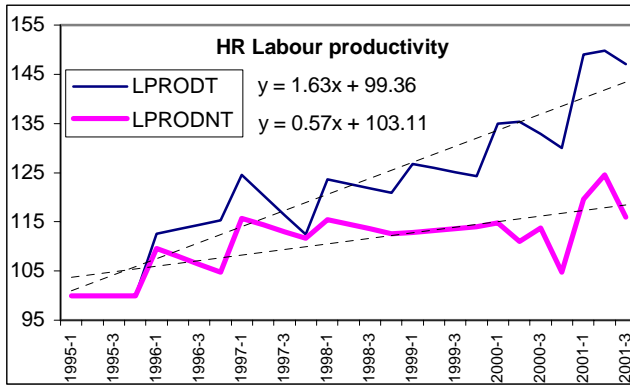
The core of the productivity hypothesis is shown in the third panel for each country. Relative prices of non-tradables have tended to rise as relative productivity in the tradable sector has increased. This provides indication of the Baumol-Bowen effect. From Chart 4 it can be noted, however, that productivity growth differential in the euro area had also been large. Thus, despite evidence that relative prices of non-tradables in central European economies have increased in line with relative productivity of tradables, one should not jump to the conclusion that the Balassa-Samuelson effect has been present vis-à-vis the euro area.

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<sup>13</sup> As noted above, if purchasing power parity does not hold for tradable goods or capital is not fully mobile, demand side factors will also have a role in determining the inflation differentials.

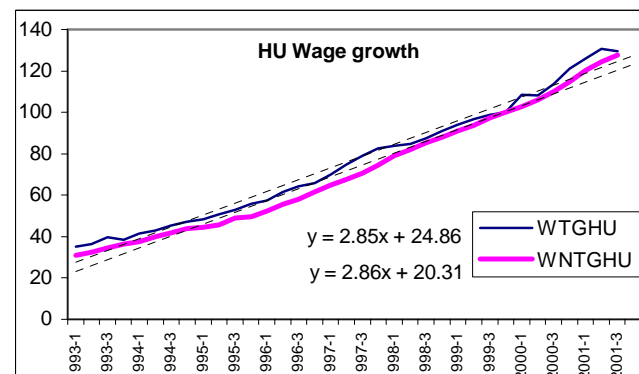
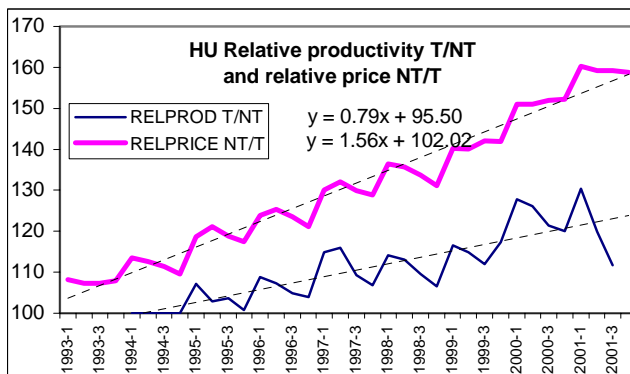
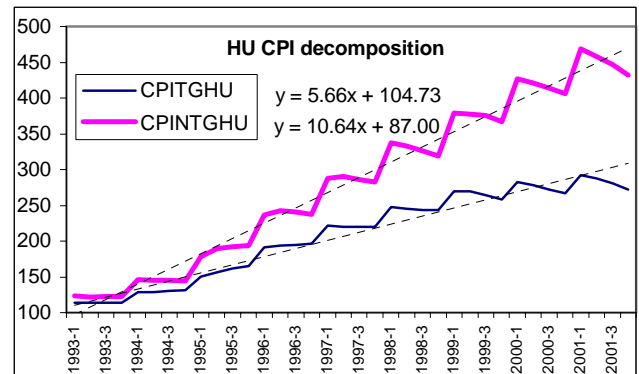
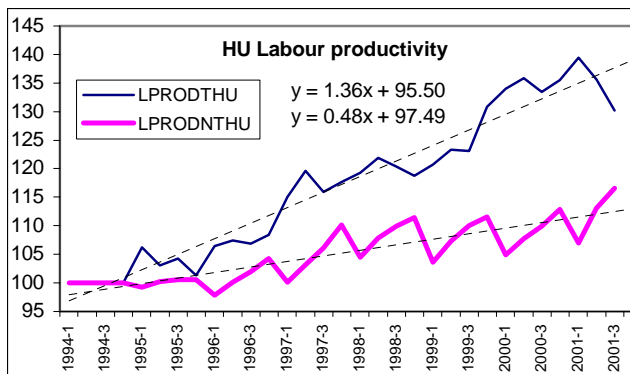
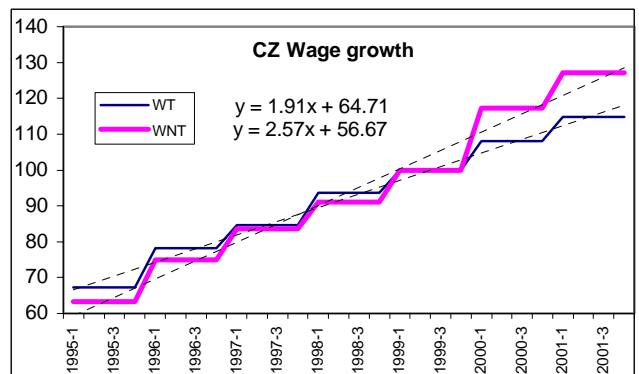
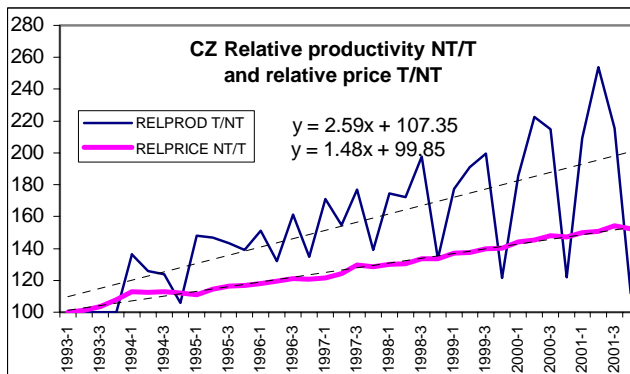
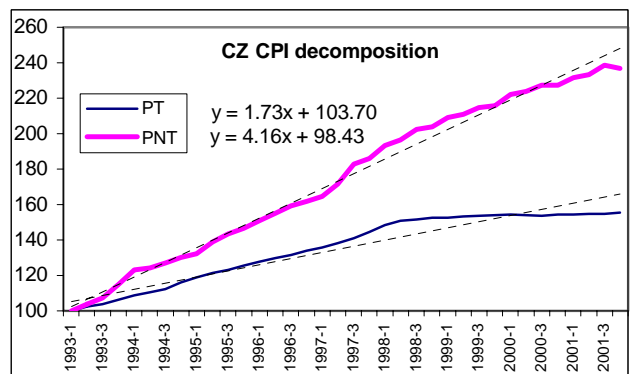
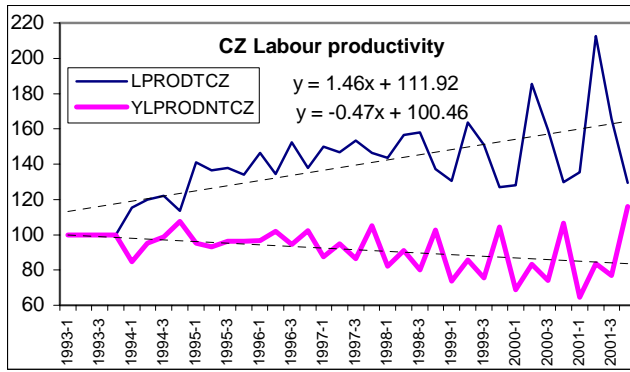
Study author(s) Country sample	Dependent variable	Sectoral decomposition		Other explanatory variables	Estimation method	Estimate of the BS effect (percentage points per annum)
		Tradables	Non-tradables			
<b>Simon and Kovács (1998)</b> Hungary, 1991–96	REER	Manufacturing (excl. agriculture, mining and energy)	Services (excl. public administration)	—	No regressions	<b>2.9</b>
<b>Cipriani (2001)</b> 10 accession candidates, 1995–99, quarterly data	$P^N/P^T$ (NT/T goods and services from CPI)	Industry and mining (goods from CPI)	Residual (excl. agriculture), services from CPI	—	OLS	<b>0.5–0.7</b>
<b>Rother (2000)</b> Slovenia, 1993–98, quarterly data	$P^N/P^T$ (producer price index/labour costs)	Manufacturing	Residual (excl. agriculture)	Monetary base, budget deficit/GDP, gvt cons/GDP	OLS	<b>1–4</b>
<b>De Broeck and Sløk (2001)</b> 25 transition economies, 1993–98	REER	Industry and construction	Services	Agricultural productivity, broad money, openness, budget balance, terms of trade, commodity prices	Pooled mean group estimation	<b>0.2–0.6</b>
<b>Egert (2002a)</b> 12 transition economies, 1993–2001, quarterly data	$P^N/P^T$ (CPI/PPI) RER (D-mark)	Industry	Not considered (productivity set at zero)	—	VAR and panel cointegration	<b>0.9</b> (pooled estimates) <b>0–3.5</b> (country estimates)
<b>Fischer (2002)</b> 10 accession candidates, 1993–99	REER	Industry	Services	Agricultural productivity, gvt cons/GDP, world real interest rate, terms of trade, commodity prices	SUR fixed effects	<b>0.7–2.2</b> (Partly attributed to investment demand channel)
<b>Halpern and Wyplosz (2001)</b> 8 accession candidates, Russia, 1991–98	$P^N/P^T$ (services/non-food manufactured goods from CPI)	Industry	Services	GDP/capita, inflation acceleration term, lagged relative price	GLS	<b>3</b>
<b>Coricelli and Jazbec (2001)</b> 19 transition economies, 1990–98	$P^T/P^N$ (sectoral GDP deflators)	Manufacturing, mining, energy, construction	Residual	Share of non-tradables consumption, government consumption, “structural misalignment” measure	Fixed effects panel estimation	<b>0.9–1.2</b>
<b>Arratibel et al (2002)</b> 10 accession candidates, 1990–2001	$P^N/P^T$ (CPI decomposition of NT/T goods and services)	Manufacturing	Not considered	Exch. rate regime, budget deficit, GDP/capita, wage growth, unemployment, oil price, terms of trade, etc.	Method of moments	Insignificant

Chart 1. Croatia and Slovenia<sup>1</sup>



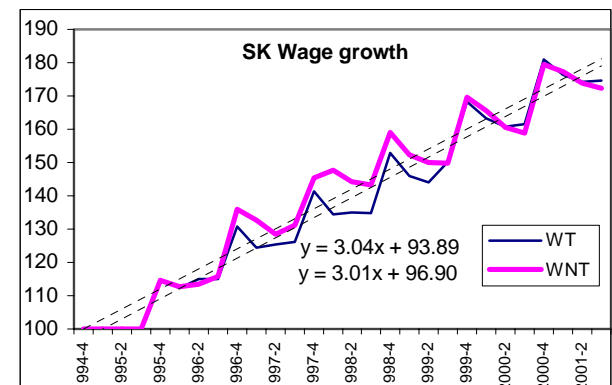
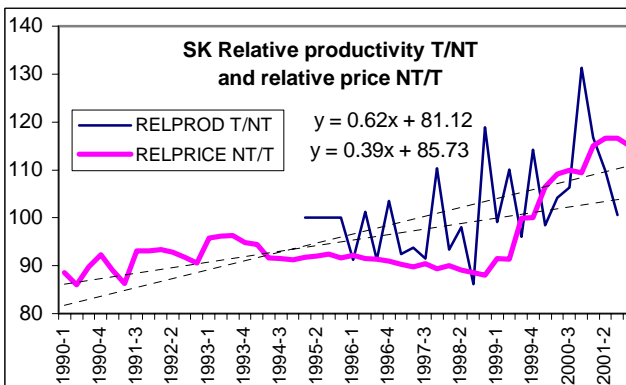
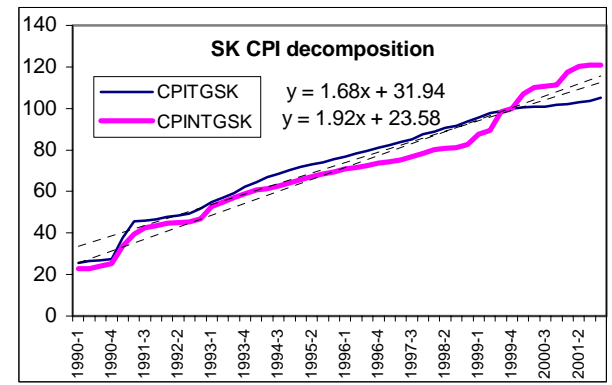
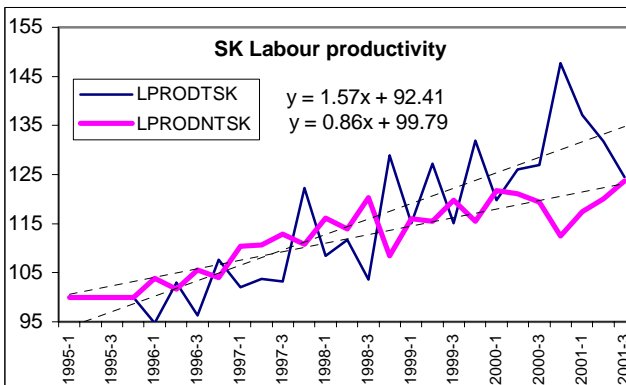
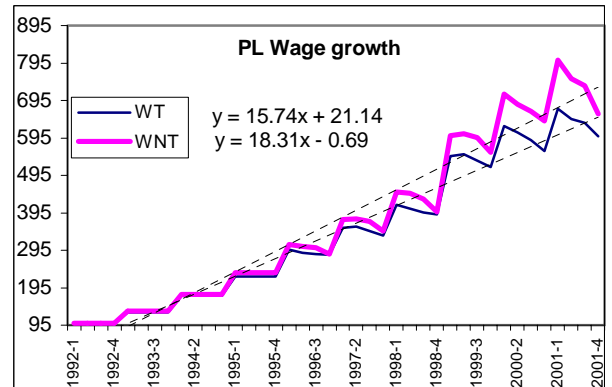
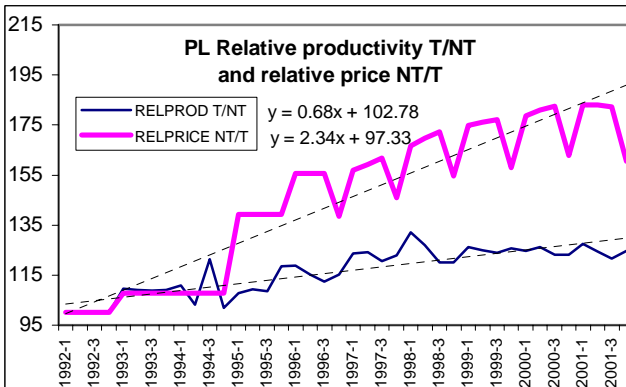
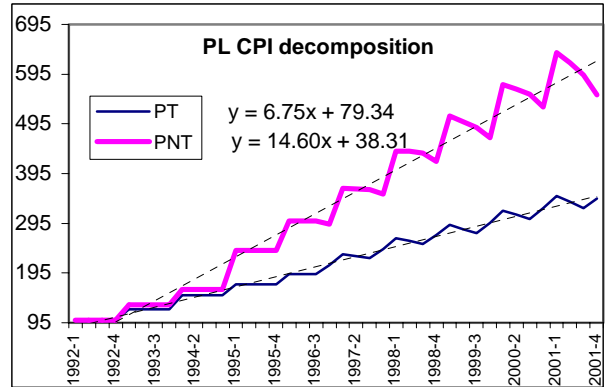
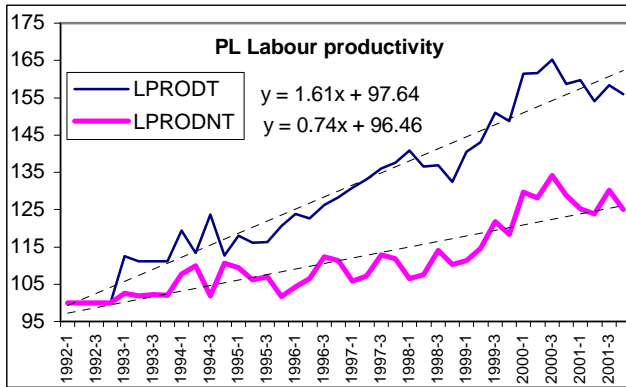
<sup>1</sup> Dotted lines represent linear time trends. Estimated regression lines show time trend ("x") regressed on the dependent variable ("y") shown in the legend on the left.

Chart 2. Czech Republic and Hungary<sup>1</sup>



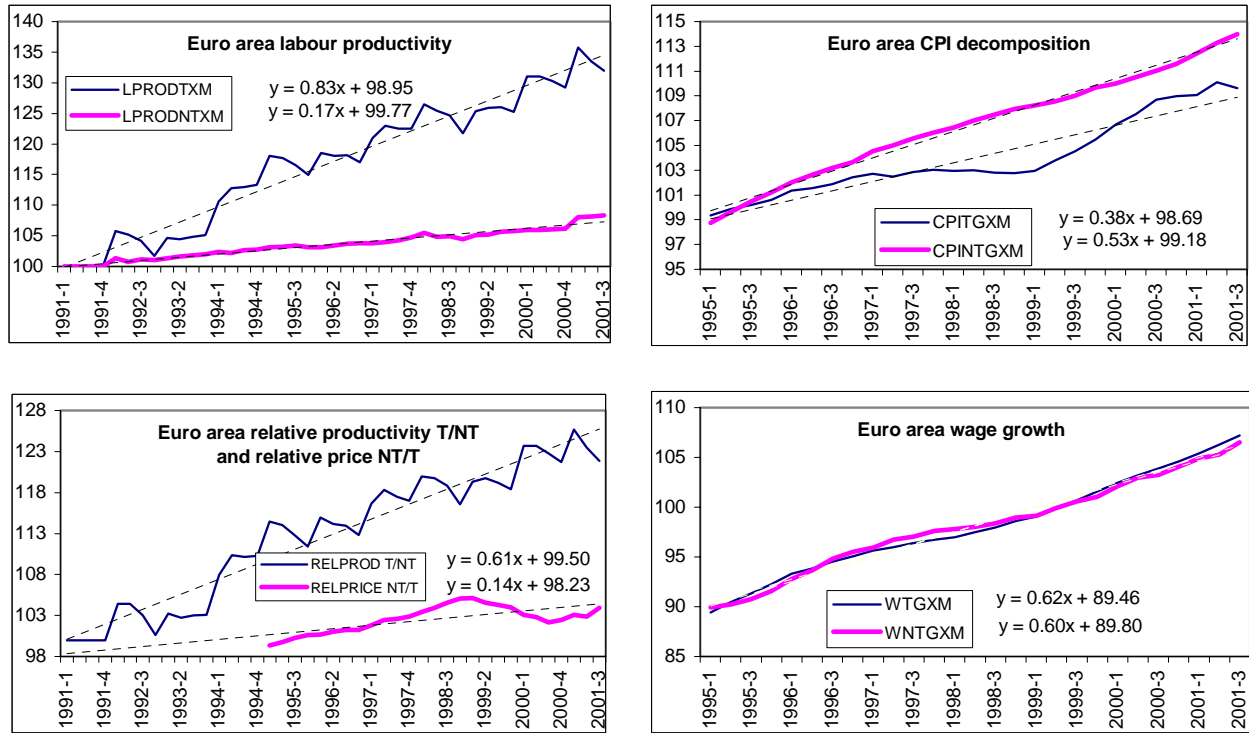
<sup>1</sup> Dotted lines represent linear time trends. Estimated regression lines show time trend ("x") regressed on the dependent variable ("y") shown in the legend on the left.

Chart 3. Poland and Slovakia<sup>1</sup>



<sup>1</sup> Dotted lines represent linear time trends. Estimated regression lines show time trend ("x") regressed on the dependent variable ("y") shown in the legend on the left.

Chart 4. Euro area<sup>1</sup>



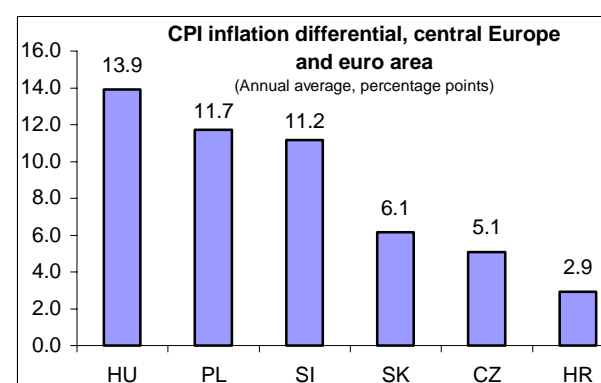
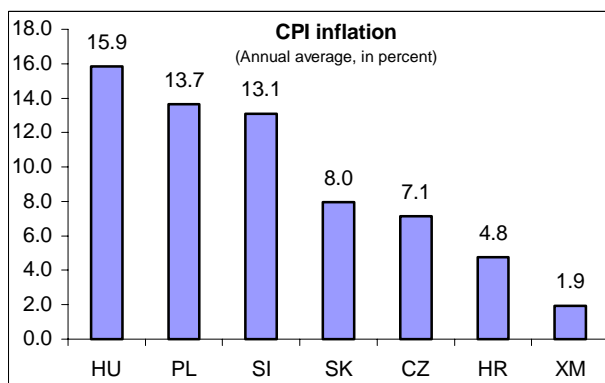
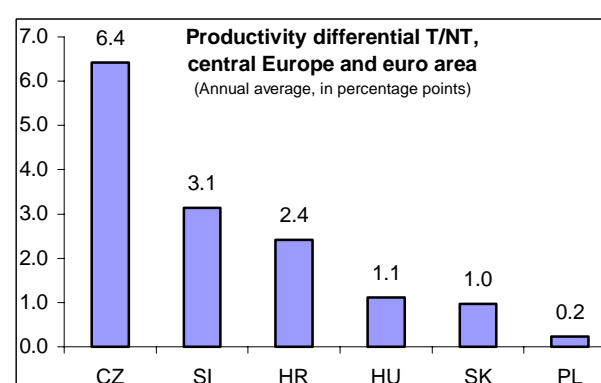
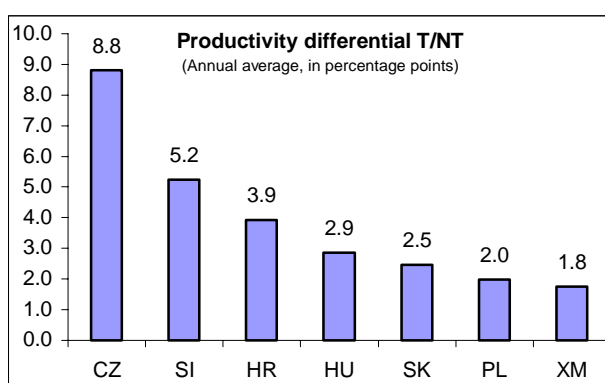
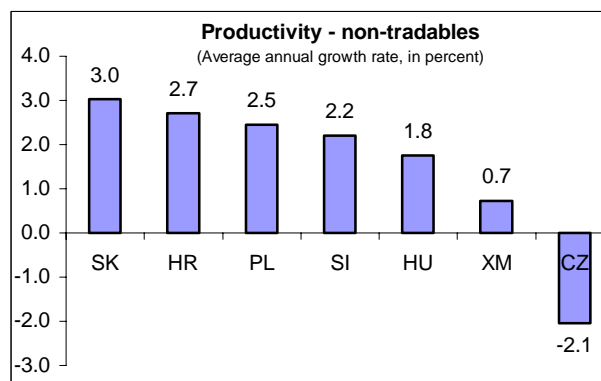
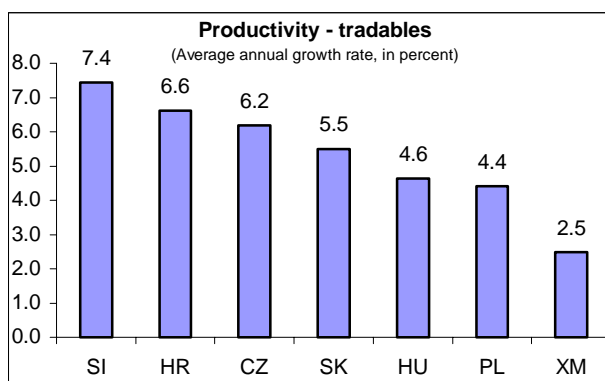
<sup>1</sup> Dotted lines represent linear time trends. Estimated regression lines show time trend ("x") regressed on the dependent variable ("y") shown in the legend on the left.

The data also suggest that the assumption of the Balassa-Samuelson model on uniform wage growth – due to sectoral labour mobility – seems to hold in most countries (see fourth panel for each country in Charts 1–4). However, the growth rate of wages in Croatia’s non-tradable industries has been consistently higher, despite higher labour productivity growth in traded goods industries. The same phenomenon could be observed in Slovakia as well as the Czech Republic (in 2000) and Poland (in 1999). In the latter two cases, however, the deviations probably reflect measurement problems. Non-uniform growth of wages suggests that relative wages may have played an additional role in the long-run relationship between sectoral prices and productivity growth differentials in Croatia and Slovakia. Relative wages were therefore used as an additional explanatory variable in deriving the Balassa-Samuelson effect in these two countries.

Data on productivity and relative prices are summarised in Chart 5. All central European economies achieved higher productivity growth than the euro area in both tradables and – with the exception of the Czech Republic – non-tradables. The average productivity differential between traded and non-traded industries ranges from 2 percentage points in Poland to almost 9 percentage points in the Czech Republic. But the average productivity differential with respect to the euro area is equivalent to one percentage point or less in Hungary, Poland and Slovakia. In contrast, inflation differentials are generally much higher, ranging from 3–14 percentage points.

On the basis of this preliminary evidence, it seems unlikely that the relatively low productivity growth differentials could explain such high inflation differentials. A cross-country plot of the data on inflation and productivity differentials provides further evidence. As can be seen from Chart 6, in this – admittedly very small – sample, the cross-country correlation between inflation and productivity differentials is negative. Countries that could in

**Chart 5. Summary of productivity and relative price data<sup>1</sup>**



<sup>1</sup> For sample periods, see Appendix 2.

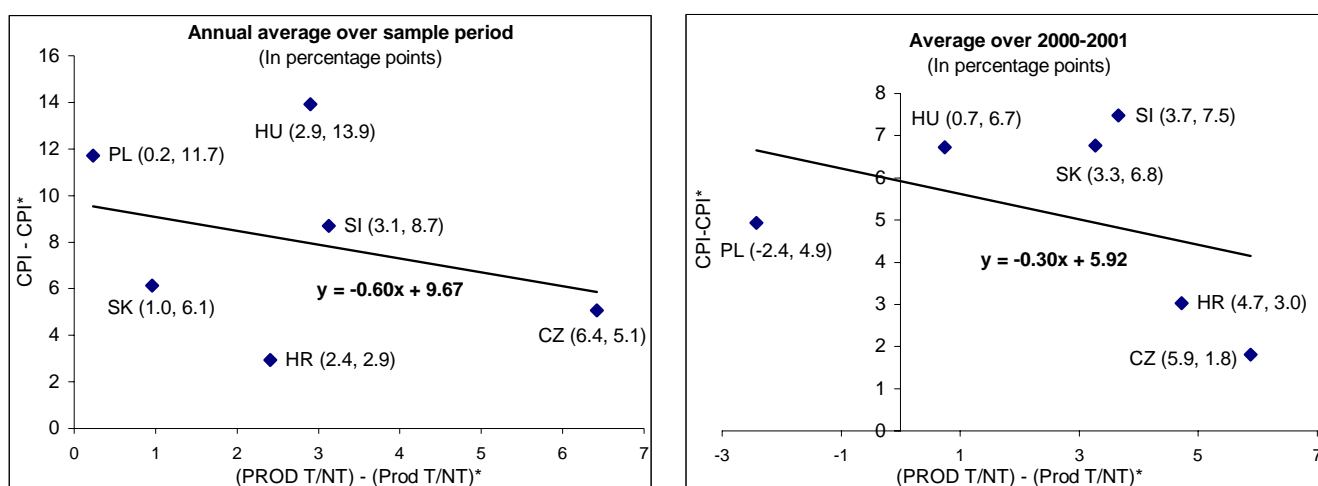
theory “afford” higher inflation differentials vis-à-vis the euro area on account of stronger productivity growth had in fact realised lower inflation differentials. This result holds for the entire sample period as well as for 2000–01.

## 5. ACCOUNTING FOR INFLATION DIFFERENTIALS: HISTORICAL DATA

According to the theoretical model captured by equation (11), differences in inflation between two countries can be explained by changes in nominal bilateral exchange rates and relative productivity differentials. Table 2 shows average sample values of different components of equation (11). It also shows percentage contributions of productivity terms to inflation



**Chart 6. Productivity (T/NT) and inflation differentials relative to euro area**



differentials in each country. These calculations provide an illustration of the relative importance of the Balassa-Samuelson effect based on historical averages.

For the entire sample period, average productivity differentials for Hungary, Poland and Slovakia explain only a fraction of inflation differentials vis-à-vis the euro area. For Slovenia, average productivity differential explains less than 15% of the “excess” inflation; for Croatia about 30%; for the Czech Republic about 70% (Table 2). For 2000 and 2001, when inflation in central Europe was lower (except in Croatia and Slovakia) and the regional currencies (except the forint and the tolar) appreciated against the euro, productivity differentials explain a higher percentage of inflation differentials in all countries with the exception of Poland and Hungary.

It should be noted that the results in Table 2 are sensitive to the assumption of equal factor intensities in tradable and non-tradable industries. Assuming that factor intensities can be approximated by factor shares – a result that holds only in equilibrium – this assumption could be verified only for Hungary, where it apparently holds.<sup>14</sup> In general, however, one would expect the factor shares in non-tradable industries to be higher and, moreover, the ratio of factor shares to be somewhat higher in the euro area than the less developed central European economies, where tradable industries are more labour intensive (relative to the euro area). This effect would tend to further reduce the contribution of productivity differentials to inflation differentials.

## 6. ESTIMATES OF THE BALASSA-SAMUELSON EFFECT

Next, an attempt is made to estimate the Balassa-Samuelson effect using time series data. The following regression equation is estimated for each country using ordinary least squares:

$$(\pi^{\text{CE}} - \pi^{\text{EA}})_t = \text{const.} + \beta_1 \Delta e^{\text{CE}} + \beta_2 [(1-\alpha)_t^{\text{CE}} (a_{\text{T}}^{\text{CE}} - a_{\text{NT}}^{\text{CE}})_t - (1-\alpha)_t^{\text{EA}} (a_{\text{T}}^{\text{EA}} - a_{\text{NT}}^{\text{EA}})_t] \quad (12)$$

<sup>14</sup> To calculate the factor shares from national accounts data, one needs breakdown of GDP by income component for different production sectors of the economy. In central Europe, only Hungary publishes these data.

where  $\pi$  is the rate of CPI inflation;  $\Delta e$  is the rate of change of the nominal exchange rate; and  $a_T$  and  $a_{NT}$  are growth rates of labour productivity in tradable and non-tradable industries; and the superscripts stand for central European countries (CE) and the euro area (EA). All variables are expressed as logs of corresponding indices. The estimation is done first on (log-) levels of indices, and then using first differences of variables. Augmented Dickey-Fuller unit root tests indicate that the time series used in regressions based on equation (12) are stationary. The regression in terms of levels, using quarterly data, results in autoregressive residuals, so a lagged dependent variable is included on the right-hand side of (12). As noted above, in Croatia and Slovakia there is evidence of non-uniform wage growth, so relative wage differentials in tradable and non-tradable industries are used as an additional explanatory variable.<sup>15</sup>

Entire sample period								
Country	d(CPI - d Exch CPI*)	rate	NT share	$\delta/\gamma$	Prod T	Prod NT	Contributio n of productivity differential <sup>2</sup>	% Explained by productivity differential <sup>3</sup>
<b>Croatia</b>	2.9	1.5	58	1.0	6.6	2.7	0.9	<b>31.5</b>
<b>Czech R.</b>	5.1	0.1	57	1.0	6.2	-2.1	3.4	<b>66.9</b>
<b>Hungary</b>	13.9	11.4	60	1.0	4.6	1.8	0.4	<b>2.8</b>
<b>Poland</b>	11.7	4.9	60	1.0	4.4	2.5	-0.2	<b>-1.3</b>
<b>Slovakia</b>	6.1	2.0	58	1.0	5.5	3.0	0.1	<b>1.8</b>
<b>Slovenia</b>	11.2	8.8	54	1.0	7.4	2.2	1.5	<b>13.3</b>
<b>Euro area</b>			76	1.0	2.5	0.7		
Average for 2000-2001								
Country	d(CPI - d Exch CPI*)	rate	NT share	$\delta/\gamma$	Prod T	Prod NT	Contributio n of productivity differential <sup>2</sup>	% Explained by productivity differential <sup>3</sup>
<b>Croatia</b>	3.0	-0.7	58	1.0	8.1	1.4	2.4	<b>78.3</b>
<b>Czech R.</b>	1.8	-3.8	57	1.0	5.4	-0.3	1.8	<b>100.2</b>
<b>Hungary</b>	6.7	0.8	60	1.0	5.0	2.3	0.1	<b>2.1</b>
<b>Poland</b>	4.9	-6.8	60	1.0	4.1	4.3	-1.6	<b>-32.9</b>
<b>Slovakia</b>	6.8	-0.8	58	1.0	6.1	0.8	1.6	<b>23.4</b>
<b>Slovenia</b>	7.5	5.9	54	1.0	6.4	0.8	1.6	<b>20.8</b>
<b>Euro area</b>			76	1.0	3.1	1.2		

<sup>15</sup> See Alberola-Ila and Tyrväinen (1998) and Swagel (1999) for an application to EMU countries. The expected sign of the wage differential coefficient  $[(w^T - w^{NT}) - (w^T - w^{NT})^*]$  is negative: higher relative wage growth in tradable industries is expected to result in employment adjustments to maintain competitiveness and, hence, lower inflation differentials. In the non-tradable sector, which is less exposed to competition, employers are expected to react to the wage pressures with an increase in prices. The estimated coefficient on wage differential for Slovakia is negative, in line with this hypothesis, but for Croatia it is positive. Both estimated coefficients are statistically highly significant.

Note: Entries in this table are in percentage points, except the last column (in percent), non-tradable shares (in percent), and the ratio of factor intensities ( $\delta/\gamma$ ).

<sup>1</sup> Based on equation (11). For sample periods, see Appendix.

<sup>2</sup> Calculated for country  $i$  as:  $(NT\ share)_i * (factor\ share_i * Prod\ T_i - Prod\ NT_i) - (NT\ share)_{XM} * (factor\ share_{XM} * Prod\ T_{XM} - Prod\ NT_{XM})$ .

<sup>3</sup> Calculated as  $(Contribution\ of\ productivity\ differential) / d(CPI-CPI^*)$ .

No other explanatory variables – in particular, demand-side factors such as government expenditure or the growth of per capita income – are included. In light of data measurement problems and preliminary results from Table 2, the main purpose of the exercise at this stage is to see whether sensible first-cut estimates of the coefficient  $\beta_2$ , which measures the impact of productivity growth (with an expected positive sign) can be obtained. The results are reported in Table 3. To allow for the possibility of delayed pass-through of productivity effects on inflation differentials, productivity terms are lagged up to four quarters for most countries. Specification tests (not reported) do not indicate violations of standard regression assumptions.

Country Sample period	Levels specification		First difference specification		Balassa-Samuelson effect <sup>2</sup>
	Change in exchange rate	Productivity differential	Change in exchange rate	Productivity differential	
<b>Croatia</b> <sup>3</sup> 1996:1–2002:1	0.317	0.069*	0.153	–0.064*	<b>0.167</b>
<b>Czech Republic</b> 1994:2–2002:1	0.103	0.153	0.138	0.074	<b>0.980</b>
<b>Hungary</b> 1996:1–2002:1	0.100	0.506	0.349	0.318	<b>0.562</b>
<b>Poland</b> 1995:1–2001:3	0.057	0.507	0.132	0.293	<b>0.118</b>
<b>Slovakia</b> <sup>3</sup> 1995:3–2001:4	0.162	0.185	0.333	0.095	<b>0.178</b>
<b>Slovenia</b> 1993:1–2002:1	0.306	0.587	0.356	0.692	<b>1.839</b>

<sup>1</sup> Based on equation (12). The estimated parameters on lagged inflation differential (not reported) are statistically highly significant in all regressions, and range in value from 0.62 (Slovenia) to 0.89 (Slovakia).

<sup>2</sup> Contribution of productivity differential to inflation differential vis-à-vis the euro area, in percentage points. Calculated from estimated parameters on productivity differentials in the second column, multiplied by average productivity differentials over the (country-specific) sample period shown in Chart 5, fourth panel.

<sup>3</sup> Due to non-uniform wage growth in tradable and non-tradable industries, regressions for Croatia and Slovakia (levels specification) include relative wage differential  $[(w^T - w^{NT}) - (w^T - w^{NT})^*]$  as an additional explanatory variable. Estimated relative wage parameters (-0.317 for Slovakia and 0.271 for Croatia) are statistically highly significant.

\* Denotes estimates that are not statistically significant at the 5% test level.

The second column in Table 3 indicates that a percentage point increase in the productivity differential in Hungary, Poland and Slovenia is associated with an increase in inflation differential of about ½ percentage point. In Slovakia, inflation relative to the euro area increases by about 0.2 percentage point, and in the Czech Republic by 0.15 percentage point for every percentage point increase in the productivity differential. The estimated productivity parameter for Croatia is positive but not statistically significant. The fourth column indicates that a percentage point faster growth of the productivity differential in Slovenia is associated with 0.7 percentage point acceleration in Slovenian inflation relative to the euro area. Estimates of this parameter for other countries are much lower.

The last column in Table 3 provides estimates of the size of the Balassa-Samuelson effect in central European economies. They are calculated from estimated parameters on productivity differentials in the second column of Table 3, multiplied by average productivity differentials over the relevant, country-specific sample periods shown in Chart 5, fourth panel. According to these estimates, differential productivity growth resulted in 2 percentage points higher inflation in Slovenia, 1 percentage point higher inflation in the Czech Republic, ½ percentage point higher inflation in Hungary, and 0.2 percentage point higher inflation in Slovakia relative to the euro area. In Croatia and Poland, the Balassa-Samuelson effect amounted to about 0.15 percentage points or less.

The estimate for Slovenia is similar to that found by Rother (2000), who estimated the contribution of the Balassa-Samuelson effect to Slovenian inflation at about 2.6 percentage points during the period 1993–98. For other countries, the estimated Balassa-Samuelson effect is considerably lower than that found in other studies (eg, estimates for Hungary and Poland in Egert (2002a and 2002b), Halpern and Wyplosz (2001), Rother (2000); Simon and Kovacs (1998); Sinn and Reutter (2001)). The estimates in this paper are closer to several recent studies that also found, using a different framework, little support for the hypothesis that inflation differentials between central European economies and the EU are due to higher productivity differentials (Cipriani (2001); Egert et al. (2002), and pooled and some country estimates in Egert (2002a and 2002b)).

A major reason why many previous studies had obtained higher estimates of the Balassa-Samuelson effect is that they had neglected to consider inflation and differential productivity growth relative to the euro area, focusing instead only on the impact of productivity differentials on domestic inflation in central Europe. To illustrate this point, Table 4 provides estimates of the impact of differential productivity growth on two domestic measures of inflation: domestic relative price of non-tradables, and domestic CPI inflation. Estimates of

this “domestic” Balassa-Samuelson effect – in fact, the Baumol-Bowen elasticity, as argued above – were obtained from the following regressions based on equation (10):

$$\log\left(\frac{P_t^{NT}}{P_t^T}\right) = \text{const.} + \beta_1 \log\left(\frac{P_{t-1}^{NT}}{P_{t-1}^T}\right) + \beta_2 \left(\frac{\delta}{\gamma}\right) \log a_t^T - \log a_t^{NT}$$

(13)

As can be seen from Table 4, in all countries with the exception of the Czech Republic and Slovenia, the contribution of productivity differentials to relative price and CPI inflation is larger than their contribution to inflation differentials vis-à-vis the euro area shown in Table 3. For example, relative prices in Hungary are estimated to have increased on average by about 2¾ percentage points, and in Croatia and Poland by 2¼ percentage points, as a result of faster productivity growth in domestic tradable industries relative to non-tradables. In Slovakia and Slovenia, differential productivity growth contributed about 1 percentage point to relative price increases, and in the Czech Republic about ½ percentage point.

The impact of differential productivity growth on domestic CPI inflation is obtained by multiplying these contributions by respective shares of non-tradables in consumer price indices. As can be seen from the penultimate column of Table 4, this effect ranged from about ⅓ percentage point in the Czech Republic, to about 1½ percentage point in Hungary and Poland. However, even these relatively large estimates of the “domestic” Balassa-Samuelson effect explain at most about one-quarter of actual CPI inflation in central European economies (see the last column of Table 4).

Country	Average $d(P^{NT}/P^T)$	$\delta/\gamma$	Prod T	Prod NT	BS elast <sup>2</sup>	Contrib. of prod. diff. to $d(P^{NT}/P^T)$ <sup>3</sup>	Contrib. of prod. diff. to CPI inflation <sup>4</sup>	% Explained by prod. differential <sup>5</sup>
<b>Croatia</b>	2.7	1.0	6.6	2.8	0.569	2.2	1.26	26.5
<b>Czech R.</b>	5.0	1.0	6.2	-2.1	0.068	0.6	0.32	4.5
<b>Hungary</b>	5.2	1.0	4.6	1.8	0.924	2.7	1.58	10.0
<b>Poland</b>	7.7	1.0	4.4	2.5	1.196	2.3	1.41	10.3
<b>Slovakia</b>	4.1	1.0	5.5	3.0	0.446	1.1	0.64	8.1
<b>Slovenia</b>	3.9	1.0	7.4	2.2	0.211	1.1	0.60	4.5
<b>Euro area</b>	0.5	1.0	2.5	0.7	0.160	0.3	0.21	11.0

Note: Entries in this table are in percentage points, except last column (in percent) and ratio of factor intensities ( $\delta/\gamma$ ).

<sup>1</sup> Based on equation (10). For sample periods, see Appendix 2.

<sup>2</sup> Estimates of the parameter  $b$  from country regressions based on equation (10):  
 $\log(P^{NT}/P^T) = \text{const} + b \cdot \log(\text{Prod T} / \text{Prod NT})$ .

<sup>3</sup> Calculated as BS elasticity \* (Ratio of factor intensities \* Prod T - Prod NT).

<sup>4</sup> Calculated as Contribution of productivity differential to relative price increase \* Share of non-tradables in CPI.

<sup>5</sup> Calculated as (Contribution of productivity differential to CPI inflation) / Average CPI inflation.

A cross-country plot of average growth rates of relative prices and relative productivity provides some limited support for the Balassa-Samuelson hypothesis only in the more recent period (Chart 7, right panel). Over the whole sample period, however, countries where relative prices of non-tradables in theory should have increased faster because of stronger differential productivity growth, in practice tended to experience slower growth of relative prices (Chart 7, left panel). This suggests that factors other than differential productivity growth have been more closely associated with increases in relative prices and overall inflation in central Europe.

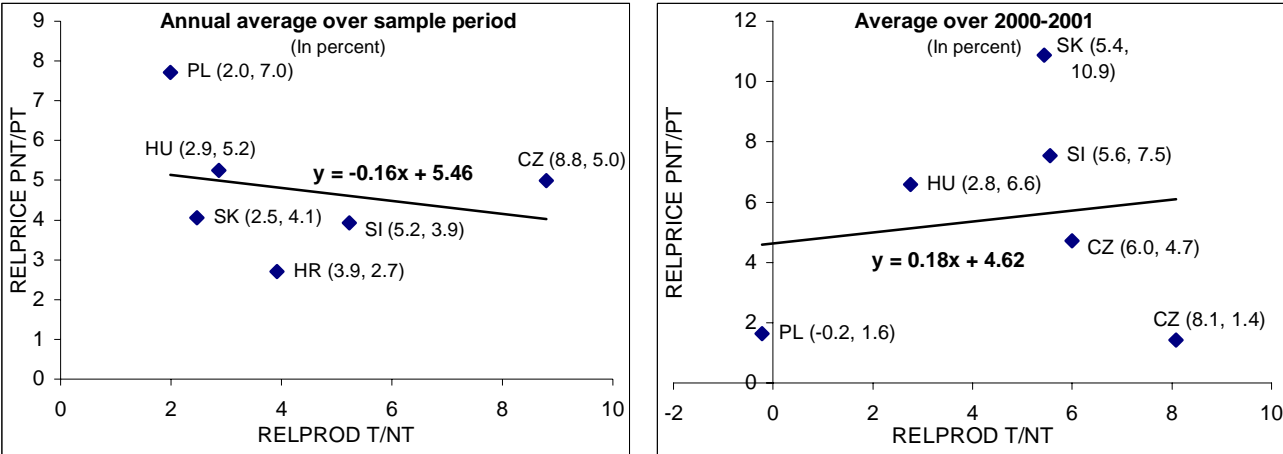
### 7. CONCLUSION

One conclusion to be drawn from the above estimates is that one needs to distinguish carefully between empirical evidence that faster productivity growth in tradable industries contributes to rising relative prices of non-tradables and domestic inflation, and evidence that productivity differentials contribute to higher inflation in central Europe compared with the euro area. Relative prices of non-tradables are rising more or less in line with relative productivity of tradables in central Europe, but the same phenomenon has been observed in the euro area, so productivity differentials alone explain only a small proportion of inflation differentials vis-à-vis the euro area. Productivity differentials also explain a relatively small proportion of domestic inflation in central European countries. Earlier studies that had found this “domestic” Balassa-Samuelson effect to be larger apparently neglected productivity growth in non-tradable sectors, which has been quite high in many countries.

These results lead to the conclusion that factors other than differential productivity growth seem to have played a more important role in determining inflation differentials, as well as increases in relative prices and CPI inflation, in central Europe. Claims that the Balassa-Samuelson effect is responsible for higher inflation in central European countries than in the euro area therefore seem to have weaker empirical foundations than previously thought. If the accession countries find it difficult to satisfy the Maastricht criteria, they will probably have to look for reasons beyond differential productivity growth, at least based on the historical performance of their tradable and non-tradable industries to date.

One should not forget that there are significant data measurement problems for some central European countries, which make it difficult to provide accurate estimates of labour productivity growth in tradable and non-tradable industries. At the same time, a more disaggregated approach followed in this paper does indicate that broadening the coverage of

**Chart 7. Growth of relative prices (NT/T) and relative productivity (T/NT)**



tradable and non-tradable sectors is essential if one wants to obtain more reliable estimates of the Balassa-Samuelson effect. In particular, neglecting productivity growth in non-tradable industries and not comparing productivity differentials to the euro area (as well as assuming equal shares of non-tradables across countries) can result in significant over-estimates of the Balassa-Samuelson effect.

These conclusions highlight the need for further research in this area, aimed in particular at improving the quality of underlying data. Without more reliable estimates of the Balassa-Samuelson effect it is hard to be confident about the prospects for meeting convergence criteria and, therefore, about the appropriateness of current monetary and exchange rate policies.

## **APPENDIX: DATA DESCRIPTION**

### ***Economies and periods covered***

Euro area (1992:1–2001:3), Croatia (1995:1–2001:3), Czech Republic (1993–2001:3), Hungary (1994–2001:3), Poland (1994–2001:3), Slovakia (1995–2001:3), and Slovenia (1992–2001:3).

### ***Traded and non-traded sectors***

*Traded goods and services:* manufacturing; mining; hotels; transportation and communications.

*Non-traded goods and services:* electricity, gas and water supply; construction; wholesale and retail trade and repair services; financial intermediation; real estate, renting and business activities; education; health and social work; and other community, social and personal activities.

Not considered are, on the traded goods side, agriculture, forestry and fishing because trade in agricultural products is distorted by Common Agricultural Policy and different agreements on agricultural trade between the EU and accession countries; on the non-traded goods side, public administration, defence and compulsory social security are not considered because of the difficulty in interpreting labour productivity figures caused by large shifts in the number of public sector employees.

The above classification follows De Gregorio, Giovannini and Wolf (1994), who defined a sector as “tradable” if more than 10% of total production is exported. In this paper, hotels and restaurants are also included among tradables because of their large service export content in several Central European countries (the Czech Republic, Hungary, Croatia, Slovenia).

### ***Description of variables***

- Quarterly indices of value-added (in constant prices) from the production-side GDP estimates. The weights used to aggregate individual industries into traded and non-traded sectors are industries’ shares in total value added (corrected for agriculture and public administration). For Poland (and some years in few other countries), only annual data on GDP breakdown by industry were available. Quarterly data on industrial production were then used to create quarterly growth rates for tradables; and quarterly GDP data to create quarterly growth rates for nontradables (as a "residual" between GDP and tradables).
- CPI rates of inflation with sub-components enabling a breakdown into traded and non-traded goods and services; the sub-components are aggregated into traded and non-traded goods inflation on the basis of respective weights in the CPI basket (quarterly averages);
- Nominal exchange rates of domestic currency against the euro (quarterly averages);
- Employment (quarterly averages) in traded and non-traded goods industries. The weights used to derive employment in traded and non-traded sectors are industries’ shares in total employment (corrected for agriculture and public administration).
- Nominal wages (quarterly averages) by industry. The weights used to derive wages in traded and non-traded sectors are industries’ shares in total employment (corrected for agriculture and public administration).

### ***Data sources***

National central banks and statistical offices (data for six Central European countries); European Central Bank (data for the euro area); BIS; and staff estimates.



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