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The Balassa-Samuelson Effect in Central and Eastern Europe: Myth or Reality? [1]

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ABSTRACT:

This paper studies the Balassa-Samuelson effect in nine Central and East European countries. Using panel cointegration techniques, we find that productivity growth in the open sector leads to inflation in non-tradable goods. Because of the low share of non-tradables and the high share of food items in addition to regulated prices, the consumer price index is misleading when analyzing the Balassa-Samuelson effect. Consequently, the appreciation of the real exchange rate, which has been established as a stylized fact over the last decade, is caused only partly by the Balassa-Samuelson effect. We identify a trend increase in the prices of tradable goods as a contributing explanation.

Key Words : Balassa-Samuelson effect, Panel cointegration, Transition economies, EMU

JEL Classification : *E31, F31,C15*.

1. Introduction

The pending accession to the European Union (EU) of the Central and East European (CEE) countries has provoked a substantial debate on when and how new entrants should adopt the Euro. Since they are not granted an opt-out clause from the EMU after joining the EU, new entrants are supposed to achieve nominal convergence in accordance with the Maastricht criteria. Conventional wisdom suggests that this may conflict with real convergence. Kopits (1999), Corker *et al.* (2000), Szapáry (2000), Halpern-Wyplosz (2001) and Buiter-Grafe (2002) provide arguments in support of this view and argue that the Maastricht criteria on inflation and exchange rate stability in the framework of the Exchange Rate Mechanism (ERM) II could be met simultaneously only with difficulty. According to the Balassa-Samuelson effect, presented in Balassa (1964) and Samuelson (1964) and on which this position is based, productivity growth in the open sector usually exceeds that in the sheltered sector. Given that wages are expected to be approximately the same across sectors, faster productivity growth in the open sector pushes up wages in all sectors, thus leading to an increase in the relative prices of non-tradable goods. Therefore, if productivity growth in one country outpaces that in the other, overall inflation will be higher in the former. In the case of the countries in the catch-up process, such inflation differentials will be the source of price level convergence with more developed EU countries and will also affect the real exchange rate calculated on the basis of the consumer price index (CPI). As long as the nominal exchange rate is determined by purchasing power parity (PPP) in the tradable sector, a productivity-induced increase in the price level through relative price adjustments will result in an appreciation of the CPI-based real exchange rate.

The Balassa-Samuelson effect should be present in CEE countries. After the initial recession, these countries experienced rapid productivity growth, in particular in their industrial sectors, accompanied by a steady increase in the relative price of non-tradables and a trend appreciation in the real exchange rate. Nevertheless, ample room remains for further productivity increases and price level convergence (Eurostat, 2001a). A conflict between nominal and real convergence could arise because, with a fixed exchange rate, relative price adjustments can take place only through non-tradable inflation. By contrast, relative price adjustments can be achieved without inflation in the presence of floating exchange rates because a nominal exchange rate appreciation will imply declining tradable prices measured in domestic currency terms. Therefore, with strong catch-up in the accession countries' productivity, doubts arise as to whether inflation and exchange rate targets can be achieved simultaneously.

A growing empirical literature on transition economies focuses both on relative price and real exchange rate developments attributable to the Balassa-Samuelson effect. Whereas the existence of a long-run relationship between non-tradable inflation and productivity growth is acknowledged, estimations concerning the extent to which the Balassa-Samuelson effect is reflected in inflation differentials and, consequently, in real exchange rate movements differ considerably. Kovács-Simon (1998), Rother (2000), and Halpern-Wyplosz (2001) show that productivity driven real appreciation is approximately 3% per year for several transition economies. By contrast, De Broeck-Slok (2001), Corricelli-Jazbec (2001), Égert (2002a,b) and Égert(2003) estimate that the Balassa-Samuelson effect justifies a lower real appreciation ranging from 0% to 1.5% per year.

This paper investigates the Balassa-Samuelson effect for nine CEE transition countries using detailed national accounts data for productivity and relative price measures. We use different classifications for the open and the sheltered sectors. The period ranges from 1995 to 2000 because we eliminate the early years of transition, during which price and productivity developments were driven more by the initial reforms than by the Balassa-Samuelson effect. Using panel cointegration methods, we find that productivity growth in the traded-goods sector is likely to cause non-tradable inflation. However, this does not mean that productivity gains will be reflected automatically in overall inflation and thus in an appreciation of the real exchange rate. Actually, the impact of productivity on inflation depends mainly on the composition of the consumer basket. When the weight of non-tradables is low, increases in relative prices will have little impact on overall inflation. In addition, regulated prices must be considered because they still constitute a substantial share in the CPI and their adjustments are both frequent and sizeable. Because regulated prices concern mostly services, the increase in the relative price of non-traded goods is accentuated. However, the Balassa-Samuelson model considers only market-based non-tradables not items subject to government intervention. Furthermore, the tradable goods price-deflated real exchange rate has trend-appreciated in those countries, which implies that PPP does not hold in the open sector. As a consequence of these two additional sources of inflation differentials, the conflict between nominal and real convergence arising from the Balassa-Samuelson effect may be weaker than other studies indicate.

The remainder of the paper is organized as follows. Section 2 discusses briefly the theoretical framework and describes the relationships between productivity, relative prices and real exchange rates derived from the model. Section 3 discusses the data and the estimation technique. Section 4 provides the empirical results and section 5 draws conclusions with respect to the real and nominal convergence process.

2. The Balassa-Samuelson Model

The Balassa-Samuelson model provides a supply-side explanation for the relative price of tradables and non-tradables in an economy and, assuming that PPP holds for traded goods, both for the differences in price levels between countries with different levels of development and the long-run behavior of the CPI-deflated real exchange rate. To establish that the relative price of non-tradables and tradables, and thus the price level composed of tradable and non-tradable goods prices, is determined entirely by supply conditions, i.e. the production functions of an economy, several assumptions are needed. First, each economy produces two kinds of goods with two different constant-return-to-scale production functions given by:

$$Y_t = A_t \cdot L_t^b \cdot K_t^{(1-b)} \text{ and} \quad (1)$$

$$Y_{nt} = A_{nt} \cdot L_{nt}^c \cdot K_{nt}^{(1-c)}, \quad (2)$$

where Y, L, K, A represent output, labor, capital and total factor productivity, respectively. The subscripts t and nt denote variables in the traded and the non-traded goods sector, respectively. The parameters b and c are positive and less than one. Second, the labor elasticity of production is larger in the non-traded goods sector than in the traded goods sector so that $c > b$. Third, the prices of tradable goods and the interest rate are determined in the world market, i.e. they are exogenous. Fourth, capital stock is fixed for one period ahead and labor is perfectly mobile across sectors, but less mobile at the international level. Fifth, wages in the traded goods sector are determined by the marginal product of labor and the exogenous price level. Moreover, due to wage equalization, nominal wages in the traded goods sector are also paid in the non-traded goods sector[2].

If these assumptions hold, the relative price of non-tradable goods is determined solely by supply conditions. This result follows from considering the first-order conditions of the profit maximization problem for producers of tradable and non-tradable goods. Using Cobb-Douglas production functions, the first-order conditions are:

$$A_t \cdot (1-b) \cdot \left(\frac{1}{K_t/L_t}\right)^b = \frac{i}{p_t}, \tag{3}$$

$$A_t \cdot b \cdot \left(K_t/L_t\right)^{(1-b)} = \frac{W}{p_t}, \tag{4}$$

$$A_{nt} \cdot c \cdot \left(K_{nt}/L_{nt}\right)^{(1-c)} = \frac{W}{p_{nt}}, \text{ and} \tag{5}$$

$$A_{nt} \cdot (1-c) \cdot \left(\frac{1}{K_{nt}/L_{nt}}\right)^c = \frac{i}{p_{nt}}, \tag{6}$$

where W, P and i denote wages, prices and the interest rate, respectively. The four endogenous variables are determined as follows. The only unknown variable in equation (3) is the labor input for the traded goods sector. Therefore, the interest rate and the capital stock determine the capital-labor ratio and consequently the labor input in the tradable sector. Equation (4) determines the nominal wage in the tradable sector, which enters exogenously in the first-order conditions for the non-tradable sector. The third and fourth first-order conditions determine jointly the labor input in the non-tradable sector and the relative price of non-tradable goods. Hence, the relative price of non-tradable goods is the result of the firms' optimization problem and reflects a microeconomic equilibrium driven solely by supply conditions.

If productivity advances in the tradable sector exceed those in the non-tradable sector, the price level will rise because of the increase in the relative price of non-tradable goods. Because tradable prices are determined in the world market, productivity advances in the traded goods sector will not have any impact on tradable price developments. Nevertheless, wages can rise at a proportional rate in the open sector without harming competitiveness. With wages equalizing across the open and sheltered sectors, an increase in the open sector's wage induces an increase in wages in the sheltered sector. In the absence of any corresponding improvements in productivity, non-tradable prices will increase. As a result, productivity gains in the open sector will lead to overall inflation through the increase in non-tradable prices, which is the internal transmission mechanism from productivity growth in the open sector to increases in non-tradable prices and to overall inflation.

Consider the differences in price levels and price developments between countries at different stages of economic development. According to the Balassa-Samuelson model, differences in productivity in the traded goods sectors and, consequently, differences in the wage levels lead to different price levels in these two economies with different levels of development. Differences in price levels are determined entirely by differences in non-tradable prices provided PPP holds for tradable goods. At the same time, the catch-up process during which less-developed countries experience faster productivity growth than more-developed economies, especially in their traded goods sector, is accompanied by an increase in the relative price of non-tradables and a trend appreciation of the CPI-deflated real exchange. Hence, the Balassa-Samuelson model also shows why deviations from PPP may occur and why currencies can systematically appreciate in real terms. The productivity growth-driven increase in the relative price of non-tradable goods is actually reflected in the trend real appreciation that can be viewed as an equilibrium process.

When testing empirically the Balassa-Samuelson effect, we can distinguish between the internal and external transmission mechanisms. The internal transmission mechanism suggests that the productivity differential between the open and the sheltered sectors and the relative price of non-tradable goods defined in terms of tradable goods should be connected. This relationship can be derived from the first-order conditions. Equating wages in the first-order conditions determines labor inputs and leads to the following equation:

$$\frac{P_{nt}}{P_t} = \frac{\partial Y_t / \partial L_t}{\partial Y_{nt} / \partial L_{nt}} . \qquad (7)$$

Hence, an increase in the relative price of non-tradables occurs when productivity increases faster in the tradable sector than in the non-tradable sector. For Cobb-Douglas production functions, marginal productivity is equal to a constant fraction of average productivity so that equation (7) can be written as[3]:

$$\frac{P_{nt}}{P_t} = \frac{b}{c} \cdot \frac{Y_t / L_t}{Y_{nt} / L_{nt}} \,. \tag{8}$$

The relative price of non-tradables is a fraction of the productivity differential between the open and the sheltered sectors because c > b by assumption.

The external transmission mechanism represents the convergence in price levels caused by different growth rates in productivity in the tradable sector and the real appreciation of the domestic currency. If the internal mechanism applies to the home and the foreign country, the difference in the price ratio between two economies will be given by the difference in the productivity ratios in the two countries. Hence, the positive long-term relationship between the development of relative productivities and relative prices is given by[4]:

$$\frac{P_{nt}}{P_t} \Bigg/ \frac{P_{nt}*}{P_t*} = \left(\frac{b}{c} \cdot \frac{Y_t / L_t}{Y_{nt} / L_{nt}} \right) \Bigg/ \left(\frac{b*}{c*} \cdot \frac{Y_t * / L_t *}{Y_{nt} * / L_{nt} *} \right). \tag{9}$$

The difference in the productivity differentials across countries and the real appreciation of the domestic currency can be linked indirectly because the difference between the domestic and the foreign relative price of non-tradable goods can be connected to the CPI-based real exchange rate. Using the real exchange rate decomposition suggested by MacDonald (1997), the real exchange rate denoted Q and given by $Q = \frac{EP*}{P}$ can be decomposed as follows:

$$Q = \frac{EP_t *}{P_t} \Bigg/ \left(\frac{\left(\frac{P_{nt}}{P_t} \right)^{(1-a)}}{\left(\frac{P_{nt} *}{P_t *} \right)^{(1-a*)}} \right), \tag{10}$$

where E denotes the nominal exchange rate expressed in foreign currency terms and a denotes the share of tradable goods in GDP. If PPP holds for the tradable sector, in other words if the term $\frac{EP_t *}{P_t}$ equals 1 in the long run, equation (10) becomes:

$$Q = \frac{1}{\left(\left(\frac{P_{nt}}{P_t}\right)^{(1-a)} \Big/ \left(\frac{P_{nt} *}{P_t *}\right)^{(1-a*)}\right)}. \tag{11}$$

Therefore, according to the Balassa-Samuelson model, we can establish a negative relationship between the difference in the relative price ratios and the CPI-deflated real exchange rate. In addition, real appreciation of the exchange rate should equal the increase in the productivity differential transmitted to the CPI via non-tradable inflation pass-through. The magnitude of this pass-through depends on the size of the (1-a) term; the larger is the share of non-tradables in the CPI, the bigger is the impact of productivity growth on overall inflation.

3. Data Sources and Estimation Techniques

The data set consists of quarterly average labor productivity data, the relative price of non-traded goods, and real exchange rates. The panel data set includes nine transition countries, namely Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia, and covers the period from the first quarter of 1995 to the last quarter of 2000. All series are transformed into natural logarithms and all variables are in index form with the first quarter of 1995 as the base. The period prior to 1995 is eliminated from the analysis because, during the early years of the transition process, changes in productivity, overall inflation, especially the relative price of non-tradable goods, and the appreciation of the real exchange rate were dominated by firm-level restructuring involving massive lay-offs, the adjustment of distorted relative prices from the Communist era and pegged exchange rate regimes motivated by concerns for macroeconomic stabilization. Therefore, even if those earlier data appear to correspond to some of the model's predictions, the Balassa-Samuelson effect did not drive price and real exchange rate movements during that turbulent period.

The national accounts and employment data are obtained from publicly available databases from the OECD, Eurostat and the Vienna Institute for International Economic Studies (WIIW). If official quarterly data are not available, we use interpolated annual data instead. The quarterly national accounts data are seasonally adjusted with X12- ARIMA. Constructing productivity and relative price variables raises the crucial issue of how to define the tradable and the non-tradable sectors, on which no consensus has been reached in the literature[5].

Due to the limited availability of detailed quarterly national accounts data, the process of defining the open and sheltered sectors consists mainly of classifying agriculture. Agricultural prices are not fully market-determined in these countries. At the same time, the share of agricultural products in total exports is still rather high. Therefore, we construct two different productivity measures. In the first, agriculture and industry excluding construction constitute the tradable sector and other sectors are considered as non-tradables (Prod_A). In the second, agriculture is dropped entirely so that the open sector consists of only industry and the sheltered sector includes the rest of the economy (Prod_B). If the level of and the change in productivity in agriculture are significantly different compared with those in industry, the calculated productivity differential between the traded and the non-traded goods sector will differ. Because productivity increases are significantly lower in agriculture, productivity growth in the open sector appears higher if only industry is considered.

Using the above classifications, average labor productivity is computed by dividing the sectoral value added by the corresponding number of employees. To measure the relative price of non-tradables, we first define the relative price as the ratio of the corresponding sectoral GDP deflators. The deflator for services obtained from the national accounts is used for non-tradable prices, while the deflator for tradables is given either by the deflators for agriculture and industry (Defl_A) or by the deflator for only industry (Defl_B).

GDP deflators do not correspond necessarily to the officially published inflation indexes, which normally uses the CPI or the producer price index (PPI) rather than sectoral deflators. Moreover, the real exchange rate is usually calculated using the CPI and PPI rather than GDP deflators. Hence, we construct three measures for the relative price of non-tradables in terms of CPI and PPI. Data on price indices are taken mainly from the OECD Main Economic Indicators (MEI). However, data from the IMF's IFS database are used when the necessary series are not available from the OECD[6].

The first ratio, CPI / PPI (serv1), is often used as a proxy for relative prices. This ratio assumes that all non-goods items in the CPI, which are not expected to be captured in the PPI, are non-tradables. Therefore, this measure corresponds roughly to the ratio of the sum of non-tradables plus tradables divided by tradables. However, this definition of tradables and non-tradables may not reflect correctly the relative price of non-tradables because the CPI can be divided roughly into food, durable goods, services, and regulated prices and items subject to regulated prices still make up a substantial share of the consumer baskets in the transition countries[7]. Although services make up the largest category having regulated prices, the other two categories also have prices regulated. Because all items other than industrial goods are considered as non-tradables, changes in food and regulated prices may cause undesirable noise in the relative price measure. Furthermore, due to the relatively low income level in these countries, the share of services in the CPI is currently about 30%[8]. As a result of these factors, an increase in the productivity differential should increase the price differential using the ratio of CPI/PPI by only a fraction of the productivity increase, equal to the weight of services in the CPI. The problem is aggravated by the fact that regulated prices consist mainly of services. Thus, the share of market-driven service prices in the CPI is small and this attenuates the impact of productivity increases. Second, non-food products are expected to correspond to goods that are included in the PPI, i.e. industrial goods. This might be a heroic assumption, especially for countries in which the PPI includes data from domestic and foreign markets. Consequently, different movements in durable goods in the CPI and industrial goods in the PPI may affect the ratio.

The second ratio of services in CPI over the CPI (serv2) corrects for some of these shortcomings because the noise from service prices is eliminated and the possible difference between durable and industrial goods is eliminated. In fact, this ratio can be viewed as non–tradable prices divided by the sum of tradable and non-tradable prices. However, the inclusion of regulated items in the service category remains a problem. The OECD does not provide series on services that exclude regulated prices for all countries. Therefore, for some countries, the category CPI services includes regulated prices and, for others, it doesn't. Moreover, the noise in service prices due to the inclusion of miscellaneous categories in services is shifted towards tradable prices because all categories except for services are defined as in the tradable sector.

The third ratio for measuring relative prices is services in CPI over PPI (serv3) is the best and close to the definition using deflators because the two components of the CPI chosen reflect mostly the deflator measures. However, a possible drawback is that it is difficult to infer from this measure what impact the increase in the service prices has on overall inflation. Table 1 presents an overview of the data used throughout this study. Average annual growth rates are displayed for the productivity differential between the traded and non-traded goods sectors and for the relative price of non-tradable goods.

(Table 1 to be inserted here)

The real exchange rate is calculated using the CPI. Nominal exchange rates, measured in foreign currency, are averages of average monthly data. Nominal exchange rates come from the WIIW monthly database for transition economies and from central bank sources for the Baltic States. The use of quarterly data and the short sample period make time series techniques difficult to apply. Therefore, we employ panel techniques, namely panel unit root and panel cointegration tests. First, the order of integration of the time series is investigated using the Im-Pesaran-Shin (1997) (IPS) panel unit root. The t-bar statistic of the IPS test, constructed as a mean of individual Augmented Dickey Fuller (ADF) statistics, is used to test the null hypothesis of a unit root. This test is used instead of the Levin and Lin test because it allows for a high degree of heterogeneity across the countries of the panel, i.e. in the autoregressive coefficient and the lag used for each country. When testing for a unit root in the series, a model with a trend and an intercept and a model with only a constant are used.

In the IPS test with a trend, the presence of a unit root around a linear trend is rejected. However, test results are not always robust with respect to the number of lags used. In the IPS test with only a constant, the presence of a unit root is never rejected, regardless of the lag length used. Furthermore, both tests in first differences clearly reject the presence of a unit root. Therefore, we conclude that the series are non-stationary processes.[9]

Since the pooled series are integrated of order 1, cointegration tests are necessary. Pedroni (1999) suggests seven tests statistics that can be used for detecting long-run cointegration relationships. All tests use residuals of a Engle-Granger-type cointegration regression to test for cointegration. Of the proposed seven test statistics, four are based on pooling along the within-dimension while the other three test statistics are based on pooling along the between-dimension. Pedroni (1999) shows that, for smaller samples, the group ADF-statistic is the most powerful among the latter three. Due to our small sample size, only this test statistic is reported. The coefficients of the cointegrating vector are determined using the panel fully modified ordinary least squares (FMOLS) estimator of Pedroni (2000). The lag length is allowed to differ across countries; it is determined by the Newey-West method.

Regarding the unit root tests, we face the problem of heterogeneous trends in the cointegration relationship in that the data may exhibit a trend in some countries but not in others. Another important drawback of panel techniques is that the robustness of the relationship cannot be determined and the size of the estimated coefficient for individual countries is impossible to estimate. It is only possible to conclude that a given cointegration relationship is verified on average for a set of countries and that the estimated coefficient reflects a mean of the heterogeneous individual coefficients. Therefore, we interpret the empirical results for a group of countries and focus more on a comparison of the determined values than on a precise number.

4. Empirical Results

Before testing for the internal relationship between relative productivity and relative prices, two crucial assumptions must be considered, namely, if real wages in the tradable sector are connected to productivity growth and if wage increases tend to equalize between the open and sheltered sectors. Figures 1 and 2 show that the assumptions seem to be fulfilled on average. Using industry for the traded goods sector, real wages in the traded goods sector deflated by the corresponding sectoral deflator move broadly in line with productivity growth. However, differences between the countries exist. Whereas productivity increases outpace real wage increases in Croatia, Estonia and Slovenia, the opposite is found in other countries. Figure 2 indicates that nominal wages develop similarly in the open and sheltered sector with the exception of Croatia and Poland.

(Figure 1 to be inserted here)

(Figure 2 to be inserted here)

Table 2 indicates that the group ADF test detects the presence of a correctly signed, statistically significant cointegration relationship between productivity and relative prices when sectoral GDP deflators are used. The result is robust to the inclusion of a trend. The size of the estimated coefficient changes depending on whether or not agriculture is included in the open sector. With agriculture in the open sector, the coefficient of 1.00 suggests that an increase (decrease) in productivity leads to an equal increase (decrease) in the relative price of non-tradables. Excluding agriculture from the analysis so that only industry remains in the open sector leads to a lower coefficient of 0.73, which indicates that the rise (fall) in productivity exceeds the rise (fall) in relative prices. The higher coefficient with agriculture in the open sector may be due to the fact that, on average, productivity gains in industry far outpaced those in agriculture. At the same time, the relative price of non-tradables seems to be less sensitive to whether or not agricultural prices are included so that prices in agriculture move similarly to those of other tradable prices. Since the two coefficients differ significantly, the Balassa-Samuelson effect is sensitive to the sectoral classification used.

Using the three ratios based on CPI and PPI, namely serv1, serv2, serv3, instead of the relative prices computed using sectoral GDP deflators, it is much more difficult to detect robust cointegrating vectors between productivity and relative prices. As Table 2 indicates, results are sensitive to the inclusion of a trend when the service component of the CPI is used. Cointegration is found only for the ratio of service prices in the CPI to the CPI when a trend is included. In general, the estimated coefficients are considerably lower than those obtained using sectoral GDP deflators. This result may be due to tradable prices in the CPI growing faster than those included in the sectoral deflators and to the high share of non-food goods with substantial price increases in the CPI, e.g. energy, still regulated in all transition countries. This is likely to reduce the impact of higher service inflation on the relative price ratio. Therefore, the lower estimated coefficients indicate that other components in the CPI are important to determining the path of the relative price of non-tradables. This finding is even more compelling because the inclusion of regulated items in services should increase this ratio independently of productivity increases.

(Table 2 to be inserted here)

To investigate the external relationship explaining inflation differentials and real exchange rate movements, we use Germany as a reference country because it is the most important trading partner of the transition countries (Eurostat, 2001b). Equation (9) is used to analyze the external relationship. The results of the cointegration analysis found in Table 3 are similar to those obtained for the internal transmission mechanism. The tests indicate the presence of a cointegrating vector connecting the productivity differential and the sectoral GDP deflator-based relative price differential relative to Germany. Furthermore, except for the first, all estimated coefficients are statistically significant and signed correctly. The coefficient when agriculture is included in the open sector is higher than when agriculture is excluded from the analysis. However, it is not statistically significant. The exclusion of agriculture increases the productivity differentials in the CEECs and reduces it in Germany, without affecting relative prices[10]. The positive coefficient of less than 1 implies that, if changes in the sectoral productivity differential and in relative prices in the home country outpace those in Germany, changes in the productivity differential relative to Germany lead to less than proportionate increases in the sectoral deflator-based relative price of non-tradable goods and consequently to a less-than-proportionate real appreciation of the currency.

Similarly to the results for the internal transmission mechanism, the tests do not detect any significant cointegration between productivity and price-index-based relative prices except for the ratio of the CPI services over to the CPI. Again, the estimated coefficients are lower than those obtained using deflator-based relative prices. The CPI services over the CPI measure is the least suited for assessing the real appreciation of the currency due to the Balassa-Samuelson effect because services have a larger share in the consumer basket in Germany than in the transition countries. As a result, this ratio is rather stable in Germany and the differential between this measure of any home country and Germany is expected to be sizeable. Hence, the importance of other components in the transition countries' consumer basket is corroborated.

(Table 3 to be inserted here)

Having determined the cointegrating relationship, we determine the impact of the productivity-driven service inflation on overall inflation. For this purpose, we apply the share of services in the CPI reported in footnote 8 to the average yearly values for the productivity differential between the open and sheltered sectors for each transition country. We assume that a 1% change in productivity leads to a 1% change in service prices, which is consistent with the estimated coefficient of 1 in Table 2 when agriculture is included in the open sector. However, the exclusion of agriculture from the open sector leads to a coefficient of 0.7 as shown in Table 3. Hence, the average productivity growth rates are multiplied by both this coefficient and the share of non-tradables in the CPI, when agriculture is excluded from the analysis (Prod_B). The results appearing in Table 4 demonstrate that, even for high productivity growth countries such as Poland, inflation attributable to productivity growth at 2.9% is just a fraction of the initial productivity differential of 9%. The composition of the consumer baskets, especially the share of non-tradables, is crucial when measuring the impact of productivity-induced non-tradable price increases on overall inflation. The weight of non-tradables is low in these countries, in particular in comparison with that of the average consumer basket for EU-countries. Hence, the impact of the Balassa-Samuelson effect on overall inflation is small. By contrast, even though the growth rate of the productivity differential averages only 0.5% to 0.6% annually in Germany, inflation attributable to the Balassa-Samuelson effect is relatively high as shown in columns 2 and 3.

(Table 4 to be inserted here)

As a result, the inflation differentials relative to Germany based on productivity increases are low and even negative for the Czech Republic, Latvia and Lithuania. The differentials are as low as 0.3% to 0.5% for Estonia and range from 0.8% to 1.2% for Croatia, Hungary and Slovenia. The inflation differential is as high as 0.9% to 1.4% for Slovakia and 1.2% to 2.4% for Poland, which implies that these two countries might encounter some difficulties with the Maastricht criterion due to the Balassa-Samuelson effect. Nevertheless, these figures are sensitive to whether agriculture is considered as a traded-good sector because they drop below 1.5% when a different classification is used. As a result, we conclude that the conflict between nominal and real convergence stemming from the Balassa-Samuelson effect may not be as serious as conventional wisdom suggests.

The inflation differentials based on productivity increases relative to Germany also specify the size of real appreciation that is justified by the Balassa-Samuelson effect. On average, this seems to be very small, especially when compared with the observed appreciation of the CPI-deflated real exchange rate. Hence, the actual real appreciation exceeds considerably the equilibrium appreciation attributable to the Balassa-Samuelson effect. However, we shall show that part of this excess appreciation can be viewed as an equilibrium appreciation related to prices of tradable goods.

Testing the relationship in equation (11) allows us to check whether the CPI-deflated real exchange rate and relative prices based on price indexes are cointegrated and to what extent real appreciation can be explained by the Balassa-Samuelson effect, i.e. whether actual real appreciation corresponds to what relative productivity and price changes would predict. From the group ADF tests in Table 3, statistically significant and well-signed cointegrating vectors between the CPI-based real exchange rate and the difference in the relative price of non-tradables are found when the difference between the ratio of services in the CPI to the CPI in the home country and that in Germany (Dserv2) and the difference between the ratio of services in CPI over PPI in the home country and that in Germany (Dserv3) are used. However, the estimated coefficients are much higher than what the Balassa-Samuelson effect would predict. According to equation (11), the coefficient should correspond to the share of non-tradables in the consumer price basket. If these weights differ in the home and foreign countries and they are stable over time, the estimated value should be somewhere between the two weights. However, the estimated coefficients shown in Table 3 exceed unity; i.e. an increase in the relative price of non-tradables is connected with a much larger appreciation of the real exchange rate.

These tests of the Balassa-Samuelson model are based on the assumption that PPP holds for tradables, which does not appear to be the case. Figure 3 clearly shows that the PPI-deflated real exchange rate appreciates in most of the countries in line with the CPI-deflated real exchange rate. The IPS tests also confirm that the PPI-deflated real exchange rates are not stationary[11]. Furthermore, cointegration tests in Table 5 indicate that the PPI-based real exchange rate is cointegrated with Dserv2 and Dserv3, when no trend is included in the cointegrating vector. These results are very similar to those when the CPI-based real exchange rate is used. Therefore, both the increase in the relative price of non-tradable goods and the increase in the price of tradable goods is systematically higher relative to Germany when measured in foreign currency.

(Table 5 to be inserted here)

These results lend support to the view that the Balassa-Samuelson effect is only one aspect of price level convergence during the catch-up process. The appreciation of the CPI-based real exchange rate is due largely to the inflation differential in goods. However, this is not surprising if one considers the small weight of non-tradables in the consumer basket in these countries and is consistent with the interpretation found in Ito *et al.* (1997) for fast growing East Asian economies. These authors conclude that, in some of the countries, productivity advances are linked with higher tradable price inflation compared to the outside world and thus a real appreciation of the PPI deflated exchange rate.

(Figure 3 to be inserted here)

The systematic appreciation of the PPI-based real exchange rate may be viewed as unsustainable in the long run if this is caused by movements in the nominal exchange rate caused by capital inflows. However, at least part of this appreciation can be thought of as an equilibrium phenomenon related to the catch-up process. In transition economies, lower real income has not only been caused by lower productivity in the production of the same traded goods, but has also been the consequence of a reduced ability to produce goods of higher technological content. This problem is exacerbated by smaller capital stocks and the lack of know-how along with institutional factors that hinder productivity, e.g. poor corporate governance, weak public administration, insufficient legislation and low-quality infrastructure.

At the beginning of the 1990s, the transition countries exported mainly food, manufactured goods and machinery of a lower quality and technological content. The foundation of the law of one price and PPP is arbitrage ensuring that the price of the same good, expressed in a common currency, is equalized at home and abroad by adjustments in the nominal exchange rate and prices. Even though trade barriers between the EU and the transition countries have been abolished, the mismatch of exports and imports and the lack of suitable counterparts lead to the exchange rate being determined not by arbitrage but rather by the balance of payments. Although exports have shifted to more technology intensive goods, some transition countries still remain highly specialized (Eurostat 2001c). During the transition process, export and supply capacities have increased significantly owing to the increasing technological content and quality of products as Havlik *et al.*(2001) show for all transition countries and Darvas and Sass (2002) demonstrate for Hungary.

Part of the higher productivity in the tradable sector reflects an ability to produce goods of higher quality and sell them at higher prices. This increasing supply capacity is tantamount to a change in the terms of trade, which could justify an appreciation of the real exchange rate through a nominal appreciation of the currency[12]. Higher prices is a result of a shift to new goods and therefore they should not be measured as inflation but rather they should show up in higher labor productivity growth. However, if quality improvements are not accounted for adequately when calculating inflation[13], they will be recorded partly as increase in producer prices. In that event, the increase in labor productivity can lead to an appreciation of the PPI-based real exchange rate through a positive inflation differential in tradable goods. At the same time, the appreciation of the CPI-deflated real exchange rate will exceed that of the PPI-based real exchange rate because the increase in labor productivity also leads to a wage-induced rise in the relative price of non-tradables. Furthermore, because all tradable goods have a non-tradable component, the productivity driven catch-up of non-tradable prices will be reflected automatically in traded goods prices. This hidden transmission mechanism between productivity and prices is not apparent in official statistics. If the appreciation of the PPI-based real exchange rate does reflect the increased ability to produce goods in higher price and quality segments, part of the price level convergence is due to the non-inflationary shift into new goods of higher quality and prices (Ferenczi *et al.,*2000, Lommatzsch and Tober, 2002).

5. Conclusions

Using the Pedroni panel cointegration technique on national account data for nine transition countries, we show that the productivity growth differential between the open and the sheltered sectors are linked strongly to increases in the relative price of non-tradables. Moreover, we find that the results are affected by the way in which sectors are classified; in particular, whether or not agriculture is considered to part of the open sector. When the productivity differential between tradables and non-tradables is related to measures for relative prices using the CPI and PPI, no robust cointegrating vectors are detected. Given that the share of non-tradables in the CPI is very low, at close to 30% on average in these countries, and it is changing rapidly, this result is not surprising. Furthermore, regulated prices still account for between 15% and 25% of the CPI; these are likely to bias price changes because increases in administered prices may exceed rises in non-tradable inflation. Moreover, changes in administered prices may be erratic because they depend on politically motivated decisions. As long as goods with regulated prices are important input factors, e.g. energy and transport, increases in these may induce cost-push inflation in the economy as a whole. Therefore, our results suggest that the Balassa-Samuelson effect may have a limited role to play in price level convergence and the real appreciation of the currency. However, with further progress in real convergence and thus a higher weight of services in the consumer baskets, the impact of the Balassa-Samuelson effect on CPI may increase.

The importance of the Balassa-Samuelson effect in transition countries is often stressed in connection with their preparations to adopt the Euro and satisfy the Maastricht criteria. Halpern and Wyplosz (2001) and Szapáry (2000) argue that the sizeable catch-up in productivity in the traded goods sector will lead to higher inflation and, hence, make it impossible to achieve either the inflation criterion or the exchange rate criterion. Likewise, Buiter and Grafe (2002) maintain that only the countries that apply large bands around central parity may be able to fulfill both criteria. Our results do not support these concerns. Both the size of the appreciation of the PPI-based real exchange rate and the weight of non-tradables in the consumer baskets of the transition countries decrease the role played by the Balassa-Samuelson effect in CPI-based real appreciation. Other factors are at least as important because price level convergence is taking place through an increase in the prices of tradable goods. At least part of the increase in the price level is due to a shift to goods of higher quality with correspondingly higher prices. Depending on the adjustment for quality improvements and the inclusion of new goods, measured inflation may be exaggerated. Increases in regulated prices may result in higher prices in all CPI categories. Furthermore, increasing real income may also increase inflation due to pricing-to-market strategies. Therefore, we conclude that the Balassa-Samuelson effect will not pose serious problems to the achievement of nominal convergence as required by the Maastricht criteria and that further investigation is needed to determine the role played by other factors in the real appreciation of the currencies of accession countries.

Endnotes:

1. The authors would like to thank John Bonin and the two anonymous referees for valuable comments and suggestions. We are also deeply indebted to Hélène and John Bonin for their help in editing this article.

2. Hence, causality in wage setting in the non-traded goods sector does not run from own marginal productivity to wages. However, as producers set the price of non-tradables and determine the amount of labor employed in this sector, wages in the non-traded sector will equal the marginal product in this sector.

3. Marginal productivity in the open and sheltered sectors can be approximated by average productivity as follows: $\frac{\partial Y_t}{\partial L_t} = A_t \cdot b \cdot \left(\frac{K_t}{L_t}\right)^{1-b} = b \cdot \frac{Y_t}{L_t}$ and $\frac{\partial Y_{nt}}{\partial L_{nt}} = A_{nt} \cdot c \cdot \left(\frac{K_{nt}}{L_{nt}}\right)^{1-c} = c \cdot \frac{Y_{nt}}{L_{nt}}$

4. Asterisks represent the foreign country.

5. De Gregorio *et al.* (1994), De Gregorio and Wolf (1994), Chinn and Johnston (1997), Duval (2001), MacDonald and Ricci (2001) define the open sector as sectors whose exports to total production exceed 10%. Thus, manufacturing, agriculture, mining and transportation are considered as open sector whereas the sheltered sector includes the rest. Canzoneri *et al.* (1999), Aitken (1999), Chinn (1997) and Swagel (1999) use manufacturing for the open sector. The sheltered sector contains the remaining sectors except for Swagel (1999) who excludes agriculture. Beside manufacturing, Alberola and Tyrväinen (1998) also include transportation in the open sector. They exclude not only agriculture but also public services from the sheltered sector.

6. The series from these two databases are slightly different. Differences of several percentage points can be observed in the CPI series obtained from the OECD and from the IMF for Slovenia and Estonia. The same applies for the PPI series for Hungary and Lithuania.

However, the OECD series is used when available; the IMF series is used only when OECD data are missing.

7. According to the European Commission (2001), the share of regulated prices in the CPI is 18%, 15%, 18.5%, 22%, 20.5% and 12.7% in the Czech Republic, Estonia, Hungary, Latvia, Lithuania and Slovenia, respectively. According to national central bank reports, the same figures are as high as 20.8% in Croatia (2002), 25.7% in Poland (2001) and 21.1% in Slovakia (2002).

8. In accordance with national statistics, the share of services in the CPI is as follows: 21.4% in Croatia (2001), 32.7% in the Czech Republic (2000), 22.7% in Estonia (2000), 28% in Hungary (2000), 20.7% in Latvia (2000), 18.7% in Lithuania (2002), 31.9% in Poland (2000), 33.1% in Slovakia (1997-99), 29% in Slovenia (2001) and 45.2% in Germany (1999.)

9. Results are available from the authors upon request.

10. Germany experienced substantial productivity increases in agriculture. This does not significantly distort tradable and non-tradable productivity measures because agriculture has a low weight in German GDP. More importantly, higher productivity gains in industry than in the service sector were accompanied by declining sectoral deflator-based relative prices. However, this development is not reflected in the price indices. The CPI/PPI ratio (serv1) and CPI services over PPI (serv3) show a slight upward movement, while CPI services and CPI series move together because services account for a big part of the German CPI. Consequently, CPI services over CPI (serv2) is very stable during the period under investigation.

11. Results of the tests are available from the authors on request.

12. Under a pegged exchange rate regime, especially in a crawling peg system, such appreciation may appear as a nominal depreciation that does not compensate fully for the inflation differential.

13. According to the Special Data Dissemination Standard (SDDS) of the IMF, not all statistical offices in these countries adjust their PPI measures for quality improvements.

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TABLES and FIGURES

Table 1 An Overview of Data, yearly averages, 1995 to 2000 (in %)

	Prod_A	Prod_B	Defl_A	Ddefl_B	serv1	serv2	serv3
Germany	1.37	1.10	-1.03	-1.16	1.02	0.15	1.18
Croatia	7.13	7.89	2.25	2.67	4.85	4.85	4.85
Czech Republic	2.51	1.35	2.88	2.13	2.68	2.13	5.09
Estonia	3.92	4.07	3.75	4.17	4.10	3.78	8.61
Hungary	5.08	5.68	3.70	3.18	0.91	1.85	2.85
Latvia	1.09	1.68	15.33	13.82	4.08	5.16	10.28
Lithuania	2.96	1.60	2.44	0.31	0.13	4.13	4.28
Poland	5.54	9.00	10.29	9.56	3.38	1.60	5.25
Slovakia	6.19	5.23	3.73	3.28	3.50	3.50	3.50
Slovenia	4.80	5.34	1.71	1.59	2.52	1.94	4.70

Table 2 Panel Cointegration Tests for the Internal Transmission Mechanism

Tested relationship		Group ADF-stat	Cointegrating vector	t-stat
Prod_A -Defl_A	Trend	-2.79**	1.00	9.40
	No trend	-3.44**		
Prod_B - Defl_B	Trend	-3.46**	0.73	13.22
	No trend	-3.81**		
Prod_A - serv1	Trend	-1.00		
	No trend	-1.02		
Prod_A - serv2	Trend	-2.17*	0.57	18.74
	No trend	-0.77		
Prod_A - serv3	Trend	1.96		
	No trend	-0.81		
Prod_B - serv1	Trend	-0.51		
	No trend	-0.51		
Prod_B - serv2	Trend	-2.60**	0.43	24.30
	No trend	-0.17		
Prod_B - serv3	Trend	1.49		
	No trend	-0.65		

Notes: The symbols ** and * denote that results are significant at the 1% and 5% level, respectively. The cointegrating vector is normalized to the relative price of non-tradable goods (**β'\{rel; prod\}= (1, β_1)**). The lag length used is 3.

Prod_A indicates the productivity differential between the open and closed sectors, with the open sector including agriculture.

Prod_B represents the productivity differential when agriculture is excluded from the analysis.

Defl_A is the relative price of non-tradable goods based on sectoral GDP deflators. Prices of tradable goods include prices in agriculture.

Defl_B stands for the relative price of non-tradable goods based on sectoral GDP deflators, when prices in agriculture are not considered.

Serv1 is the CPI to PPI ratio.

Serv2 is the ratio of services in CPI to the CPI.

Serv3 is the ratio of services in CPI to the PPI.

Table 3 Panel Cointegration Tests for the External Transmission Mechanism

Tested relationship		**Group ADF-stat**	**Cointegrating vector**	
DProd_A - DDefl_A	Trend	-3.88**	1.11	0.21
	No trend	-1.97*		
DProd_B - DDefl_B	Trend	-5.22**	0.89	3.92
	No trend	-2.06*		
DProd_A - Dserv1	Trend	-0.49		
	No trend	1.23		
DProd_A - Dserv2	Trend	-1.82*	0.50	15.92
	No trend	-0.18		
DProd_A - Dserv3	Trend	-1.60		
	No trend	0.34		
DProd_B - Dserv1	Trend	-0.59		
	No trend	1.65		
DProd_B - Dserv2	Trend	-3.26**	0.33	23.33
	No trend	-0.29		
DProd_B - Dserv3	Trend	-1.01		
	No trend	0.28		
DServ1 - RER(CPI)	Trend	-0.77		
	No trend	-1.01		
DServ2- RER(CPI)	Trend	-0.29	-1.82	-27.30
	No trend	-3.67**		
DServ3- RER(CPI)	Trend	-1.29	-1.19	-34.24
	No trend	-2.83**		

Notes: In addition to the notes in Table 2, D indicates the difference between the transition countries and Germany and RER(CPI) is the real exchange rate using the CPI as the deflator.

Table 4 Productivity Growth and Inflation Differential Relative to Germany, 1995 to 2000 (in %)

	Share of services in CPI	P(Prod_A)	P(Prod_B)	P(Prod_B2)	DP(Prod_A)	DP(Prod_B)	DP(Prod_B2)
Germany	45.2	0.62	0.49	0.35	0.00	0.00	0.00
Croatia	21.4	1.53	1.69	1.18	0.91	1.20	0.83
Czech R.	32.7	0.82	0.44	0.31	0.20	-0.05	-0.04
Estonia	22.7	0.89	0.92	0.87	0.27	0.43	0.52
Hungary	28.0	1.42	1.59	1.11	0.80	1.10	0.77
Latvia	20.7*	0.23	0.35	0.36	-0.39	-0.14	0.01
Lithuania	18.7	0.55	0.30	0.34	-0.07	-0.19	-0.01
Poland	31.9	1.77	2.87	2.01	1.15	2.38	1.66
Slovakia	33.1	2.05	1.73	1.21	1.43	1.23	0.86
Slovenia	29.0	1.39	1.55	1.08	0.77	1.06	0.74

Notes:

P(Prod_A) and P(Prod_B) are average yearly growth rates of the productivity differential from 1995 to 2000 multiplied by the share of services in CPI.

P(Prod_B2) is P(Prod_B) multiplied by 0.7.

dP(Prod_A) is the difference between P(Prod_A) of the country considered and P(Prod_A) for Germany.

dP(Prod_B) is the difference between P(Prod_B) of the country considered and P(Prod_B) for Germany.

dP(Prod_B2) is the difference between P(Prod_B2) of the country considered and P(Prod_B) for Germany

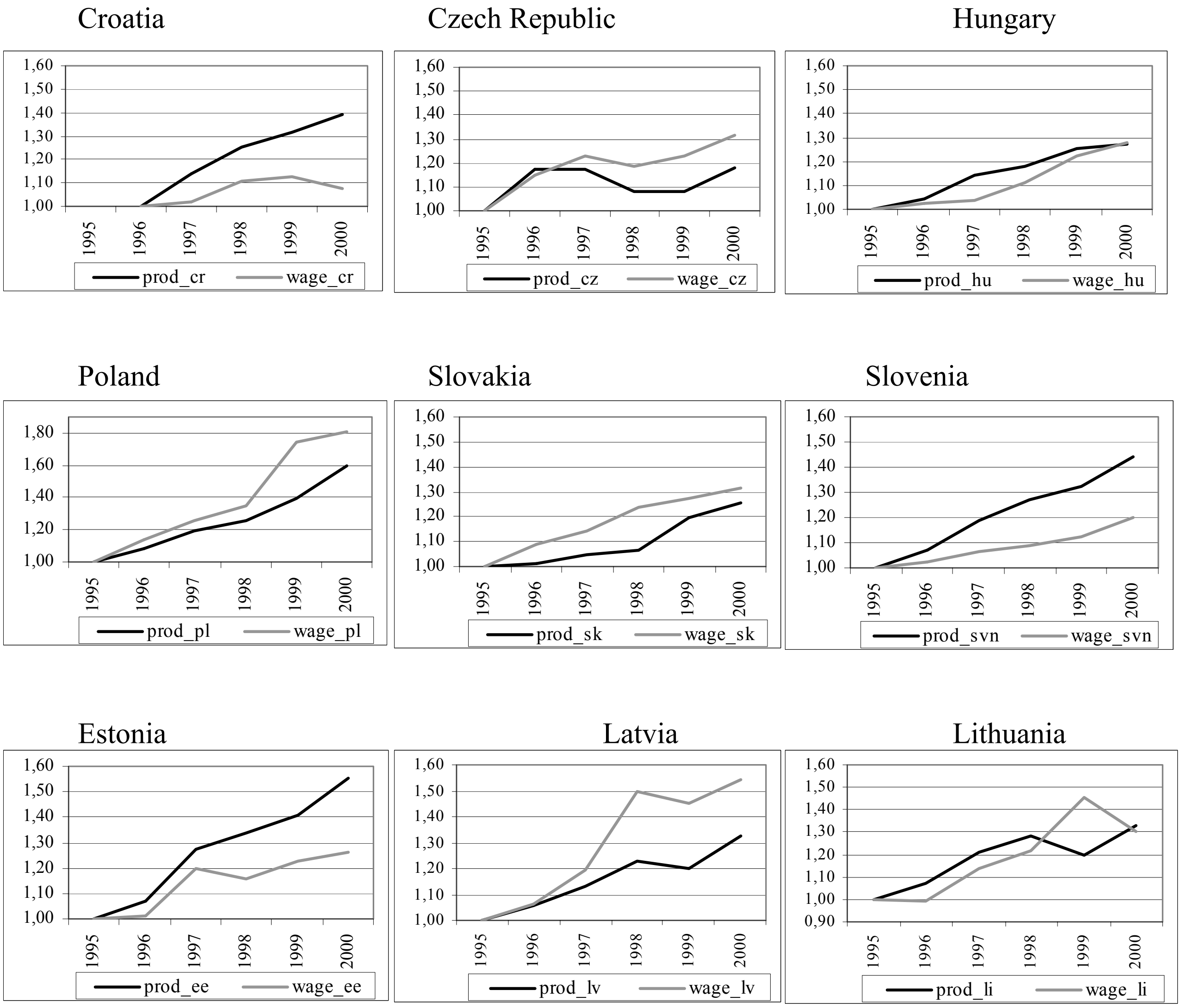
* Since data are not available for Latvia, the average of the other two Baltic States is used.

Table 5 Panel Cointegration Tests for the PPI-based Real Exchange Rate and Relative Prices

Tested relationship		**Group ADF-stat**	**Cointegrating vector**	**t-stat**
DServ1 -> RER(PPI)	Trend	-0.31		
	No trend	-0.83		
DServ2-> RER(PPI)	Trend	-0.79	-1.30	-23.21
	No trend	-3.53**		
DServ3-> RER(PPI)	Trend	-0.13	-0.70	-25.03
	No trend	-2.32*		

Notes: See Table 2.

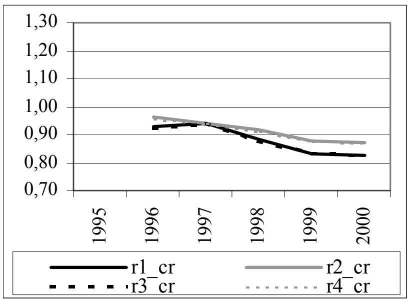
Figure 1 Productivity and Real Wage Developments in Industry



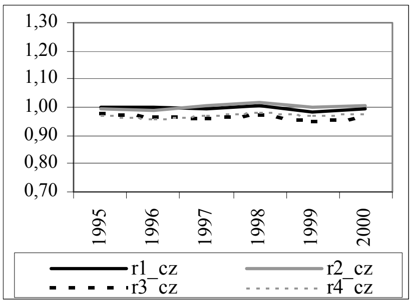
Note: Productivity is the average labor productivity in industry while real wage is the nominal wage in industry deflated by the sectoral deflator.

Figure 2 The Nominal Wage Equalization Process Across Sectors

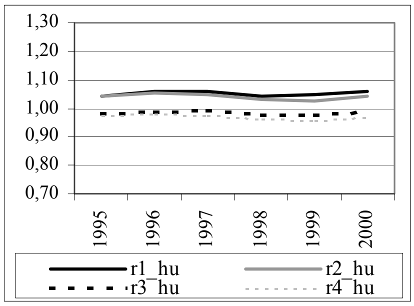
Croatia



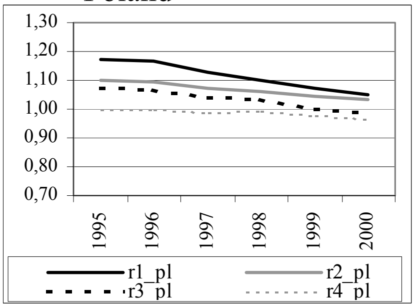
Czech Republic



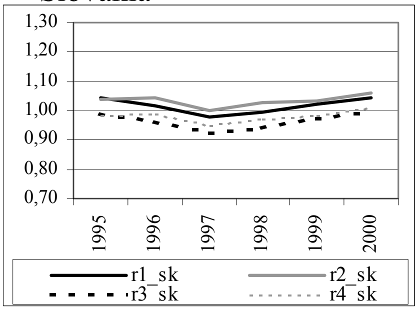
Hungary



Poland



Slovakia



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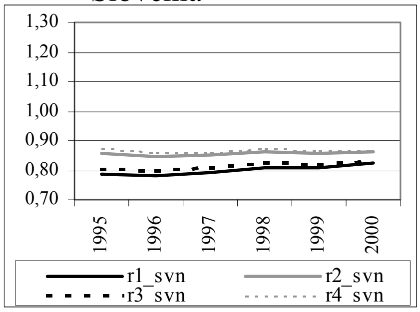

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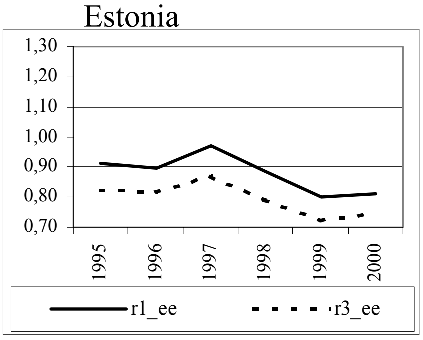

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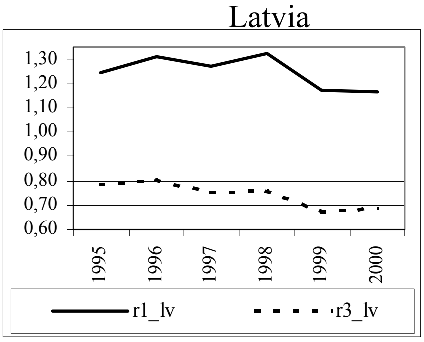

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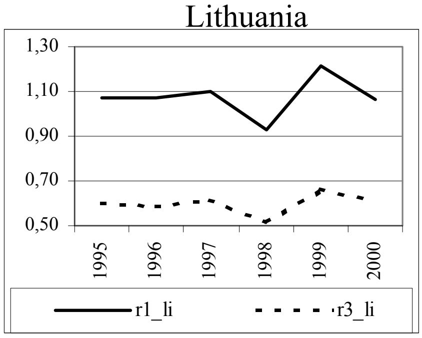
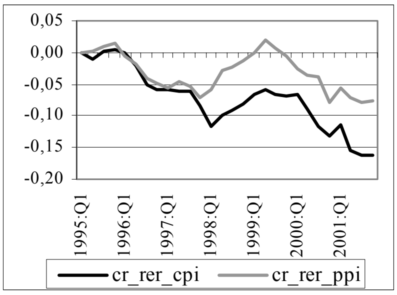


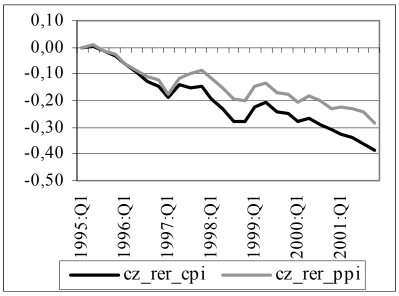
Notes: The series labeled r1 represents the nominal wage in industry over the nominal wage in non-tradable sectors whereas r2 is the wage in industry over the nominal wage in the whole economy. The nominal wage in the sheltered sector is the average nominal wage in all sectors, excluding industry and agriculture, weighted by the number of employees in the corresponding sector. The series r3 and r4 are computed as average nominal wages in industry and agriculture over nominal wages in the sheltered sector and in the economy as a whole, respectively. Once again, the average of wages in industry and agriculture is calculated using the number of sectoral employees as weights.

Figure 3 The CPI and the PPI-deflated Real Exchange Rate vis-à-vis Germany

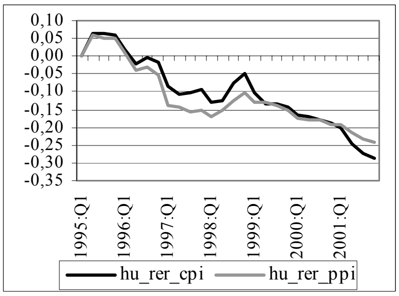
Croatia



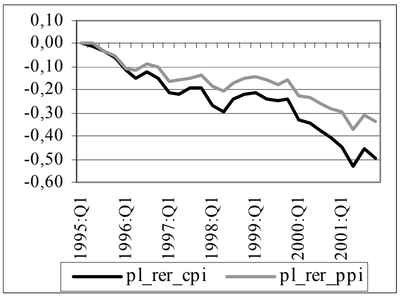
Czech Republic



Hungary



Poland



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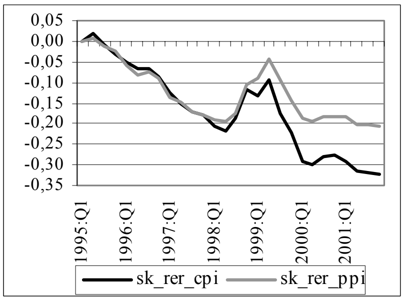

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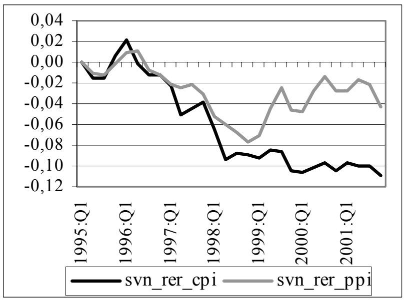

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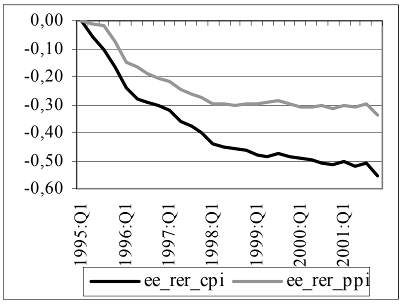

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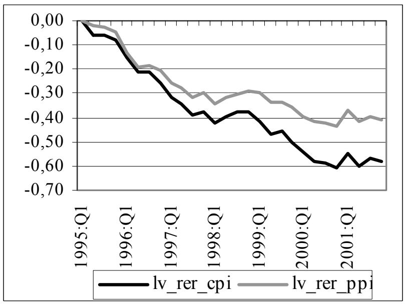

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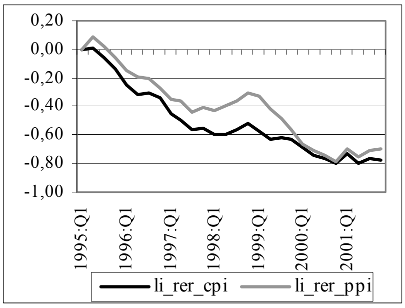

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