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# Catching-Up and Inflation in the Baltics and Southeastern Europe: the Role of the Balassa-Samuelson Effect

*Dubravko Mihaljek and Marc Klau*[*]

*Bank for International Settlements*

## Abstract

This paper estimates the Balassa-Samuelson effects for five Central, Eastern and Southeastern European countries with fixed exchange rate regimes on a disaggregated set of quarterly data covering the period from the mid-1990s to the first quarter of 2008. The Balassa-Samuelson effects are clearly present and explain around 16% of inflation differentials vis-à-vis the euro area (about 0.4 percentage points on average); and around 47% of domestic relative price differentials between non-tradables and tradables; or about 23% of total domestic inflation (about 1.1 percentage points on average). The paper presents mixed evidence on whether the Balassa-Samuelson effects have declined since 2001 compared with the second half of the 1990s.

**JEL Classification**: E31, F36, O11, P20

**Keywords:** Balassa-Samuelson effect, productivity, inflation, transition, convergence, European monetary union, Maastricht criteria

[*] Senior Economist and Head of Departmental Research Assistance, respectively, Monetary and Economic Department, Bank for International Settlements, CH-4002 Basel, Switzerland. Corresponding author: dubravko.mihaljek@bis.org. The views expressed in this paper are those of the authors and do not necessarily represent those of the BIS. Helpful comments from Reiner Martin and participants of the OeNB seminar "Recent Developments in the Baltic Countries: What Are the Lessons for Southeastern Europe?" (March 2009) are gratefully acknowledged. This is a shortened version of the BIS Working Paper No. 270 (December 2008), which will also appear in a volume of a *European Economy Occasional Paper* (European Commission, Directorate General Economic and Financial Affairs, 2009).

# 1. Introduction

This paper presents recent estimates of the Balassa-Samuelson effect for five countries in Central, Eastern and Southeastern Europe (CESEE) with fixed or tightly managed exchange rate regimes – Bulgaria, Croatia, Estonia, Latvia and Lithuania. The magnitude of the Balassa-Samuelson effect for these countries is of considerable interest for policymakers and relevant EU institutions because, under a fixed exchange rate regime, faster productivity growth in tradable versus non-tradable sectors at home compared to the euro area will result in higher overall inflation and therefore real exchange rate appreciation. If monetary policy were to keep inflation around the Maastricht benchmark – average of three EU countries with lowest inflation plus 1½ percentage point – but the Balassa-Samuelson effect was greater than the 1½ percentage point margin, the inflation criterion might be missed.[1] The authorities might therefore feel compelled to maintain, at least temporarily, relatively restrictive monetary and fiscal policies in order to meet the inflation criterion. This might dampen economic growth and job creation. In such circumstances, it might be difficult to explain to the public why the economy needs to slow down in order to adopt the common currency – reasonable observers might argue that the country is being "punished" for catching up too fast.

Recent empirical studies found the Balassa-Samuelson effect to be relatively small. For instance, in our earlier paper (Mihaljek and Klau, 2004) we found that the Balassa-Samuelson effect in Central European countries explained on average only between 0.2 and 2.0 percentage points of annual inflation differentials vis-à-vis the euro area. We also argued that, as the pace of catching-up decelerates, these effects were likely to decrease and hence should not become a determining factor in the ability of these countries to satisfy the Maastricht inflation criterion. Other studies (including Cipriani, 2001; Coricelli and Jazbec, 2001; Égert, 2002a and 2002b; Égert et al., 2003; Flek et al., 2002; Kovács, 2002; Lojschova, 2003) similarly found these effects to be small.

One contribution of the present paper is the size and up-to-dateness of the sample – we analyse quarterly data from the mid-1990s through the first quarter of 2008. For the countries in our sample – Bulgaria, Croatia, Estonia, Latvia and Lithuania – there are only a handful of empirical studies of the Balassa-Samuelson effect.[2] Moreover, for these five countries there have been hardly any estimates of

[1] According to the Maastricht inflation criterion, EMU candidates have to show a price stability performance that is sustainable and an average rate of inflation (observed over a period of one year before the examination) that does not exceed by more than 1½ percentage points that of, at most, the three EU Member States with the best price stability performance.

[2] See Burgess et al. (2003); Chukalev (2002); Égert (2005a) and (2005b); Égert et al. (2003); Funda et al. (2007); Mihaljek and Klau (2004) and (2007); Nenovsky and Dimitrova (2002); and Wagner and Hlouskova (2004).

the Balassa-Samuelson effect covering the period since 2004.[3] This period is relevant because, with the exception of Croatia, all countries in the sample have since joined the European Union. The Baltic states have also entered the exchange rate mechanism ERM II and all three have already missed the Maastricht tests in 2006 and 2008, although Lithuania almost managed to meet the reference value for inflation in 2006. Assessing the size of the Balassa-Samuelson effect for these countries is therefore of particular interest.

Another contribution of the present paper is greater precision of our estimates than in the past (eg, compared with Mihaljek and Klau, 2004). One reason is the much better quality of the data that have been released over the past few years by national statistical authorities for the Baltic states and Bulgaria. This has enabled us to extend the coverage of tradable sectors to agriculture, forestry and fishing, which are major sources of exports of several countries in the region; and to directly include one additional key variable, the share of non-tradables, in regression equations that are being estimated. We also examine whether productivity growth and the Balassa-Samuelson effects have diminished in recent years, an issue that has not been addressed systematically in the literature so far.

Finally, one advantage of our approach is the simple, transparent estimating framework that can be easily interpreted by policymakers and replicated by researchers with access to more disaggregated data.

Section 2 discusses the analytical framework and some relevant data issues. Section 3 reviews historical developments in productivity and inflation differentials within CESEE countries and between those countries and the euro area over the sample period. Section 4 discusses our econometric estimates of the Balassa-Samuelson effects. Section 5 summarises the main results and briefly notes some of their policy implications.

## 2. Analytical Framework

Using the distinction introduced in our 2004 paper, we discuss two versions of the Balassa-Samuelson effect, the "international" effect (equation 1) and the "domestic" effect (equation 2):[4]

$$\hat{p}_t - \hat{p}_t^* = const + \hat{e}_t + (1-\alpha_t)[\left(\frac{\delta}{\gamma}\right)\hat{a}_t^T - \hat{a}_t^{NT}] - (1-\alpha_t^*)[\left(\frac{\delta^*}{\gamma^*}\right)\hat{a}_t^{T*} - \hat{a}_t^{NT*}] \quad (1)$$

[3] In Mihaljek and Klau (2007) we cover the period through 2005:Q1 for six Central European countries.

[4] The two equations are derived in Mihaljek and Klau (2004); see also Égert (2003) and Égert et al. (2006).

$$\hat{p}_t^{NT} - \hat{p}_t^{T} = \left(\frac{\delta}{\gamma}\right)\hat{a}_t^{T} - \hat{a}_t^{NT} \qquad (2)$$

where circumflexes (^) stand for the growth rates; "*" denotes variables in the euro area; $\hat{p}_t - \hat{p}_t^*$ is the difference in consumer price inflation between a given CESEE country and the euro area; $\hat{p}_t^{NT} - \hat{p}_t^{T}$ represents the difference in domestic inflation rates of non-tradables and tradables, i. e. the growth rate of the relative price of non-tradables; $\hat{e}_t$ is the rate of nominal exchange rate depreciation (units of domestic currency vis-à-vis the euro); $\alpha_t$ is the share of traded goods in the consumption basket; $\hat{a}_t^T$ and $\hat{a}_t^{NT}$ are the growth rates of average labour productivity in tradable and non-tradable sectors, respectively; $\gamma$ and $\delta$ are production function coefficients (labour intensities in traded and non-traded sectors); and *const* is a term containing coefficients $\alpha$, $\gamma$ and $\delta$.

Equation (1) states that the difference in rates of inflation between two countries can be expressed as the sum of changes in the exchange rate (of the home country's currency vis-à-vis the foreign currency) and productivity growth differentials between traded and non-traded industries at home and abroad, weighted by the respective non-tradables' shares.

Equation (2) states that the growth rate of the relative price of non-tradable goods can be expressed as the difference in average labour productivity growth between tradable and non-tradable sectors.

Both versions of the Balassa-Samuelson effect are thus hypotheses about the structural origins of inflation: in the international version, about the tendency for inflation in the catching-up economies to be higher than in the economies they are converging to; and in the domestic version, about the tendency for the domestic prices of non-tradables to rise faster than those of tradables.

The structural factor that explains the tendency in both cases is the relative productivity growth differential. Historically, productivity growth in the traded goods sector has been faster than in the non-traded goods sector. If the law of one price holds, 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 overall inflation in the economy.

Charts A1 and A2 in the Appendix verify two key assumptions of the Balassa-Samuelson hypothesis: first, that productivity growth in the tradable sector bids up wages in that sector; and second, that wage growth in the tradable sector spreads to the non-tradable sector. As shown in chart A1, real wage growth in tradable industries generally closely follows productivity growth in tradables over the sample period. In some cases (Croatia, Latvia, Lithuania), strong productivity gains in tradables are not entirely passed onto real wages in that sector. Chart A2 provides clear evidence of wage equalisation between tradables and non-tradables in CESEE countries – it is remarkable how closely together wages in the two sectors have moved over longer periods in virtually all the five countries.

We derive the non-tradables' shares from national income accounts in constant prices rather than the weight of non-tradables in consumer price indices (usually proxied by the weight of services in the CPI). While the latter is analytically correct – equation (1) is derived from the expression for the CPI as a weighted average of tradables and non-tradables – the former is preferable in empirical work because of the downward bias in the CPI weights of services in CESEE countries. For instance, market-based non-tradables account for only around 20 to 30% of the CPI basket in the Baltic states and Southeastern Europe, although they represent on average around two-thirds of the value added in the economy. Using the CPI weights for non-tradables would therefore seriously underestimate the "true" Balassa-Samuelson effects.

The Balassa-Samuelson effect is sensitive to the classification of tradable and non-tradable sectors. There is no accepted criterion for this classification, and data do not always allow one to make a clear distinction. Consider for instance an often used benchmark for tradables proposed by De Gregorio et al. (1994): tradable industries are those with a share of exports in value added of 10% or more. To take an extreme example, housing is usually considered a quintessential non-tradable. But much of the housing in coastal areas of Bulgaria, Croatia and some Baltic states has been constructed and sold to non-residents in recent years. Data on such sales are generally unavailable, so a substantial part of "exports" of the construction industry might be underreported. Business services are another example of an industry typically classified as non-tradable, even though many companies in this sector are providing their services to (i.e., are outsourcing for) foreign companies.

The classification used in this paper nonetheless follows the traditional approach: agriculture, hunting and forestry; fishing; mining and quarrying; and manufacturing are classified as tradables (NACE branches A–D); while electricity, gas and water supply; construction; wholesale and retail trade; hotels and restaurants; transport, storage and communication; financial intermediation; and real estate, renting and business activities (NACE branches E–K) are classified as non-tradables.[5] Not considered because of their largely non-market content are public administration, defence and compulsory social security; education; health and social work; other community, social and personal services; and activities of households (NACE branches L–P).

[5] The Appendix provides a detailed description of all data used in the paper.

The Balassa-Samuelson effect is also sensitive to the assumption about factor intensities in non-traded and traded sectors ($\delta$ and $\gamma$). Like the rest of the literature, we assume that $\delta/\gamma = \delta^*/\gamma^* = 1$, i. e., that factor intensities in tradable and non-tradable sectors are the same and do not differ across countries. The reason is practical: very few countries publish income-based GDP data disaggregated for different sectors of the economy. We verified this assumption only for the case of Hungary – the assumption that factor intensities can be approximated by factor shares seems to hold there. In general, however, the labour share in non-tradable industries is higher and, moreover, the ratio of labour shares should be higher in the euro area because tradable industries in CESEE are probably more labour-intensive than in the euro area. This effect would tend to reduce the contribution of productivity differentials to inflation differentials. In other words, it is likely that the "true" Balassa-Samuelson effects are lower than those estimated here under the assumption of equal factor intensities.

# 3. Productivity and Inflation in Tradable and Non-tradable Sectors

Table 1 summarises developments in productivity growth and inflation in our sample of five CESEE countries and the euro area from an initial observation in the 1996–98 period to the first quarter of 2008. In line with the Balassa-Samuelson hypothesis, productivity growth was higher in tradable sectors, and relative prices increased faster in non-tradable sectors, in all six economies considered.[6] However, no clear pattern between productivity differentials and relative price differentials seems to emerge at first sight: Latvia, for instance, had the second highest productivity differential and the lowest relative price differential; while Bulgaria had the lowest productivity differential and the highest relative price differential (chart 1).

[6] In the euro area, inflation of non-tradables was only marginally higher than that of tradables.

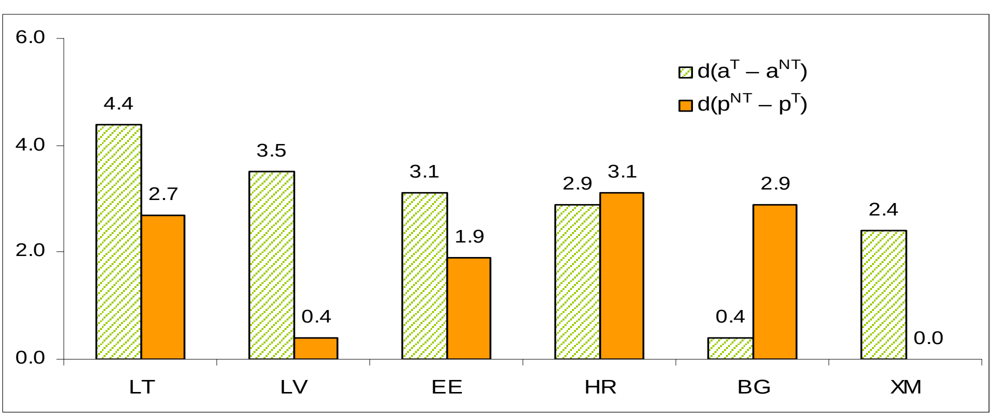
*Table 1: Productivity Growth and Inflation in CEE*[1]

| Country ($t_0$) | Productivity Growth | | | Inflation | | | |
|---|---|---|---|---|---|---|---|
| | $a^T$ | $a^{NT}$ | $a^T - a^{NT}$ [2] | P [3] | $p^T$ | $p^{NT}$ | $p^{NT} - p^T$ [4] |
| Bulgaria (1998:Q2) | 3.3 | 2.9 | 0.4 | 6.8 | 4.7 | 7.6 | 2.9 |
| Croatia (1997:Q1) | 5.2 | 2.3 | 2.9 | 3.4 | 2.8 | 5.9 | 3.1 |
| Estonia (1997:Q1) | 9.0 | 5.9 | 3.1 | 5.1 | 4.2 | 6.1 | 1.9 |
| Latvia (1998:Q2) | 8.8 | 5.3 | 3.5 | 5.0 | 5.1 | 5.5 | 0.4 |
| Lithuania (1996:Q1) | 9.6 | 5.2 | 4.4 | 3.3 | 2.1 | 4.8 | 2.7 |
| ***Average*** | ***7.2*** | ***4.3*** | ***2.9*** | ***4.7*** | ***3.8*** | ***6.0*** | ***2.2*** |
| Euro area (1997:Q1) | 2.8 | 0.4 | 2.4 | 2.0 | 1.9 | 1.9 | 0.0 |

[1] *Four-quarter percentage changes, period averages (initial observation $t_0$ shown in parentheses after the country name). T = tradables; NT = non-tradables. For the composition of tradable and non-tradable industries and price indices see the Appendix.*
[2] *Difference between productivity growth in tradable and non-tradable sectors, in percentage points.*
[3] *Overall CPI inflation.*
[4] *Difference between inflation of non-tradable and tradable components of the CPI, in percentage points.*

*Chart 1: Domestic Productivity Growth and Relative Price Differentials*

*in percentage points, period average*




*Source: Authors' calculations, based on the data described in the Appendix.*

Yet when one looks at country averages, there seems to be strong support for the domestic Balassa-Samuelson hypothesis. More specifically, data in table 1 suggest that the average productivity differential $(a^T - a^{NT})$ (2.9 percentage points), corrected for the share of non-tradables (67%, shown in table 2), accounted for 88% of the sectoral price differential $(p^{NT} - p^T)$ of 2.2 percentage points.

Table 2 summarises developments in productivity and inflation differentials of CESEE countries vis-à-vis the euro area. All countries in the sample recorded higher average annual inflation than the euro area over this period, with the differential ranging from around 1.3 percentage points in Croatia and Lithuania to 4.8 points in Bulgaria. All CESEE countries (with the exception of Bulgaria) also achieved faster productivity growth in tradables vs. non-tradables than did the euro area. The sectoral productivity differential was on average equal to 0.9 percentage point, or 0.3 point when corrected for the share of non-tradables. This suggests that productivity differentials could explain only around 11% of the CESEE countries' average 2.7 percentage points inflation differential vis-à-vis the euro area. On this preliminary evidence, the international Balassa-Samuelson effect appears to be weaker than the domestic effect, which is in line with previous findings in the literature.[7]

As with the domestic Balassa-Samuelson effect, no clear cross-country pattern emerges between the average size of productivity differentials vis-à-vis the euro area on the one hand and inflation differentials on the other (chart 2). The two differentials are of about the same size only in Lithuania. This preliminary evidence suggests that the international Balassa-Samuelson effects might be small.

With the Balassa-Samuelson effect explaining only about one-tenth of inflation differentials vis-à-vis the euro area in this simple accounting framework, it is clear that other factors probably play a more important role in inflationary dynamics in CESEE countries. What these factors are will not be pursued in this paper; for an exhaustive review see Égert (2007). We turn instead to the task of trying to estimate the Balassa-Samuelson effects more precisely in an econometric framework.

[7] Although countries in our sample have fixed (or, in the case of Croatia, tightly managed) exchange rates, only Bulgaria had the fixed exchange rate against the euro for the entire sample period, so changes in the exchange rates do explain a fraction of inflation differentials vis-à-vis the euro area.

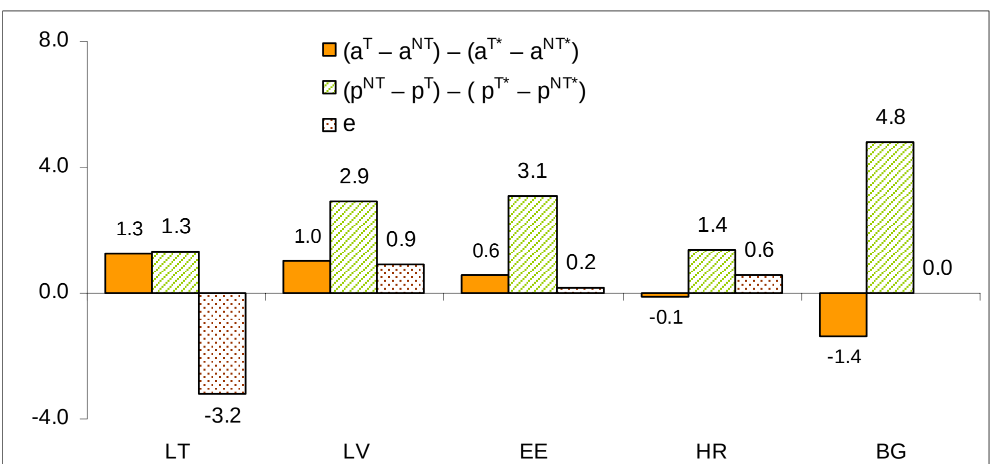
*Table 2: Productivity and Inflation Differentials in CEE vis-à-vis the Euro Area*[1]

| Country ($t_0$) | Inflation Differential $p - p^*$ | Change in Nominal Exchange Rate [2] $E$ | Sectoral Productivity Differential $(a^T - a^{NT})-(a^{T*} - a^{NT*})$ | Share of Non-tradables (%) $(1 - \alpha)$ | Balassa-Samuelson Effect [3] $(1-\alpha)(a^T-a^{NT})- (1-\alpha^*)(a^{T*}-a^{NT*})$ |
|---|---|---|---|---|---|
| Bulgaria (1998:Q2) | 4.8 | 0.0 | –2.0 | 62.7 | –1.4 |
| Croatia (1997:Q1) | 1.4 | 0.6 | 0.5 | 56.5 | –0.1 |
| Estonia (1997:Q1) | 3.1 | 0.2 | 0.7 | 71.0 | 0.6 |
| Latvia (1998:Q2) | 2.9 | 0.9 | 1.1 | 76.9 | 1.0 |
| Lithuania (1996:Q1) | 1.3 | –3.2 | 4.4 | 66.4 | 1.3 |
| ***Average*** | ***2.7*** | ***–0.3*** | ***0.9*** | ***66.7*** | ***0.3*** |
| Euro area (1997:Q1) | … | … | 2.4 | 68.7 | … |

[1] *Four-quarter percentage changes, period averages (initial observation $t_0$ shown in parentheses after the country name).*
[2] *Negative sign denotes appreciation (fewer units of domestic currency per euro), positive depreciation.*
[3] *Contribution of sectoral productivity differentials to the inflation differential vis-à-vis the euro area.*

## *Chart 2: Productivity and Inflation Differentials vis-à-vis the Euro Area*

*in percentage points, period average*




*Source: Authors' calculations, based on the data described in the Appendix.*

# 4. Econometric Estimates of the Balassa-Samuelson Effects

To estimate the two versions of the Balassa-Samuelson effect using time series data, equations (1) and (2) are re-specified as follows:

$$log(CPI/CPI^*)_t = c_1 + \beta_0 log(CPI/CPI^*)_{t-1} + \beta_1 log(E_t/E_{t-1}) + \beta_2[(1-\alpha)\, log(LP^T/LP^{NT})_t - (1-\alpha^*)\, log(LP^{T*}/LP^{NT*})_t] + \varepsilon_t \quad (3)$$

$$log(CPI^{NT}/CPI^T)_t = c_2 + \gamma_0 log(CPI^{NT}/CPI^T)_{t-1} + \gamma_2\, log(LP^T/LP^{NT})_t + \upsilon_t \quad (4)$$

where $c_1$ *and* $c_2$ are constants; "*" denotes variables in the euro area; *CPI* is the index of changes in consumer prices; $CPI^{NT}$ and $CPI^T$ are indices of changes in non-tradable and tradable goods prices; *E* is index of nominal exchange rate changes; $LP^T$ and $LP^{NT}$ are indices of average labour productivity growth in tradable and non-tradable industries; and $\varepsilon_t$ and $\upsilon_t$ are error terms.

These two equations are estimated separately for each CESEE country because we are interested in whether these effects might be a determining factor in the ability of each of these countries to meet the Maastricht inflation criterion. Admittedly, from an econometric perspective, pooling of the data for all countries or for groups of countries based on exchange rate regimes (e. g. , fixed vs floating regimes) or other criteria (eg, geographical region, size of the economy) and estimating panel regressions seems highly attractive. However, in the assessment of the Maastricht criteria, convergence reports are prepared for individual countries, not groups of countries. Moreover, as the results below will show, there is considerable heterogeneity among the countries in our sample, so pooling of the data might bias the estimates and make the interpretation of the results tenuous.

By construction, all regression variables are differenced – all productivity and price indices in equations (3) and (4) show seasonally adjusted, four-quarter percentage changes, and the exchange rate enters the regressions in the form $(E_t/E_{t-1})$. The stationarity of all time series was tested using the augmented Dickey-Fuller test. The results are not shown because of the large volume of test output.[8] The vast majority of time series proved to be stationary in difference form with constant and/or with constant and trend, making it possible to use ordinary least squares to estimate the regression equations. This has significantly simplified the estimation procedure.

A lagged dependent variable is included on the right-hand side in both regressions. One reason is that the Breusch-Godfrey tests pointed to serial correlation of residuals in many regressions. Another is that we wanted to capture persistence in inflation differentials and, at the same time, allow the possibility of partial adjustment of inflation differentials to the changes in explanatory variables.

[8] There would be over 180 test results to report: 12 different time series for 5 countries, each for 3 cases (with constant, trend, constant and trend).

The short-run Balassa-Samuelson elasticity is thus given by the coefficient $\beta_2$, and long-run elasticity by $\beta_2/(1-\beta_0)$.

Standard regression statistics are not reported. The fit of regressions is generally very good (adjusted $R^2$ of 0.90 or higher), and standard test statistics are for the most part satisfactory. Many regressions of equation (4), and some of equation (3), initially had serially correlated residuals, but after applying standard transformations of lagged dependent variables, serial correlation was eliminated from most (though not all) regressions. As with the small number of non-stationary time series, it is highly unlikely that the presence of serial correlation in such a small number of cases could contaminate the estimates.

The estimates of the *international Balassa-Samuelson effects* are shown in table 3. With few exceptions, all estimated parameters have the expected positive sign and are statistically significant at the 5% (or higher) test level. The estimates of the short-run Balassa-Samuelson coefficient $\beta_2$ range from –0.10 (Croatia) to +0.12 (Latvia), and of the long-run coefficient from –1.3 (Croatia) to around 2.4 (Lithuania). On average, the short-run Balassa-Samuelson coefficient is about 0.03 and the long-run coefficient is about 0.65.

*Table 3: Estimates of the International Balassa-Samuelson Effect*

*Dependent Variable: Inflation Differential vis-à-vis the Euro Area*

| **Country (Period yy:q)** | **Explanatory Variables** | | | | **International Balassa-Samuelson Effect**[1] | |
|---|---|---|---|---|---|---|
| | $\log(CPI/CPI^*)_{t-1}$ | $\log(E_t/E_{t-1})$ | $(1-\alpha)_t\log(LP^T/LP^{NT})_t-(1-\alpha^*)_t\log(LP^{T*}/LP^{NT*})_t$ | | **Short-run** | **Long-run** |
| | $\beta_0$ | $\beta_1$ | $\beta_2^{short\ run}$ | $\beta_2^{long\ run}$ | | |
| Bulgaria (98:2–07:3) | 0.796 | … | –0.003 | –0.016 | 0.006 | 0.031 |
| Croatia (98:4–08:1) | 0.923 | 0.127* | –0.102 | –1.317 | 0.013 | 0.165 |
| Estonia(97:1–08:1 | 0.963 | … | 0.058 | 1.583 | 0.035 | 0.947 |
| Latvia(98:4–07:3) | 0.815 | 0.104* | 0.120 | 0.649 | 0.115 | 0.619 |
| Lithuania(96:2–08:1) | 0.963 | –0.097 | 0.086 | 2.352 | 0.170 | 4.628 |
| ***Average*** | ***0.892*** | ***0.045*** | ***0.032*** | ***0.650*** | ***0.068*** | ***1.278*** |

*All estimated coefficients are statistically significant at the 5% (or higher) test level, except for those marked with "*", which are significant at the 10% test level, and those marked with "x", which are not significant.*

[1] *Contribution of sectoral productivity differential to inflation differential vis-à-vis euro area, in percentage points. Calculated as $\beta_2^i$ times the average productivity differential $[(1-\alpha)(LP^T-LP^{NT})-(1-\alpha^*)(LP^{T*}-LP^{NT*})]$ over the period for which the regression is estimated; i denotes short-run and long-run elasticities.*

When these coefficient estimates are multiplied by the actual productivity growth differentials vis-à-vis the euro area $(LP^T–LP^{NT}) – (LP^{T*}–LP^{NT*})$ observed over the sample periods, one obtains the international Balassa-Samuelson effects. The short-run effects were around 0.07 percentage point on average; the long-run effects around 1.3 points on average. According to this calculation, inflation in CESEE countries was on average about 1.3 percentage points higher than in the euro area because productivity growth in tradables vs. non-tradables in these countries was faster than in the euro area. In Lithuania, the estimated long-run international Balassa-Samuelson effect was higher than the 1½ percentage point margin allowed by the Maastricht treaty; in Estonia it was close to 1 percentage point; and in Latvia around 0.6 point. In Croatia, the estimated Balassa-Samuelson effect was below 0.2 percentage point; in Bulgaria, it was very small (0.03 point).

Very high estimates of the international Balassa-Samuelson effect for Lithuania are the result of unusually strong productivity growth in Lithuania's tradable industries. For instance, real output per worker in tradables doubled between Q4:2002 and Q1:2008, while in non-tradables it increased 15% (in the euro area, real output per worker increased 15% in tradables and 3% in non-tradables over the same period). Strong productivity growth in Lithuania's tradables resulted in turn from a 50% increase in real output and a 28% reduction in employment in tradable industries. No other country in the sample recorded such a large increase in output combined with such a large decline in employment.

For Bulgaria and Croatia, the estimates of the coefficient $\beta_2$ for the short-run Balassa-Samuelson effect are negative. This reflects the fact that tradable/non-tradable productivity growth differentials in these countries are lower than in the euro area (see table 2). Nonetheless, when these negative coefficients are multiplied by, on average, negative productivity growth differentials vis-à-vis the euro area $(LP^T–LP^{NT}) – (LP^{T*}–LP^{NT*})$, one obtains positive international Balassa-Samuelson effects for both countries (table 3, last two columns).

All five countries exhibit a very high persistence of inflation differentials vis-à-vis the euro area: estimates of the coefficient $\beta_0$ averaged 0.9 percentage point. Estimates of this coefficient had the lowest standard errors.

Estimates of the pass-through of exchange rate changes to inflation differentials are less satisfactory. For Lithuania, the estimated coefficient was negative and highly significant; and for Croatia and Latvia it was significant at the 10% level only. Bulgaria and Estonia have kept fixed exchange rates against the euro over the sample period, so exchange rates were not included in their regressions. Latvia and Lithuania switched from their pegs to the Special Drawing Rights (SDR) and the US dollar, respectively, closer to 2004, when they joined the EU, so the results for these countries – in particular the negative exchange rate pass-through for Lithuania – are not entirely surprising.

While these results on the whole suggest that the long-run Balassa-Samuelson effects in the Baltics and Southeastern Europe (SEE) might be fairly large, one should not jump to the conclusion that they support claims that the Maastricht inflation criterion needs to be reconsidered. The only country for which the above regression estimates are very robust to small changes in specifications is Lithuania. For all other countries, small changes in initial or final observations, or in the lag structure of explanatory variables, often affected the size and statistical significance of the estimates.

Estimates of the *domestic Balassa-Samuelson effects* are shown in table 4. All estimates of the coefficient $\gamma_2^s$ except one are statistically highly significant. However, the sign of the short-run Balassa-Samuelson coefficient for Latvia and Lithuania is negative, although the size of the coefficient in each case is relatively small. In these two countries, faster productivity growth in tradable vs. non-tradable industries has been associated with a small *decline* in the relative price of non-tradables, contradicting the Balassa-Samuelson hypothesis. In all other countries, the coefficient on relative productivity growth has the expected positive sign; its size ranges from 0.08 (Estonia) to 0.24 (Bulgaria).

Estimates of the coefficient $\gamma_0$ on lagged relative price changes have the expected positive sign and are statistically highly significant. Their fairly large size indicates strong persistence of past relative price changes and also leads to high estimates of the long-run effects of differential productivity growth $\gamma_2^l$.

The contribution of changes in relative productivity differentials $(LP^T–LP^{NT})$ to changes in relative price differentials $(CPI^{NT}/CPI^T)$ is obtained by multiplying the short-run and long-run coefficients $\gamma_2$ with the respective average values of productivity differentials over the sample periods. For the countries with positive Balassa-Samuelson effects – Bulgaria, Croatia and Estonia – these contributions amount to 0.1–0.3 percentage point in the short run and 0.8 to 2.6 points in the long run.

The contribution of relative productivity differentials to relative price differentials can be translated into the contribution to *overall* inflation as follows. Starting from the definition of consumer price inflation as a weighted average of tradable and non-tradable goods price inflation (equation 5):

$$\hat{p}_t = \alpha\hat{p}_t^T + (1-\alpha)\hat{p}_t^{NT} \quad (5)$$

where $\alpha$ is the share of traded goods in the CPI basket, and using the expression for the relative price of non-tradables from equation (2) one obtains equation (6):

$$\hat{p}_t = \hat{p}_t^T + (1-\alpha)(\hat{a}_t^T - \hat{a}_t^{NT}) \quad (6)$$

I. e., the contribution of relative productivity differentials to overall inflation is proportionate to the share of non-tradables $(1–\alpha)$ multiplied by the contribution of relative productivity differentials to relative price differentials. This expression gives estimates of the domestic Balassa-Samuelson effect shown in the last two columns of table 4. For Bulgaria, Croatia and Estonia, the short-run effect amounts up to 0.2 percentage point, and the long-run effect up to 1.8 points. Faster growth of relative prices of non-tradables, resulting from faster growth of productivity in tradable relative to non-tradable industries, may thus have contributed over the long run around 1.8 percentage points to inflation in Estonia, about 0.9 point in Croatia and 0.5 point in Bulgaria. For these three countries, the domestic Balassa-Samuelson effect explains on average 23% of overall domestic CPI inflation of 5.1% over the sample period.

*Table 4: Estimates of the Domestic Balassa-Samuelson Effect*

*Dependent Variable: Domestic Relative Price Differential $P^{NT/}$Portugal*

| **Country (Period yy:q)** | **Explanatory variables** | | | **Contribution of $(LP^T/LP^{NT})$ to $(CPI^{NT}/CPI^T)$** | | **Domestic Balassa-Samuelson effect[2]** | |
|---|---|---|---|---|---|---|---|
| | **$\log(CPI^{NT}/CPI^T)_{t-1}$** | **$\text{Log}(LP^T/LP^{NT})_t$** | | | | | |
| | $\gamma_0$ | $\gamma_2^s$ | $\gamma_2^l$ | **Short-run** | **Long-run** | **Short-run** | **Long-run** |
| Bulgaria (98:2–07:3) | 0.873 | 0.244 | 1.924 | 0.103 | 0.811 | 0.065 | 0.509 |
| Croatia(98:4–08:1) | 0.794 | 0.121 | 0.584 | 0.320 | 1.552 | 0.181 | 0.877 |
| Estonia(97:1–08:1) | 0.877 | 0.077* | 0.628 | 0.315 | 2.561 | 0.223 | 1.814 |
| Latvia(98:4–07:3) | 0.897 | –0.039 | –0.377 | –0.128 | –1.248 | –0.099 | –0.963 |
| Lithuania(96:2–08:1) | 0.965 | –0.036 | –1.023 | –0.156 | –4.481 | –0.103 | –2.975 |
| ***Average*** | ***0.881*** | ***0.074*** | ***0.347*** | ***0.091*** | ***–0.161*** | ***0.053*** | ***–0.147*** |

*All estimated coefficients are significant at the 1% test level, except the one for Estonia marked with "*", which is sgnificant at the 10% test level.*

*[1] Contribution of the sectoral productivity differential ($LP^T$–$LP^{NT}$) to non-tradable/tradable goods inflation, in percentage points. Calculated as $\gamma_2^i$ times the average productivity differential observed over the sample period, where i denotes short-run and long-run elasticities.*

*[2] Contribution of sectoral productivity differential ($LP^T$–$LP^{NT}$) to ($CPI^{NT}/CPI^T$) adjusted for the share of non-tradables ($1-\alpha$); in percentage points. This is a proxy for the contribution of ($LP^T$–$LP^{NT}$) to overall inflation.*

What is the evidence on the size of the *Balassa-Samuelson effect over tim*e?

In the simple accounting framework presented in tables 1 and 2, the results are mixed. If we take the last quarter of 2001 as the mid-point of the sample, the international and domestic Balassa-Samuelson effects declined in the more recent sub-period (from 2002 to Q1:2008) in Bulgaria, Croatia and Latvia; but increased in Estonia and Lithuania (table 5).

The results of econometric estimates are also mixed. For the international effect, the Chow breakpoint test indicated the presence of a structural breakpoint in the series for differential productivity growth $(LP^T–LP^{NT})–(LP^T*–LP^{NT}*)$ only for Croatia (at 2004:Q1) and Lithuania (at 2000:Q1). Evidence on changes in the size of the short-run Balassa-Samuelson coefficient $\beta_2^s$ in the respective sub-periods was mixed. The size of the coefficient declined in the second sub-period (ie, from the breakpoint through 2008:Q1) in Croatia and Lithuania, but did not change in Bulgaria, Estonia and Latvia. These estimates are unreliable, however, because of the short length of the time series and the long time lags (7–10 quarters) with which differential productivity growth affects inflation differentials vis-à-vis the euro area.

For the domestic Balassa-Samuelson effect, the Chow breakpoint test indicated the presence of a structural breakpoint in the $(LP^T/LP^{NT})$ series for all the countries except Latvia. The breakpoints were at 2002:Q1 for Bulgaria, Croatia and Romania; 2003:Q1 for Estonia; and 2001:Q1 for Lithuania. The size of the short-run coefficient $\gamma_2^s$ declined in the second, more-recent sub-period in Bulgaria, Croatia and Estonia, reflecting the slowing of productivity growth in tradables vs. non-tradables in recent years compared with the second half of the 1990s. The coefficient $\gamma_2^s$ increased in the more recent sub-period only in Lithuania. Because of the short length of the time series, these sub-period estimates of the domestic Balassa-Samuelson effects are less reliable than the estimates shown in table 4, though on the whole they are somewhat better than those for the international effect by sub-periods.

*Table 5: Balassa-Samuelson Effect over Time*

| Country | Accounting Framework[1] | | | | Change in Econometric Estimates[2] | |
|---|---|---|---|---|---|---|
| | International BSE | | Domestic BSE | | Internatio-nal BSE | Domestic BSE |
| | $t_0$–2001:Q4 | 2002:Q1–2008:Q1 | $t_0$–2001:Q4 | 2002:Q1–2008:Q1 | | |
| Bulgaria | 0.7 | –2.8 | 0.7 | –2.8 | no Δ | ↓ |
| Croatia | 0.8 | –0.5 | 4.7 | 1.7 | ↓ | ↓ |
| Estonia | –1.4 | 1.9 | 4.2 | 4.7 | no Δ | ↓ |
| Lithuania | –0.5 | 2.7 | 2.1 | 6.2 | ↓ | ↑ |
| Latvia | 2.3 | 0.5 | 4.2 | 2.6 | no Δ | no Δ |

*[1] Based on the historical data summarised in tables 1 and 2.*
*[2] Based on the estimates of regression equations (3) and (4) for two sub-periods of the main mid-1990s–2008:Q1 period (determined for each country by Chow breakpoint tests). The entries indicate no change (no Δ), increase (↑) or decrease (↓) in the estimated Balassa-Samuelson coefficient between the earlier and later periods.*

# 5. Concluding Remarks

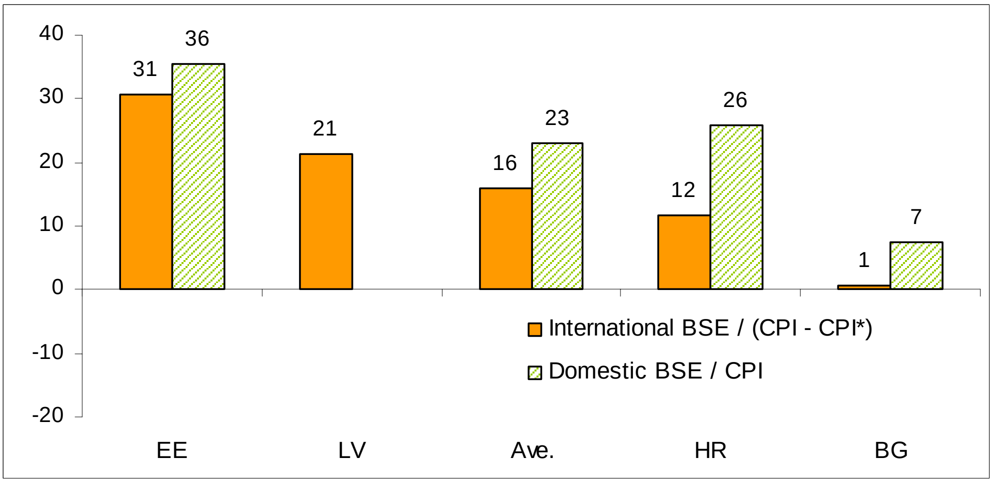
This paper has confirmed the presence of the Balassa-Samuelson effects in three Baltic states, Bulgaria and Croatia in the period since the mid-1990s through the first quarter of 2008. Higher productivity growth in tradable relative to non-tradable industries has contributed to both higher inflation vis-à-vis the euro area (the international Balassa-Samuelson effect) and faster increases in domestic relative prices of non-tradables (the domestic Balassa-Samuelson effect).

As shown in chart 3, for Bulgaria, Croatia, Estonia and Latvia the international effects explain on average around 16% of inflation differentials vis-à-vis the euro area (about 0.4 percentage points on average). For Lithuania, the international Balassa-Samuelson effect is higher than the inflation differential vis-à-vis the euro area; the entry for Lithuania is therefore not shown in chart 3. This result is a consequence of the unusually strong productivity growth in Lithuania discussed above.

The domestic Balassa-Samuelson effects for Bulgaria, Croatia and Estonia explain on average 47% of the domestic relative price differentials of non-tradables vs. tradables, or about 23% of overall domestic CPI inflation (about 1.1 percentage points on average). For Latvia and Lithuania, domestic Balassa-Samuelson effects are negative, i. e., faster productivity growth in tradable vs. non-tradable industries has been associated with a small *decrease* in the relative price of non-tradables and hence overall inflation. For these two countries domestic Balassa-Samuelson effects subtract from rather than add to overall inflation.

For several reasons, estimates of the Balassa-Samuelson effects obtained in this paper are likely to be upward biased. In particular, we used the shares of non-tradables in value added rather than in the consumption basket, and we classified some low-productivity tradable services as non-tradables. Additional control variables such as regulated prices, which are important in non-tradable sectors, might also reduce the Balassa-Samuelson effects compared to the ones estimated in this paper. However, by extending our sample to a larger number of countries and a much longer period; by including the important sector of agriculture in tradables; and especially by using country- and time-specific shares of non-tradables, we have obtained more precise and representative estimates of the Balassa-Samuelson effects than have other available studies.

*Chart 3: Percentage of Inflation Differential vis-à-vis the Euro Area and of Domestic CPI Inflation – Explained by International and Domestic Balassa-Samuelson Effects*




*Source: Authors' calculations, based on the data described in the Appendix.*

Real convergence since the early 2000s seems to have reduced the domestic Balassa-Samuelson effects in several countries and the international effects in somewhat fewer countries. But for several countries, the size of both effects may have increased. Although most of the estimates of the Balassa-Samuelson effects are rather small, these effects cannot be entirely disregarded. Moreover, they can help understand competitiveness issues. More specifically, estimates of the international Balassa-Samuelson effect in table 5 (accounting framework) suggest that Bulgaria, Croatia and Latvia lost competitiveness in recent years, whereas Estonia and Lithuania appear to have maintained it. This contrasts with real exchange rate developments, which suggest that Croatia, Latvia and Lithuania maintained their competitiveness over time, or at least until 2007. Such differences indicate a need to evaluate in more detail alternative measures of competitiveness, not least given the important role external imbalances have played in the Baltic and fixed exchange rate SEE countries in recent years.

As discussed in Mihaljek and Klau (2008), the experience of Slovenia and Slovakia, both of which have relatively strong Balassa-Samuelson effects vis-à-vis the euro area (estimated at 2.0 and 1.7 percentage points, respectively), shows that it is possible to fulfil the Maastricht inflation criterion even if these effects might be higher than the 1½ percentage point margin allowed by the Maastricht treaty. At the same time, it cannot be ruled out that a strong Balassa-Samuelson effect could complicate the policy tradeoffs for some EMU candidate countries. Arguably, Lithuania's strong Balassa-Samuelson effect, estimated at 4.6 percentage points, may have been one of the factors behind the country's unsuccessful bid to join the euro area in 2007. This suggests that the Balassa-Samuelson effects are likely to remain on the policy and research agenda for a while, given that the pace of catching-up is likely to remain uneven across countries seeking to join EMU.

Against this background, one should perhaps caution against attempts to start using estimates of the Balassa-Samuelson effects in policy assessment. Obtaining precise and reliable estimates of these effects is much more difficult than, for instance, obtaining estimates of potential GDP. In particular, measurement errors and room for discretion in transforming the data and applying even the simplest estimating procedures are not negligible. Issues of equal treatment would inevitably arise if one sought to standardise these estimating procedures in practice. Therefore, one would be hard pressed to recommend, in good confidence, an operationalisation of the concept of the Balassa-Samuelson effect for the assessment of the Maastricht inflation criterion.

# Appendix

## Data Description

- Traded goods and services are: agriculture, forestry and hunting; fishing; mining and quarrying; manufacturing.
- Non-traded goods and services are: electricity, gas and water supply; construction; wholesale and retail trade, repair of motor vehicles, personal and household goods; transport, storage and communication; financial intermediation; real estate, renting and business activities.
- Not included are public administration, defence and compulsory social security; education; health and social work; other community, social and personal services; and activities of household.

## Description of Variables

- Quarterly indices of value added growth (in constant prices) from the production-side estimates of GDP. Sectors are aggregated into traded and non-traded using industries' shares in total value added in a given quarter.
- CPI rates of inflation with subcomponents (quarterly averages of monthly rates). The breakdown into traded and non-traded goods and services followed the production-side classification as closely as possible. However, the complete matching of sectors with price indices was not always possible. The subcomponents are aggregated into traded and non-traded goods inflation using their weights in the CPI basket.

- Nominal exchange rates of domestic currency against the euro (quarterly averages of daily rates).
- Employment (total number of workers, quarterly averages of monthly figures) in traded and non-traded goods industries following the above classification. Employment in traded and non-traded sectors obtained from industries' shares in total employment (quarterly averages).

## Data Transformations

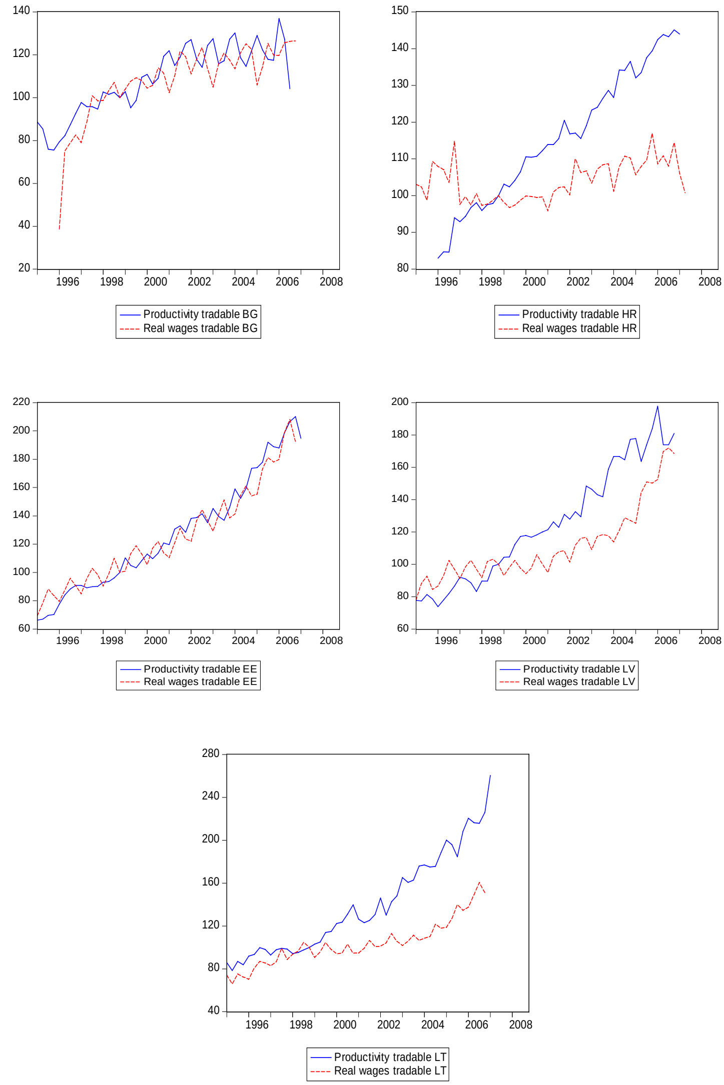
- All variables entering regressions are first expressed in terms of chain indices showing four-quarter percentage changes, with 1999:Q4 = 100.
- For some initial observations in the mid-1990s (sectoral breakdown of value added and employment), quarterly data were linearly interpolated from annual data.
- All indices are then seasonally adjusted using the X-12 procedure.
- Finally, natural logarithms of seasonally adjusted indices are taken.
- These time series are tested for stationarity using the augmented Dickey-Fuller unit root test.

## Data Sources

*Eurostat; national central banks and statistical offices; European Central Bank; BIS Data Bank; BIS staff estimates.*

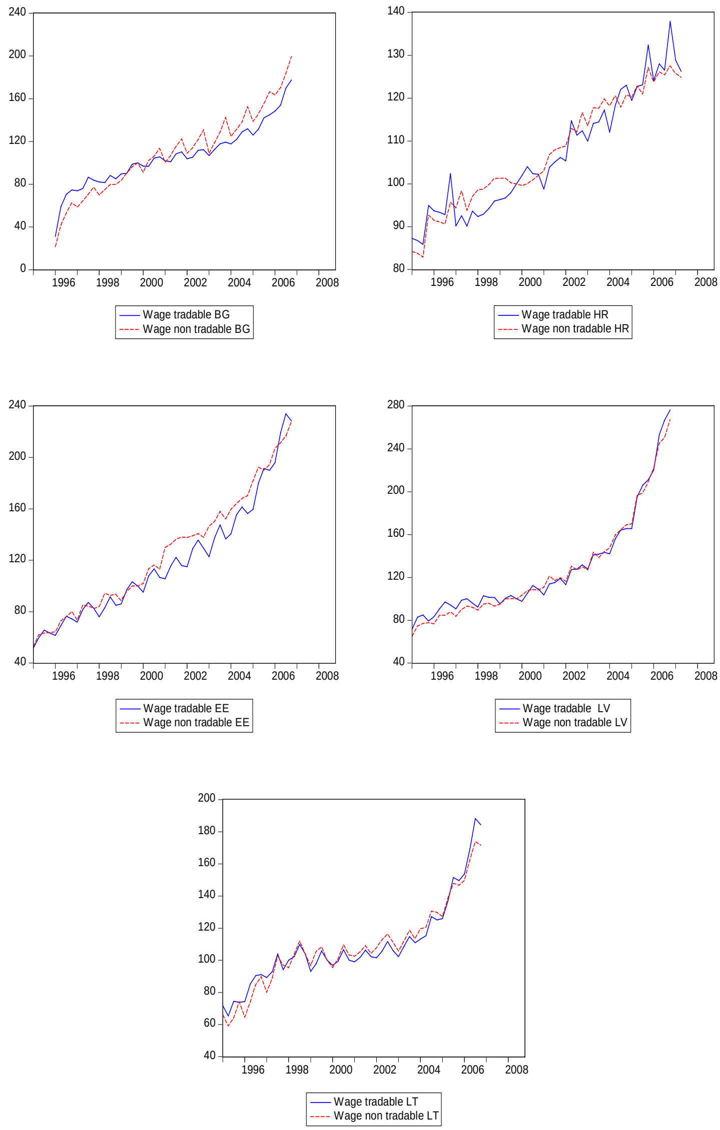
## *Appendix Chart A1: Productivity and Wages in Tradable Industries*

*2000:Q4 = 100; not seasonally adjusted*



## *Appendix Chart A2: Wages in Tradable and Non-tradable Industries*

*2000:Q4 = 100; not seasonally adjusted*



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