COMENIUS UNIVERSITY BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS
Department of Applied Mathematics and Statistics

# The Balassa-Samuelson Effect in the Enlarging EU

MASTER THESIS

Bratislava, 2008 Mária Machová

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Economic and Financial Mathematics

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# Balassa-Samuelsonov efekt v rozširujúcej sa EÚ

DIPLOMOVÁ PRÁCA

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I declare this thesis was written on my own, with the only help provided by my supervisor and the referred-to literature.

Bratislava, April 27, 2008 . . . . . . . . . . .

Mária Machová

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# Abstract

In this thesis we perform an panel data econometric analysis of the Baumol-Bowen and Balassa-Samuelson effects for twenty-four European countries (divided into three groups) vis-á-vis the base country created by aggregation of countries Germany, Austria, Belgium, Netherlands and Luxembourg. The Balassa-Samuelson effect explains differences in inflation rates and real exchange rates by different productivity growth differentials between the tradable and non-tradable sectors among countries. In the econometric study we use fixed effects model with one-way error component. The extended model without the assumption of perfect labor mobility is used. We find the evidence of the Balassa-Samuelson effect being present. With an average value less than half a percent per annum, it is however too small to explain observed inflation differentials between twenty-four European countries and the base country. We thus base our inflation simulations not only on Balassa-Samuelson effect, but also on the other explanatory variables as well.



**Key words:** Baumol-Bowen effect, Balassa-Samuelson effect, panel data, fixed effects model, inflation, real exchange rate, purchasing power parity

# Abstrakt

V diplomovej práci sa zaoberáme ekonometrickou analýzou Baumol-Bowenovho a Balassa-Samuelsonovho efektu v 24 európskych krajinách (rozdelených na tri skupiny) oproti "základnej krajine", ktorá je agregátom Nemecka, Rakúska, Belgicka, Holandska a Luxemburska. Balassa-Samuelsonov efekt vysvetľuje rozdiely v miere inflácie a reálneho výmenného kurzu diferenciálom rastu produktivity medzi obchodovateľným a neobchodovateľným sektorom medzi krajinami navzájom. Tento efekt odhadujeme pomocou "fixed effects" modelu s disturbačným členom prvého rádu pre panelové dáta. Na analýzu je použitý rošírený model, ktorý upúšťa od prepokladu dokonalej mobility pracovnej sily. Existencia Balassa-Samuelsonovho efektu sa potvrdila, ale pri priemernej hodnote menšej ako pol percenta ročne sa tento efekt nejaví postačujúcim pri vysvetľovaní pozorovaných rozdielov inflácií medzi vybranými európskymi krajinami oproti základnej krajine. Preto do našich simulácií inflácie zahrnieme okrem Balassa-Samuelsonovej premennej aj iné vysvetľujúce premenné.



**Kľúčové slová:** Baumol-Bowenov efekt, Balassa-Samuelsonov efekt, panelové dáta, "fixed effects" model, inflácia, reálny výmenný kurz, parita kúpnej sily

# Contents

# Introduction

The Balassa-Samuelson effect explains differences in inflation rates and real exchange rates by different productivity growth differentials between the tradable and non-tradable sectors among countries. This effect has also been discussed for its implications for interpretation for inflation and exchange rate criteria for membership in the Monetary European Union (EMU). If the productivity growth differential between the tradable and non-tradable sectors is larger in the accession countries than in the euro area, the relative price of non-tradable goods is rising faster in the accession countries than in the euro area. If the countries have fixed exchange rate, Balassa-Samuelson effect results in consumer price index inflation and real exchange rate appreciation. Countries with floating exchange rate may experience some combination of nominal appreciation and consumer price index inflation. In order to fulfill the Maastricht inflation criterion the authorities of accession countries need to use very restrictive monetary and fiscal policies, see Mihaljek and Klau (2004).

The evidence of existence of the Balassa-Samuelson effect in the accession countries has been presented in many papers (i.e. Mihaljek and Klau (2004), Wagner and Hlouskova (2004), Jazbec (2002)). In our thesis we follow work of Wagner and Hlouskova (2004).

We derive the extended Baumol-Bowen (domestic version of Balassa-Samuelson model) and Balassa-Samuelson models without the assumption of perfect labor mobility. In our study we examine the assumptions in the standard model like wage homogeneity, purchasing power parity in tradable sector and the presence of demand side effects on the inflation differentials and real exchange rate movements.

In the empirical application, based on the data we have collected, we quantify the Baumol-Bowen and Balassa-Samuelson effect in Western, Eastern and Delta countries (specified in section 3.1) with respect to the base country (aggregate of Germany, Austria, Belgium, The Netherlands and Luxembourg). However these effects are expected to be different in the Eastern than in the Western countries. As expected, the Baumol-Bowen and Balassa-Samuelson effects has been found stronger in the Eastern countries.

We observed the differences between the Balassa-Samuelson model specified in the tradable and non-tradable sector vis-á-vis the model specified with consumer price index based inflation and the corresponding real exchange rate. A better fit is expected in the narrower two-sectoral specification, which has been confirmed by the data.

We find the evidence of the Balassa-Samuelson effect being present. With the average value smaller than half percent it is not sufficient to explain observed inflation differentials between twenty-four European countries and the base country. Thus Balassa-Samuelson effect is not powerful enough for explaining inflation differentials (real exchange rate) movements, other explanatory variables are important to obtain a better fit. Therefore we base our inflation simulations not only on Balassa-Samuelson effect, but also on the other explanatory variables as well. The assumptions and details of our simulations can be found in section 3.3. In 1996–2005 the mean inflation projection is between 1.69% for Cyprus to 8.6% for Romania. The mean prediction for the aggregate inflation of Central and Eastern European Countries is 5.49% and of all twenty-four states 3.08%.

The thesis is organized as follows: Section 1 briefly describes the Baumol-Bowen and Balassa-Samuelson effects and the connection between purchasing power parity and these effects. We discuss the standard and the extended model and summarize some existing studies. In section 2 the econometric methods and tests are presented. In section 3 the data description, estimates of the Baumol-Bowen and Balassa-Samuelson effects and inflation projections for the countries can be found. Section 4 briefly concludes the results. In Appendix the data description tables, definitions of variables and some further results can be found.

# 1 The Balassa-Samuelson model

In this chapter we describe the basics of the Balassa-Samuelson effect, the model itself and the differences between the Baumol-Bowen (BB) and Balassa-Samuelson (BS) effects. We explain the link between the purchasing power parity concept and the BS model. An overview of results from the related literature is presented.

## 1.1 Purchasing power parity

Purchasing power parity (PPP) has been discussed by economists for a long time. We consider a single good. The law of one price applies for a specific good if the price of this good denominated in the same currency is the same in the considered group of countries. If this law would not hold true, there would be a possibility of arbitrage by buying the good cheaper in one country and by selling it for a higher price in another country, aside from transaction and other transportation costs.

When we move from one good to a basket of goods and services, we arrive at the PPP itself. Denoting the exchange rate of the currency of country $i$ to the currency of the base country[1] by $E_{it}$, the price of the basket of goods considered in country $i$ denominated in national currency as $P_{it}$ and $P_t^*$ as the price of the basket of goods of the base country in Euros, then the real exchange rate $Q_{it}$ for the chosen baskets of goods is defined as

$$Q_{it} = E_{it} \frac{P_t^*}{P_{it}} \tag{1.1}$$

or expressed in logarithms, denoted by lower case letters, as

$$q_{it} = e_{it} + p_t^* - p_{it}. \tag{1.2}$$

Throughout, sub-script $i$ stands for country (cross-section) and sub-script $t$ for time. The strong version of PPP, also called the absolute version of PPP states that the real exchange rate is equal to one. Even if the law of one price holds for all goods,

[1] In our application the base country is the aggregate of Germany, Austria, Belgium, Netherlands and Luxembourg, thus $E_{it}$ is given as local currency units per Euro for those countries that do not have Euro as their currency.

the absolute version of PPP is guaranteed to hold only if baskets of goods in different countries have the same shares of goods, which is very unlikely. Some other reasons for the invalidity of strong PPP listed by Wagner (2005) are distribution costs, market imperfections or impediments to trade.

The weak version of PPP, also known as the relative version of PPP, states that PPP holds for a group of countries if $EP^*$ is proportional to $P$, thus the real exchange rate is constant. The Balassa-Samuelson model offers reason why we should not expect PPP to hold in long run.

## 1.2 The Baumol-Bowen and Balassa-Samuelson effect

The standard model inspired by Béla Balassa (1964) and Paul Samuelson (1964) explains movements of the real exchange rate or changes in price levels by sectoral productivity growth differentials across countries. Lets derive the model used in our study following Wagner and Hlouskova (2004). In this model two-sector small open economy is considered, thus the price of tradable goods $P_T$ and the world market interest rate $R$ are taken as given. Production occurs in the tradable and non-tradable sector. We denote the tradable sector with $T$ and the non-tradable with $N$. The firms in both sectors are supposed to be perfectly competitive and profit maximizing. We use for simplification Cobb-Douglas production functions for each sector, thus

$$
\begin{aligned}
Y_T(K_T, L_T) &= A_T K_T^{1-\alpha_T} L_T^{\alpha_T} \\
Y_N(K_N, L_N) &= A_N K_N^{1-\alpha_N} L_N^{\alpha_N}
\end{aligned}
$$

where $Y_i$ denotes the real sectoral output, $A_i > 0$ the sectoral productivity, $K_i > 0$ is the capital used for production in the sector $i$, $L_i > 0$ is the labor used and $\alpha_i \in (0,1)$ is the sectoral labor intensity for $i = T, N$. Profit maximization in each sector with the price of tradable goods taken as numeraire then has the form

$$\max_{K_T,L_T} \quad A_T K_T^{1-\alpha_T} L_T^{\alpha_T} - W_T L_T - R K_T \tag{1.3}$$

$$\max_{K_N,L_N} \quad P_N A_N K_N^{1-\alpha_N} L_N^{\alpha_N} - W_N L_N - R K_N, \tag{1.4}$$

where $W_s$ is denoting wages in sector $s$ for $s = T, N$. From the first order conditions for (1.3) and (1.4) we get

$$R = (1-\alpha_T) A_T \left(\frac{L_T}{K_T}\right)^{\alpha_T} \tag{1.5}$$

$$= (1-\alpha_N) P_N A_N \left(\frac{L_N}{K_N}\right)^{\alpha_N} \tag{1.6}$$

$$W_T = \alpha_T A_T \left(\frac{L_T}{K_T}\right)^{\alpha_T - 1} \tag{1.7}$$

$$W_N = \alpha_N P_N A_N \left(\frac{L_N}{K_N}\right)^{\alpha_N - 1} \tag{1.8}$$

In the model perfect mobility of labor between the two sectors is assumed that implies wage homogeneity between the tradable and non-tradable sectors. If labor is perfectly mobile between the sectors and for some reason wages start to rise only i.e. in non-tradable sector, then some employees from non-tradable sector move to the tradable sector to obtain a better payment, $L_T$ would rise and since $\alpha_T < 1$ it implies decline in wages in tradable sector in (1.8) and this would happen until the wages in both sectors equalize. From sectoral wage equality it follows, that $\frac{R}{W_T} = \frac{R}{W_N}$, thus we obtain

$$\frac{L_T}{K_T} = \frac{\alpha_T}{\alpha_N} \frac{1-\alpha_N}{1-\alpha_T} \frac{L_N}{K_N}. \tag{1.9}$$

Using (1.5), (1.6) and (1.9) we get the relative price of non-tradables to tradables, expressed in logarithms as

$$p^{rel} = \tilde{c}^{2} + \frac{\alpha_N}{\alpha_T} a_T - a_N, \tag{1.10}$$

[2] $\tilde{c} = \alpha_T(\alpha_T - \alpha_N)\, r + \frac{\alpha_N(1-\alpha_T)}{\alpha_T}\, ln(1-\alpha_T) + \alpha_N\,(ln(\alpha_T) - ln(\alpha_N)) - (1-\alpha_N) ln(1-\alpha_N)$

where $p^{rel} = p_N - p_T$ is the logarithm of relative price of non-tradable to tradable goods and services, $\tilde{c}$ is a function of only exogenous variables or coefficients.

We can see that if $\alpha_N = \alpha_T$, (1.10) has the form

$$p^{rel} = a_T - a_N + \tilde{c},$$

thus the relative price of non-tradable to tradable good is directly proportional to the sectoral productivity differential in the country. $\alpha_N$ is supposed to be higher than $\alpha_T$ in transition countries, since the non-tradable sector is more labor intensive than the tradable sector, thus even if the growth of sectoral productivity is the same ($\Delta a_T = \Delta a_N$) this can lead to rising of the relative price of non-tradable goods in (1.10). The above described effect characterized by (1.10) is known as the Baumol-Bowen effect.

The interpretation is that if the productivity in the tradable sector grows faster than in the non-tradable sector $\Delta a_T > \Delta a_N$, wages in the tradable sector are increasing, as can be seen in (1.7). This together with assumption of perfect labor mobility implies a similar rise of wages in the non-tradable sector too, although the productivity growth in the non-tradable sector is by assumption lower than in the tradable sector. If the firms in the non-tradable sector want to remain profitable, this results in higher prices of non-tradables, thus leading to higher inflation in this sector. $\Delta p^{rel}$ is called dual inflation.

Some authors refer to (1.10) as the Balassa-Samuelson effect, although the Baumol-Bowen effect is only a part of the BS effect. The BS effect combines the real exchange rate evolution with the BB effects in the home and foreign country. Henceforth, starred variables denote the foreign country. The aggregate price levels are weighted averages of the sectoral price levels weighted by the expenditure shares noted as $\delta$ for the home country and $\delta^*$ for foreign country. Expressed in logarithms

$$p = (1-\delta)p_T + \delta p_N \tag{1.11}$$

$$p^* = (1-\delta^*)p_T^* + \delta^* p_N^* \tag{1.12}$$

Using the definition of the real exchange rate in (1.2) and the above equations (1.11) and (1.12) we obtain

$$\begin{aligned} q &= (e + p_T^* - p_T) - \delta(p_N - p_T) + \delta^*(p_N^* - p_T^*) && (1.13) \\ &= (e + p_T^* - p_T) - \delta p^{rel} + \delta^* p^{rel*} && (1.14) \end{aligned}$$

If absolute PPP holds in the tradable sector, i.e. $e + p_T^* - p_T = 0$, the real exchange rate is given by

$$\begin{aligned} q &= -\delta p^{rel} + \delta^* p^{rel*} && (1.15) \\ &= c - \delta \left( \frac{\alpha_N}{\alpha_T}\, a_T - a_N \right) + \delta^* \left( \frac{\alpha_N^*}{\alpha_T^*}\, a_T^* - a_N^* \right). && (1.16) \end{aligned}$$

In the last equation we have used the Baumol-Bowen effect as in (1.10). If the expenditure shares are sufficiently similar we can say that if the inter-sectoral productivity growth rate differential in the home country is larger than the productivity growth differential abroad, it leads to an appreciation of the real exchange rate of the home country. This is typically the case in the transition economies, where consequently the Balassa-Samuelson model is often used to explain the appreciation of their real exchange rates.

When using again the definition of the real exchange rate (1.2) in (1.16) and by taking first differences we get

$$\Delta p - \Delta p^* = c + \Delta e + \delta \left( \frac{\alpha_N}{\alpha_T}\, \Delta a_T - \Delta a_N \right) - \delta^* \left( \frac{\alpha_N^*}{\alpha_T^*}\, \Delta a_T^* - \Delta a_N^* \right) \qquad (1.17)$$

thus this model can be used also for explaining the inflation differentials across countries by nominal exchange rate movements and the productivity differentials across countries. In a monetary union or other countries, where the exchange rate is fixed (i.e. $\Delta e = 0$), the BS effect is reflected in inflation differentials across countries.

## 1.3 Extended model

In this section we present the equations for Baumol-Bowen and Balassa-Samuelson model when the assumption of perfect labor mobility is relaxed. Motivation for that relaxation is the fact that employees, who are working in one sector could not work in another sector due to inappropriate qualification or abilities for such work. Hence, the wage process is not present in this case.

We obtain the analogue of (1.10) from the first order conditions for profit maximization (1.5)–(1.8) as

$$p^{rel} = c + \frac{\alpha_N}{\alpha_T}\, a_T - a_N + \alpha_N(w_N - w_T) \tag{1.18}$$

This extended Baumol-Bowen effect can be interpreted similarly as the standard version. Moreover, if wages in tradable sector are higher than in the non-tradable sector, this lowers the pressure on dual inflation.

The extended Balassa-Samuelson model can be derived similarly as the standard model. By inserting the expression of relative prices in (1.14) we obtain

$$\begin{aligned} q = c + (e + p_T^* - p_T) - \delta \left( \frac{\alpha_N}{\alpha_T}\, a_T - a_N + \alpha_N(w_N - w_T) \right) \\ + \delta^* \left( \frac{\alpha_N^*}{\alpha_T^*}\, a_T^* - a_N^* + \alpha_N^*(w_N^* - w_T^*) \right) \end{aligned} \tag{1.19}$$

After using the real exchange rate definition (1.2) and taking the differences without the assumption that absolute PPP holds in the tradable sector, we get the expression for inflation differentials

$$\begin{aligned} \Delta p - \Delta p^* = c + \Delta p_T - \Delta p_T^* + \delta \left( \frac{\alpha_N}{\alpha_T}\, \Delta a_T - \Delta a_N + \alpha_N(w_N - w_T) \right) \\ - \delta^* \left( \frac{\alpha_N^*}{\alpha_T^*}\, \Delta a_T^* - \Delta a_N^* + \alpha_N^*(w_N^* - w_T^*) \right) \end{aligned} \tag{1.20}$$

We derive from the above equations various variables corresponding to the Balassa-Samuelson effect. From (1.16) after setting $\alpha_N = \alpha_T$ and $\alpha_N^* = \alpha_T^*$ we obtain $BS_{it}$. From now on we use the sector specific index as super script and country and time specific indices as sub-scripts[3]. We denote $a_T - a_N$ as $a^{rel}$. $BSE1_{it}$ follows from extended model (1.19). Supposing that expenditure shares in non-tradable sector are the same in the home and foreign country, we obtain $BSE2_{it}$ from $BSE1_{it}$. Later also the differential of relative productivities $\Delta a_{it}^{rel} - \Delta a_{it}^{rel*}$ is used as a Balassa-Samuelson variable. The expenditure shares are computed as the share of real output in the non-tradable sector of the sum of real outputs in the tradable and non-tradable sectors. Finally the definitions of variables representing the Balassa-Samuelson effect used in the application are the following

$$
\begin{aligned}
BS_{it} &= \delta_{it} a_{it}^{rel} - \delta_t^* a_{it}^{rel*} \\
BSE1_{it} &= \delta_{it}(a_{it}^{rel} + \alpha_{it}^N w_{it}^{rel}) - \delta_t^*(a_{it}^{rel*} + \alpha_t^{N*} w_{it}^{rel*}) \\
BSE2_{it} &= (a_{it}^{rel} + \alpha_{it}^N w_{it}^{rel}) - (a_{it}^{rel*} + \alpha_t^{N*} w_{it}^{rel*}).
\end{aligned}
$$

## 1.4 Summary of chosen existing studies

In this section we list briefly some results about the Baumol-Bowen and Balassa-Samuelson effects from the literature.

Balassa (1964) and Samuelson (1964) in their works are using model described in section 1.2. They argue that high-income countries have a grater relative productivity advantage in production of tradable goods, thus they produce such goods relative cheaply. If the law of one price holds true for tradable goods, the relative price of non-tradable goods is lower in low-income countries, implying systematic deviations from PPP even in the long run.

This standard model of Balassa and Samuelson has been extended to allow the absence of absolute PPP in the tradable sector, demand-side determination of the relative price in non-tradables and distinguishing non-market-based prices of non-tradables from market-based prices of non-tradables, as mentioned by Egert et al. (2006).

These authors point out, that the failure of absolute PPP in the tradable sector can be explained by several arguments. One of these is the absence of perfect

[3]When unnecessary we drop these indices.

competition or transportation costs in this sector. Another one is the home bias and market segmentation which plays a role to pricing-to-market. The home consumers may prefer buying the home products more than from foreign country, i.e. the products are not perfectly substitutable. In Benigno and Thoenissen (2003) and Lee and Tang (2003) models the prices in the tradable sectors consisting of the home-produced component $p^H$ and foreign-produced component $p^F$. Taking the shares of tradable goods expenditure allocated to home produced tradable goods as $\beta$, the price index for tradable goods for home country has the form: $p^T = \beta p^H + (1-\beta)p^F$. Denoting the shares of tradable goods expenditure allocated to home produced tradable goods as $\beta^*$ for the foreign country, the price index for tradable goods for foreign country has the form: $p^{T*} = \beta^* p^{H*} + (1-\beta^*)p^{F*}$. Using the equation above and the definition of the real exchange rate in tradable sector as $q^T = e + p^{T*} - p^T$ we obtain

$$q^T = (\beta - \beta^*)(p^F - p^H) + \beta^*(e + p^{H*} - p^H) + (1-\beta^*)(e + p^{F*} - p^F),$$

where the first term $(\beta - \beta^*)(p^F - p^H)$ represents the home-bias. $\beta \neq \beta^*$, since foreign individuals have different tastes towards home-produced tradable goods than home agents. The home bias is defined as a situation where for a common relative price, home consumers consume more home-produced tradable goods than do foreign consumers, thus $\beta > \beta^*$. This can cause real exchange rate to deviate from absolute PPP even if the law of one price holds for all goods.

The importance of other factors for the determination of the relative price of non-tradable goods than only the relative productivity differential has been emphasized by Bergstrand (1991). He provides an empirical evidence that the systematic cross-country relationship between real per capita incomes and national price levels (real exchange rates) can also be attributed partly to a demand-side hypothesis. Assuming non-homothetic tastes, he argues that countries with higher real per capita income face in equilibrium higher demand for non-tradable goods relative to tradable goods, thus rising their relative price. This points out the importance of augmenting the relative price determination with demand variables such as government and private consumption in explaining the non-tradable prices.[4]

From the empirical view Egert et al. (2006) lists two generations of papers according to Balassa-Samuelson effect. In the first generation papers (i.e. Sinn and Reutter (2001), Jazbec (2002)) high presence of BS effect have been found. However, in the second generation papers (i.e. Egert (2002), Mihaljek and Klau (2004), Wagner (2005)) the presence of Balassa-Samuelson effect is found, but the ability of Balassa-Samuelson effect to explain the real exchange rates movements or price differentials is not found as high as in the first generation papers. The main difference in the second generation papers is the finding that relative PPP does not hold in tradable sector. This does not imply that Balassa-Samuelson has small impact on overall real exchange rate movements because BS effect is supposed to explain the difference between the overall inflation-deflated (consumer price index (CPI)) and the tradable goods price based real exchange rate. Hence, if the share of market-based non-tradable prices in the CPI is large enough, the gap between the two exchange rates may be substantial, allowing that BS effect can explain large part of overall exchange rate movements. Hence, another reason for limited explanation of real exchange rate appreciation by BS model is the small ratio of market-based non-tradable goods in the CPI, see Egert et al. (2006).

In some papers (i.e. Lojschova (2003), Wagner and Hlouskova (2004)) the assumption of perfect sectoral labor mobility has been relaxed and the term $w^N - w^T$ has been added in the Balassa-Samuelson variable.[5]

[4] We have experimented with demand variables as the growth of gross domestic product per capita (GDPPC) from the previous period and ratio of government consumption in gross domestic product (GDP) in our empirical study, however this does not bring correct results, thus it was later omitted.

[5] This is also present in our empirical application.

# 2 Econometric methods

In this section we describe the econometric methods used[6].

## 2.1 Econometric analysis of panel data

Panel data are repeated observations for a set of cross-section units. Compared to cross-section or time series data, the usage of panel data allows us to observe some additional aspects and brings some more advantages. For instance Baltagi and Badi (1995), (p. 3-7), lists the following advantages

- individual heterogeneity control
- more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency
- better ability to study the dynamics of adjustment
- better ability to identify and measure effects which could not be analyzed in pure cross-sections or pure time series data
- construction and testing of more complicated behavioral models in comparison with cross-sections or time series.

Furthermore the usage of panel data instead of cross-section or time series data increases the number of observations, which is an advantage in our application with short time series for the Central and Eastern European countries.

We distinguish balanced and unbalanced panels. For balanced panels the number of time series observations is the same for all cross-section members. If a panel is not balanced, it is called unbalanced.

Suppose, that the regression for each country has the form

$$y_{it} = \alpha + X_{it}\beta + u_{it} \qquad i = 1, \ldots, N; t = 1, \ldots, T \tag{2.1}$$

[6] Random effects model is not used in our application. It is stated to demonstrate the difference with fixed effects model.

where $\alpha$ is scalar, $y_{it}, u_{it} \in \mathbb{R}^{NT}$, $\beta \in \mathbb{R}^K$ and $X_{it} \in \mathbb{R}^{1\times K}$. In our application we consider the disturbances in the one-way error component model

$$u_{it} = \mu_i + \varepsilon_{it}$$

with $\mu_i$ standing for the potentially unobservable individual effect and $\varepsilon_{it}$ the idiosyncratic disturbance.

When we rewrite (2.1) in vector form for all countries $i = 1, \ldots, N$, we get

$$y = \alpha\iota_{NT} + X\beta + u \tag{2.2}$$

where $\alpha \in \mathbb{R}$, $y$, $u \in \mathbb{R}^{NT}$, $\beta \in \mathbb{R}^K$, $X \in \mathbb{R}^{NT\times K}$ and $\iota_{NT}$ is the column vector of ones with dimension $NT$. For simplicity throughout this section we consider $X$ to be non-stochastic and of full column rank.[7] Substituting $Z = [\iota_{NT}, X]$, $\delta = (\alpha, \beta)'$ and $u = Z_\mu\mu + \varepsilon$ with $Z_\mu = I_N \otimes \iota_T$ where $\otimes$ is the Kronecker product and $\mu = (\mu_1, \ldots, \mu_N)'$ into (2.2) we obtain

$$y = Z\delta + Z_\mu\mu + \varepsilon \tag{2.3}$$

The individual effects $\mu_i$ can be assumed to be either constant or random variables. According to this we distinguish the fixed effects model, where the parameters $\mu_i$ are considered to be constant and the random effects model with stochastic $\mu_i$.

## 2.2 Fixed effects model

In the fixed effects model the $\mu_i$ are assumed to be fixed and are estimated as individual specific intercepts, with only $\varepsilon_{it}$ remaining as disturbance term. We suppose that the $\varepsilon_{it}$ are independent and identically distributed and as mentioned

[7] The discussed methods have wider applicability but focusing in the description on the simplified set-up of non-stochastic regressors helps us to keep the description short. When necessary we comment in the empirical section upon potential deviations from the illustrative set-up discussed in this section.

we assume a non-stochastic regressor matrix $X$ with full column rank,

$$E[\varepsilon_{it}] = 0 \tag{2.4}$$

$$E[\varepsilon_{it}\varepsilon_{js}] = \begin{cases} \sigma_\varepsilon^2 & \text{for i=j, t=s} \\ 0 & \text{otherwise.} \end{cases} \tag{2.5}$$

If we use ordinary least squares (OLS) to estimate (2.3), the dimension of the matrix to be inverted is potentially huge in case of a large cross-sectional dimension. To avoid this problem we can use instead some properties of projection matrices. $P = Z_\mu(Z_\mu' Z_\mu)^{-1} Z_\mu'$ is a projection matrix on the space spanned by $Z_\mu$ with the form $P = I_N \otimes \tilde{J}_T$ where $I_N$ is the identity matrix of dimension $N$ and $\tilde{J}_T$ is a $T \times T$ dimensional matrix with all elements equal to $\frac{1}{T}$ . $Pu$ is a vector of average disturbances over time for each country. $Q = I_{NT} - P$ is a projection matrix on the orthogonal space of $Z_\mu$, i.e. the typical element of $Qu$ has the form $u_{it} - \bar{u}_i$. By substituting the disturbance term in (2.2) and multiplying (2.2) in the fixed effects case by $Q$ we obtain

$$\begin{aligned} Qy &= \alpha Q\iota_{NT} + QX\beta + QZ_\mu\mu + Q\varepsilon \\ &= QZ\beta + Q\varepsilon \end{aligned} \tag{2.6}$$

since $QZ_\mu = Q\iota_{NT} = 0$. Briefly, $Q$ removes the individual effects from the regression. We can now use OLS estimation for $\beta$ without computational difficulties irrespective of the cross-section dimension. The OLS estimator for $\beta$ in (2.6) is simply given by

$$\hat{\beta} = (X'QX)^{-1}X'Qy.$$

This estimator is also called least-squares dummy variable (LSDV) or within-group estimator. For the separate identification of $\alpha$ and $\mu$ we need one more assumption, e.g. $\Sigma_{i=1}^N \mu_i = 0$. If we return to the regression for the individual countries

$$y_{it} = \alpha + \beta x_{it} + \mu_i + \varepsilon_{it} \tag{2.7}$$

and take the averages over time as $\bar{y}_i = \Sigma_{i=1}^{T} y_{it}/T$, $\bar{x}_i = \Sigma_{i=1}^{T} x_{it}/T$ and $\bar{\varepsilon}_i = \Sigma_{i=1}^{T} \varepsilon_{it}/T$ we obtain

$$\bar{y}_i = \alpha + \beta \bar{x}_i + \mu_i + \bar{\varepsilon}_i. \tag{2.8}$$

Subtracting (2.8) from (2.7) we get

$$y_{it} - \bar{y}_i = \beta(x_{it} - \bar{x}_i) + (\varepsilon_{it} - \bar{\varepsilon}_i), \tag{2.9}$$

By defining the averages across all observations as $\bar{y} = \Sigma_{i=1}^{N} \Sigma_{j=1}^{T} y_{ij}/NT$, $\bar{x} = \Sigma_{i=1}^{N} \Sigma_{j=1}^{T} x_{ij}/NT$ and $\bar{\varepsilon} = \Sigma_{i=1}^{N} \Sigma_{j=1}^{T} \varepsilon_{ij}/NT$ we obtain

$$\bar{y} = \alpha + \beta \bar{x} + \bar{\varepsilon} \tag{2.10}$$

if the assumption $\sum_{i=0}^{N} \mu_i = 0$ is applied. Under this assumption $\alpha$ can be estimated from (2.10) as $\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}$. Then we can compute $\hat{\mu_i}$ from (2.8) as $\mu_i = \bar{y}_i - \hat{\alpha} - \hat{\beta}\bar{x}_i$. Under the stated assumptions $\hat{\beta}$ is the best linear unbiased estimator (BLUE). Under quite general sets of assumptions for $T \to \infty$ and N fixed the estimators for $\alpha$, $\mu$, $\beta$ are all consistent. If T is fixed and $N \to \infty$, the estimator of $\beta$ is still consistent, but the estimators of the individual effects $\alpha + \mu_i$ are not consistent, since the number of these parameters increases as $N$ increases, but the number of observations to estimate each fixed effect stays fixed, see Baltagi and Badi (1995), (p.12).

## 2.3 Random effects model

In the random effects model $\mu_i$ is not anymore fixed but random. Suppose that $\mu_i$, $\varepsilon_{it}$ are independent and identically distributed. Moreover we assume as before that

$X$ is non-stochastic with full column rank,

$$E[\mu_i] = E[\varepsilon_{it}] = 0 \tag{2.11}$$

$$E[\mu_i \mu_j] = \begin{cases} \sigma_\mu^2 & \text{for} \quad i = j \\ 0 & \text{for} \quad i \neq j \end{cases} \tag{2.12}$$

$$E[\varepsilon_{it} \varepsilon_{js}] = \begin{cases} \sigma_\varepsilon^2 & \text{for} \quad i = j, t = s \\ 0 & \text{otherwise} \end{cases} \tag{2.13}$$

$$E[\mu_i \varepsilon_{jt}] = 0. \tag{2.14}$$

The variance-covariance matrix of $u$ then looks like

$$\Omega = E[uu'] = \sigma_\mu^2 (I_N \otimes J_T) + \sigma_\varepsilon^2 (I_N \otimes I_T)$$

where $J_T$ is the square matrix of ones of dimension $T$. In order to obtain the generalized least squares (GLS) estimator, we need $\Omega^{-1}$. Using the spectral decomposition like Baltagi and Badi (1995), (p.14) we get

$$\Omega^{-1} = \frac{1}{\tilde{\sigma}^2} P + \frac{1}{\sigma_\mu^2} Q \tag{2.15}$$

$$\Omega^{-1/2} = \frac{1}{\tilde{\sigma}} P + \frac{1}{\sigma_\mu} Q \tag{2.16}$$

where $\tilde{\sigma}^2 = T\sigma_\mu^2 + \sigma_\varepsilon^2$. Due to the special form of $\Omega$, GLS can be applied for estimation and feasible GLS estimators are readily available.

## 2.4 Poolability of the data

Since we are working with a data set comprising several countries, the question arises whether the data can be pooled or estimation has to be performed separately on sub-groups or even country specifically. Suppose the first group includes $N_1$ and the second $N_2$ countries. Consider for both sub-groups of countries the regression

$$y_i = (\alpha + \mu_i)\iota_{N_i T} + X_i \beta_i + \varepsilon_i \quad \text{for} \quad i = 1, 2$$

where $\alpha$, $\mu_i \in \mathbb{R}$, $y_i$, $\varepsilon_i \in \mathbb{R}^{N_iT}$, $X_i \in \mathbb{R}^{N_iT\times K}$, $\beta_i \in \mathbb{R}^K$. We assume $\Omega = E[\varepsilon\varepsilon'] = diag\{\Omega_1,\ldots,\Omega_N\}$ with $\Omega_i = \sigma_i^2 I_T$. Stacking the above regressions we obtain

$$y = \alpha\iota_{NT} + Z_\mu\mu + X\beta + \varepsilon$$

where

$$y = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} \quad X = \begin{pmatrix} X_1 & 0 \\ 0 & X_2 \end{pmatrix} \quad \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix} \quad \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix}$$

We want to test the hypothesis $H_0 : \beta_1 = \beta_2$. Under this hypothesis we have the restricted model in the form

$$y = \alpha\iota_{NT} + Z_\mu\mu + X^*\beta^* + \varepsilon, \tag{2.17}$$

where

$$X^{*'} = (X_1', X_2')$$

Consider the fixed effects model which we transform in order to eliminate heteroscedasticity. If we premultiply the model by $\Omega^{-1/2}$ and use the tilde notation for the transformed variables we have

$$\tilde{y} = \alpha\,\Omega^{-1/2} + \tilde{Z}_\mu\mu + \tilde{X}\beta + \tilde{\varepsilon} \tag{2.18}$$

with $\tilde{y} = \Omega^{-1/2}y$, $\tilde{Z}_\mu = \Omega^{-1/2}Z_\mu$, $\tilde{X} = \Omega^{-1/2}X$, $\tilde{\varepsilon} = \Omega^{-1/2}\varepsilon$ for the unrestricted model and

$$\tilde{y} = \alpha\,\Omega^{-1/2} + \tilde{Z}_\mu\mu + \tilde{X}^*\beta^* + \tilde{\varepsilon} \tag{2.19}$$

with

$$\tilde{X^*} = \Omega^{-1/2}X^*$$

for the restricted one. Moreover

$$Var(\tilde{\varepsilon}) = Var(\Omega^{-1/2}\varepsilon) = (\Omega^{-1/2})Var(\varepsilon)(\Omega^{-1/2})' = (\Omega^{-1/2})\;\Omega\;(\Omega^{-1/2})' = \sigma^2 I_{NT}.$$

Under the assumptions stated and the additional assumption of normally distributed errors, we can use the F test for testing $H_0 : \beta_1 = \beta_2$. The test statistics has the form

$$
\begin{aligned}
F &= \frac{(\tilde{e}^{*'}\tilde{e}^{*} - \tilde{e}_1^{'}\tilde{e}_1 - \tilde{e}_2^{'}\tilde{e}_2)/K}{(\tilde{e}_1^{'}\tilde{e}_1 + \tilde{e}_2^{'}\tilde{e}_2)/((N_1+N_2)T-2K)} \\
&= \frac{(e^{*'}\Omega e^{*} - e_1^{'}\Omega e_1 - e_2^{'}\Omega e_2)/K}{(e_1^{'}\Omega e_1 + e_2^{'}\Omega e_2)/((N_1+N_2)T-2K)} \qquad (2.20) \\
&\sim F_{K,(N_1+N_2)T-2K}
\end{aligned}
$$

where $\tilde{e_i}^{'}\tilde{e_i}$ is the residual sum of squares (RSS) from OLS estimation of (2.18) and $\tilde{e}^{*'}\tilde{e}^{*}$ the RSS of the pooled OLS estimation (2.19) and $e^*$ is the vector of residuals from (2.17). If the null hypothesis cannot be rejected, we can pool the data and do not need to estimate the parameters for the sub-groups.

In the above discussion we have considered $\Omega$ as known, however in most practical applications $\Omega$ has to be estimated. Therefore the form of $\Omega$ is used to compute the parameters estimations. Using the consistent estimators of $\sigma_i^2$ for $i = 1, \ldots, N$ is then used for the composition of $\hat{\Omega}$ using the Cholesky decomposition. More details for this proposition can be found in Baltagi and Badi (1995), (p. 49-50).

The test statistics with estimated $\hat{\Omega}$ instead of known $\Omega$ multiplied by $K$ has $\chi_K^2$ ditribution.

$$
\hat{F} = \frac{e^{*'}\hat{\Omega}e^{*} - e_1^{'}\hat{\Omega}e_1 - e_2^{'}\hat{\Omega}e_2}{(e_1^{'}\hat{\Omega}e_1 + e_2^{'}\hat{\Omega}e_2)/((N_1+N_2)T-2K)} \sim^{ass} \chi_K \qquad (2.21)
$$

# 3 Empirical part

In this section we present the empirical results. At the beginning we describe the data and the sectoral classification. Later in the chapter the description follows how we have found the presence of mechanism needed for the Baumol-Bowen and Balassa-Samuelson effects. Afterwards the equations used in the estimations are presented with the estimations of the Baumol-Bowen and Balassa-Samuelson effects. Finally we present the inflation simulations.

## 3.1 Data description

The application is for twenty-four European countries (EU24)[8]. These are divided into three groups named as "East", "Delta" and "West"[9].

The Eastern group consists of Cyprus (CY), Czech Republic (CZ), Estonia (EE), Croatia (HR), Hungary (HU), Lithuania (LT), Latvia (LV), Slovakia (SK), Slovenia (SL) and Poland (PL).

The Delta group includes Bulgaria (BG) and Romania (RO). Although these two countries with the others in the Eastern group belong to Central and Eastern European Countries (CEECs), they behave differently experiencing much higher inflation differentials than in Eastern countries. They also have small differential of the relative productivity growth rates vis-á-vis the base country. This effect can be seen in Figure 2. Later on in this chapter under CEECs we will mean all states in Eastern and Delta group.

The Western group consists of Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Portugal (PT), Sweden (SE), United Kingdom (UK), Norway (NO) and Switzerland (CH).

The "base" country (BC) is an aggregate of five countries, namely Germany, Austria, Belgium, The Netherlands and Luxembourg. The list of countries abrevi-

[8]Note, that not all of these countries are members of the European Union, the abbreviation is used for simplification.

[9]In the text we also use naming "Eastern" and "Western" countries for East and West groups, although it does not correspond to the geographical location in all cases. Later on these names are used without quotation marks.

ations can be found in Appendix in the Table 14. The data used are annual and the sample period is 1988–2005 for West group and base country, and 1995–2005 for East and Delta group.

| Country | $\Delta a^T$ | $\Delta a^N$ | $\Delta p^T$ | $\Delta p^N$ | $\Delta p^{AGR}$ | $\Delta p^{PUB}$ | Sectoral output shares T | N | AGR | PUB |
|---|---|---|---|---|---|---|---|---|---|---|
| Averages over 1996–2005 | | | | | | | | | | |
| BG | 2.80 | -0.31 | 36.26 | 37.76 | 27.98 | 39.31 | 0.24 | 0.40 | 0.26 | 0.11 |
| CY | 3.06 | 1.35 | 2.67 | 2.24 | 1.30 | 4.47 | 0.13 | 0.62 | 0.04 | 0.21 |
| CZ | 4.76 | 2.37 | 2.84 | 4.54 | 0.34 | 8.13 | 0.34 | 0.48 | 0.04 | 0.14 |
| EE | 9.14 | 7.12 | 5.29 | 7.22 | 7.19 | 8.47 | 0.24 | 0.54 | 0.06 | 0.17 |
| HR | 5.58 | 5.11 | 2.61 | 4.46 | 3.66 | 8.60 | 0.28 | 0.47 | 0.09 | 0.16 |
| HU | 5.22 | 1.57 | 8.18 | 9.48 | 2.46 | 11.83 | 0.28 | 0.46 | 0.07 | 0.19 |
| LT | 9.00 | 5.00 | 3.14 | 4.81 | 1.55 | 5.50 | 0.27 | 0.47 | 0.10 | 0.16 |
| LV | 7.20 | 5.53 | 2.33 | 6.90 | 1.87 | 8.55 | 0.24 | 0.51 | 0.07 | 0.17 |
| SK | 7.43 | -0.47 | 1.80 | 8.13 | 0.69 | 6.60 | 0.34 | 0.44 | 0.06 | 0.17 |
| SL | 6.24 | 2.18 | 5.34 | 7.09 | 5.06 | 7.02 | 0.31 | 0.46 | 0.04 | 0.20 |
| PL | 5.41 | 4.63 | 4.33 | 7.81 | 3.70 | 8.84 | 0.30 | 0.47 | 0.07 | 0.17 |
| RO | 5.18 | 3.67 | 31.84 | 35.94 | 29.78 | 37.38 | 0.35 | 0.36 | 0.18 | 0.10 |
| DK | 3.05 | 1.19 | 2.78 | 1.64 | -6.79 | 3.00 | 0.19 | 0.52 | 0.03 | 0.26 |
| ES | 0.44 | -0.93 | 1.66 | 3.82 | 0.96 | 3.21 | 0.22 | 0.52 | 0.05 | 0.21 |
| FI | 5.50 | 1.06 | -2.42 | 1.96 | 0.04 | 2.99 | 0.32 | 0.44 | 0.04 | 0.20 |
| FR | 3.64 | 0.68 | -1.33 | 1.92 | -1.15 | 2.77 | 0.20 | 0.54 | 0.03 | 0.23 |
| GR | 3.66 | 1.82 | 2.06 | 3.06 | 1.47 | 4.67 | 0.15 | 0.58 | 0.08 | 0.19 |
| IE | 7.39 | 1.33 | 1.78 | 5.94 | 1.79 | 7.47 | 0.37 | 0.42 | 0.05 | 0.16 |
| IT | -0.05 | -0.34 | 3.44 | 3.94 | 0.16 | 4.19 | 0.23 | 0.54 | 0.03 | 0.20 |
| PT | 2.09 | 0.92 | 1.24 | 2.83 | -0.45 | 5.29 | 0.23 | 0.52 | 0.05 | 0.21 |
| SE | 5.85 | 1.51 | -1.96 | 1.57 | -4.84 | 3.93 | 0.29 | 0.46 | 0.02 | 0.22 |
| UK | 3.11 | 2.67 | 1.30 | 2.34 | -2.35 | 4.10 | 0.23 | 0.56 | 0.02 | 0.20 |
| NO | 2.63 | 2.12 | 8.37 | 2.38 | -0.57 | 4.66 | 0.28 | 0.48 | 0.03 | 0.22 |
| CH | 2.44 | 1.26 | -0.19 | 0.77 | -1.55 | 0.87 | 0.23 | 0.50 | 0.02 | 0.25 |
| BC | 3.01 | 0.94 | -0.05 | 0.39 | -2.50 | 1.04 | 0.24 | 0.52 | 0.02 | 0.22 |

Table 1: Sectoral productivity growth rates, sectoral inflation rates and sectoral output shares. Average annual growth rates over the period 1996–2005.

For the sectoral classification we used the General Industrial Classification of Economic Activities (NACE). Our tradable sector consists of mining and quarrying (C), manufacturing (D), electricity gas and water supply (E). We are considering sectors between construction (F) and real estate and business activities (K) as non-tradable sector. We aggregate NACE sectors A and B to agriculture (AGR) and sectors L to P to public sector (PUB). For more detailed structure see Table 15 in Appendix. The data sources can be found in Appendix in Table 17, the data transformations for the empirical study are available in Table 18. The formulas used for the aggregation of the variables for the base country are listed in Table 19.

With the choosen clasification of the tradable and non-tradable sectors [10], about 65% to 83%[11]of economy is taken into account as can be found in the right part of Table 1. Thats why we specify two different price indices and measures of the real exchange rate for the empirical equations, like Wagner and Hlouskova (2004) do. The first price differential is given by $p_{it}^{CPI} - p_t^{CPI*}$, i.e. by calculating the logarithmic difference of the consumer price indices (CPI). As the second price differential we take $p_{it}^{T+N} - p_t^{(T+N)*}$, thus the logarithmic price differentials in two sectors, tradable and non-tradable. The same is done for the real exchange rate by specifying $q_{it} = e_{it} + p_t^{CPI*} - p_{it}^{CPI}$ for the whole economy and $q_{2,it} = e_{it} + p_t^{(T+N)*} - p_{it}^{T+N}$ for the two-sector economy. Based on these different dependent variables we estimate two sets of equations with the wider and narrower sectoral specification. Hence, we could observe how the composition of the sectors influences the estimation outputs.

Average sectoral productivity growth rates, sectoral inflation rates and sectoral output shares over the periods 1996–2005 and 2001–2005 can be found in Table 1 and Table 2 respectively. In the period 1996–2005 the productivity growth rate in tradable sector was higher than that in non-tradable sector ($\Delta a^T > \Delta a^N$) for all countries. In the period 2001–2005 $\Delta a^T - \Delta a^N$ was negative for Estonia (-0.18%), Croatia (-2.14%), Romania (-1.64%) in CEECs and for Italy (-0.15%), Portugal (-0.01%) in the Western countries. The difference between the productivity growth rates in tradable and non-tradable sectors in CEECs is in both periods highest for Slovakia (7.9% in the period 1996–2005 and 11.98% in the period 2001–2005). In Western countries it is highest for Ireland (6.05% in period 1996–2005 and 4.78% in period 2001–2005).

[10]When considering only the tradble and non-tradable sector it is also called narrowed version BS effect.

[11]The smallest percentage in both periods is for BG (64% in the period 1996–2005 and 65% in in the period 2001–2005.) and greatest for CZ (82% in the period 1996–2005 and 83% in in the period 2001–2005).

| Country | $\Delta a^T$ | $\Delta a^N$ | $\Delta p^T$ | $\Delta p^N$ | $\Delta p^{AGR}$ | $\Delta p^{PUB}$ | Sectoral output shares T | N | AGR | PUB |
|---|---|---|---|---|---|---|---|---|---|---|
| Averages over 2001–2005 | | | | | | | | | | |
| BG | 4.09 | 2.31 | 2.76 | 4.42 | 0.52 | 4.68 | 0.24 | 0.41 | 0.24 | 0.11 |
| CY | 1.89 | -0.02 | 2.46 | 1.82 | 1.54 | 4.29 | 0.12 | 0.63 | 0.04 | 0.21 |
| CZ | 5.15 | 3.24 | 1.05 | 1.81 | -2.83 | 6.35 | 0.34 | 0.48 | 0.04 | 0.13 |
| EE | 8.06 | 8.24 | 1.76 | 3.19 | 6.60 | 7.75 | 0.25 | 0.55 | 0.04 | 0.16 |
| HR | 5.09 | 7.23 | 2.92 | 4.06 | 3.03 | 4.89 | 0.28 | 0.49 | 0.08 | 0.15 |
| HU | 4.98 | 3.05 | 5.13 | 5.51 | -3.70 | 8.91 | 0.28 | 0.46 | 0.08 | 0.19 |
| LT | 9.68 | 4.43 | 1.65 | 1.90 | 0.57 | 2.17 | 0.29 | 0.48 | 0.08 | 0.15 |
| LV | 8.32 | 6.12 | 3.44 | 4.45 | 5.67 | 6.77 | 0.24 | 0.54 | 0.07 | 0.16 |
| SK | 10.08 | -1.90 | -0.86 | 8.40 | -2.53 | 8.07 | 0.35 | 0.42 | 0.06 | 0.16 |
| SL | 5.26 | 1.57 | 3.62 | 5.99 | 3.85 | 5.54 | 0.32 | 0.45 | 0.03 | 0.20 |
| PL | 4.60 | 3.16 | 1.91 | 2.03 | 1.12 | 4.50 | 0.30 | 0.47 | 0.07 | 0.16 |
| RO | 3.89 | 5.53 | 18.61 | 18.67 | 16.30 | 23.29 | 0.35 | 0.37 | 0.18 | 0.10 |
| DK | 2.54 | 0.82 | 2.28 | 2.34 | -10.30 | 3.31 | 0.19 | 0.53 | 0.03 | 0.25 |
| ES | 0.14 | -0.40 | 2.48 | 4.71 | 3.33 | 3.73 | 0.21 | 0.53 | 0.05 | 0.21 |
| FI | 5.14 | 0.91 | -2.56 | 1.68 | -0.68 | 4.51 | 0.34 | 0.44 | 0.03 | 0.19 |
| FR | 3.19 | 0.80 | -1.37 | 2.54 | -0.25 | 3.10 | 0.20 | 0.54 | 0.03 | 0.23 |
| GR | 4.01 | 1.12 | 3.84 | 3.37 | 3.14 | 4.66 | 0.15 | 0.59 | 0.07 | 0.19 |
| IE | 6.50 | 1.72 | -0.25 | 4.88 | 5.06 | 9.40 | 0.39 | 0.42 | 0.04 | 0.15 |
| IT | -0.97 | -0.82 | 2.40 | 3.29 | -0.61 | 3.36 | 0.22 | 0.55 | 0.03 | 0.20 |
| PT | 0.60 | 0.61 | 1.87 | 2.78 | -0.62 | 4.45 | 0.22 | 0.53 | 0.04 | 0.21 |
| SE | 5.40 | 1.70 | -1.17 | 1.45 | -6.91 | 3.58 | 0.30 | 0.46 | 0.02 | 0.22 |
| UK | 3.79 | 2.13 | 1.68 | 2.66 | 2.88 | 4.00 | 0.21 | 0.58 | 0.01 | 0.19 |
| NO | 2.94 | 2.16 | 4.90 | 2.66 | -3.59 | 4.62 | 0.28 | 0.49 | 0.03 | 0.21 |
| CH | 2.70 | -0.09 | 0.21 | 1.14 | -0.92 | 1.19 | 0.23 | 0.50 | 0.02 | 0.26 |
| BC | 2.75 | 1.07 | 0.89 | 1.33 | -3.20 | 1.69 | 0.24 | 0.53 | 0.02 | 0.22 |

Table 2: Sectoral productivity growth rates, sectoral inflation rates and sectoral output shares. Average annual growth rates over the period 2001–2005.

Dual inflation ($\Delta p^N - \Delta p^T$) is positive for all CEECs in both periods except for Cyprus (-0.43% for 1996-2005). For Western countries the dual inflation is negative for Denmark (-1.14%) and Norway (-5.99%) in the period 1996-2005 and in the period 2001–2005 it is negative for Greece (-0.05%) and Norway (-2.25%). Dual inflation for CEECs is the largest one (in both periods) for Slovakia (6.33% in 1996-2005 and 9.26% in 2001–2005) and for Western countries it is largest for Finland (4.38% in 1996-2005) and for Ireland (6.13% in 2001-2005). Regarding inflation rates in the agriculture and the public sector, we observe that $\Delta p^{AGR} < \Delta p^{PUB}$ for all

Western and Eastern countries. Bulgaria, Hungary, Slovakia, Slovenia and Romania experience the highest inflation in the non-tradable sector and Estonia, Lithuania, Latvia and Poland have the highest inflation for the agriculture sector.

Briefly, the productivity growth differentials between the tradable and non-tradable sector and dual inflation are present in most countries, thus the base for Baumol-Bowen effect is observable.

In Figure 3 and Figure 4, which can be found in Appendix, we present the above discussed information graphically for the period 1995–2005. Solid lines represent relative prices of non-tradable to tradable goods, fine dashed lines indicates relative productivities in the tradable and non-tradable sectors and dashed lines are showing relative wages in non-tradable and tradable sector. All quantities are normalized to 100 in 1995. Rise in the relative productivities and relative prices indicates the potentional presence of Baumol-Bowen effect. This can be observed for all the countries except Romania, Italy and Norway, where the evolution of these variables was unstable. The wage homogeneity imply the relative wages to be equal to one, expressed in indices as in our case to be constant. This is not present in more countries i.e in Estonia, Hungary, Lithuania, Romania, France and Spain. For Slovakia, Poland, Greece and Spain the trend for relative prices and relative wages is very similar. This information for base country is presented in Figure 1, where all the above stated assumptions are present.

Based on what we have seen in Table 1, Table 2, Figure 3 and Figure 4 we can graphically examine the existence of the main mechanism for the Balassa-Samuelson effect in CEECs and Western group with respect to the base country. In Figure 2 the differential of the relative productivity growth rates in the CEECs and Western countries to the relative productivity growth rate in the base country for respective time period is displayed. The standard version of the Balassa-Samuelson model implies a positive correlation between these variables. In the top three figures the values for CEECs are presented. We can see that the correlation is negative and we can observe different behavior of Bulgaria and Romania. This behaviour led us to separate the group Delta from the CEECs as mentioned above. In the middle

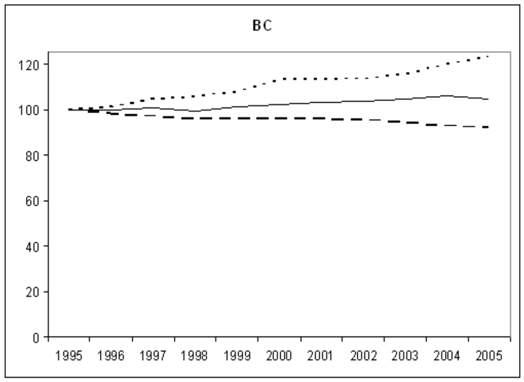


Figure 1: Solid line: relative prices of non-tradable goods to tradable goods (N/T); fine dashed line: relative productivities in the tradable and non-tradable sector (T/N); dashed line: relative wages in non-tradable and tradable sector (N/T). All quantities normalized to 100 in 1995. Base country (BC) is the aggregate of Germany, Austria, Belgium, The Netherlands and Luxembourg.

three figures the graphs for CEECs without Bulgaria and Romania are displayed. Now the correlation is positive, but relatively low. The lower three figures for Western countries shows negative correlation. Hence, some of the Western countries that could in theory 'afford' higher inflation differentials vis-á-vis the base country due to stronger relative productivity growth actually experienced lower inflation differentials in all three periods. We conclude that the ability of relative productivity differential growth rate vis-á-vis the base country to explain the inflation differentials vis-á-vis the base country is higher in Eastern than in the Western group. We can see, that in the period 2004–2005 there are countries, which have experienced lower inflation than the base country. This is the case for Czech Republic, Finland, Switzerland and Sweden. From the above analysis we can see that the relative productivity differential growth rate vis-á-vis the base country is not sufficient to explain the inflation differentials vis-á-vis the base country, therefore in the empirical analysis additional explanatory variables are established.

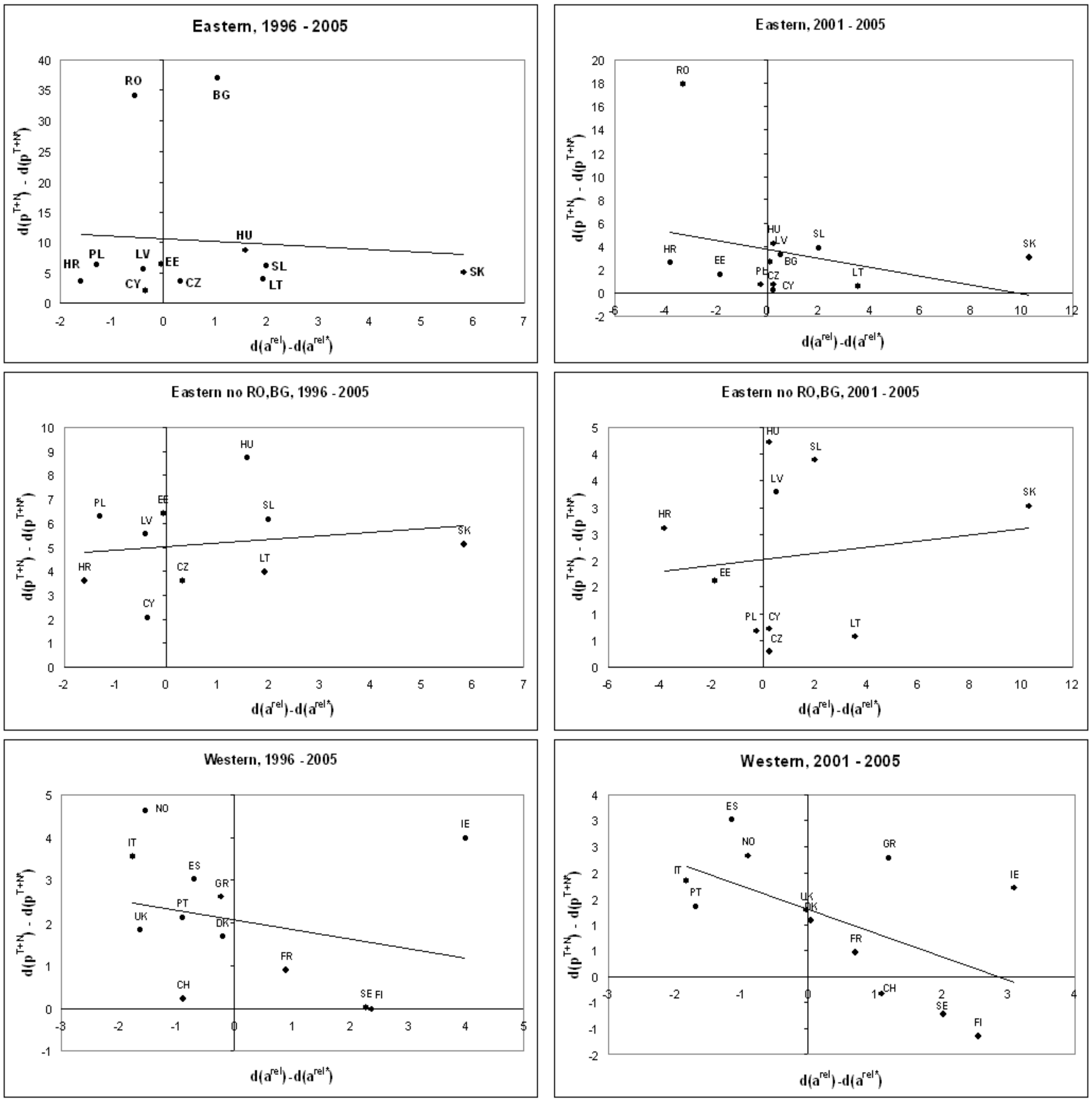


Figure 2: Relative productivity (T/N) and inflation differentials vis-á-vis the base country. The inflation rates are computed only over the tradable and non-tradable sectors. The left chart displays the averages over the period 1996–2005, the right chart over the period 2001–2005.

## 3.2 Quantification of the BB and BS effects

In this section we quantify the Baumol-Bowen and Balassa-Samuelson effects based on the extended model presented in section 1.3. In our application we allow cross-sectional heteroscedasticity. We use panel data with fixed effects using feasible GLS method as described in section 2.2. One-way error component model is used for the disturbance term. The equations are defined in growth rates.

| Label | Equation | | |
|---|---|---|---|
| $\Delta BBE$ | $\Delta p_{it}^{rel}$ | $=$ | $c_i + \beta_1 \Delta a_{it}^{rel} + \beta_2 \Delta w_{it}^{rel} + u_{it}$ |
| $\Delta Aq$ | $\Delta q_{it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BSE1_{it} + u_{it}$ |
| $\Delta Aq_2$ | $\Delta q_{2,it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BSE1_{it} + u_{it}$ |
| $\Delta Ap$ | $\Delta p_{it}^{CPI} - \Delta p_t^{CPI*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BSE1_{it} + u_{it}$ |
| $\Delta Ap_2$ | $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BSE1_{it} + u_{it}$ |
| $\Delta Bq$ | $\Delta q_{it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BSE2_{it} + u_{it}$ |
| $\Delta Bq_2$ | $\Delta q_{2,it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BSE2_{it} + u_{it}$ |
| $\Delta Bp$ | $\Delta p_{it}^{CPI} - \Delta p_t^{CPI*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BSE2_{it} + u_{it}$ |
| $\Delta Bp_2$ | $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BSE2_{it} + u_{it}$ |
| $\Delta Cq$ | $\Delta q_{it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BS_{it} + \beta_3 \Delta w_{it}^{N} + \beta_4 \Delta w_{it}^{T*} + u_{it}$ |
| $\Delta Cq_2$ | $\Delta q_{2,it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta BS_{it} + \beta_3 \Delta w_{it}^{N,rel} + \beta_4 \Delta w_{i,t-1}^{rel*} + u_{it}$ |
| $\Delta Cp$ | $\Delta p_{it}^{CPI} - \Delta p_t^{CPI*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BS_{it} + \beta_3 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Cp_2$ | $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta BS_{it} + \beta_3 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Dq$ | $\Delta q_{it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta (a_{it}^{rel} - a_t^{rel*}) + \beta_3 \Delta w_{it}^{N,rel} + \beta_4 w_{it}^{N} + u_{it}$ |
| $\Delta Dq_2$ | $\Delta q_{2,it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta (a_{it}^{rel} - a_t^{rel*}) + \beta_3 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Dp$ | $\Delta p_{it}^{CPI} - \Delta p_t^{CPI*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta (a_{it}^{rel} - a_t^{rel*}) + \beta_3 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Dp_2$ | $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta (a_{it}^{rel} - a_t^{rel*}) + \beta_3 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Eq$ | $\Delta q_{it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta a_{it}^{rel} + \beta_3 a_t^{rel*} + \beta_4 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Eq_2$ | $\Delta q_{2,it}$ | $=$ | $c_i + \beta_1 \Delta q_{it}^{T} + \beta_2 \Delta a_{it}^{rel} + \beta_3 a_t^{rel*} + \beta_4 (I_E + I_W) \Delta w_{it}^{N,rel} + \beta_5 I_D \Delta w_{it}^{rel*} + u_{it}$ |
| $\Delta Ep$ | $\Delta p_{it}^{CPI} - \Delta p_t^{(CPI)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta a_{it}^{rel} + \beta_3 a_t^{rel*} + \beta_4 \Delta w_{it}^{N,rel} + u_{it}$ |
| $\Delta Ep_2$ | $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ | $=$ | $c_i + \beta_1 (\Delta p_{it}^{T} - \Delta p_t^{T*}) + \beta_2 \Delta a_{it}^{rel} + \beta_3 a_t^{rel*} + \beta_4 (I_E + I_W) \Delta w_{it}^{N,rel} + \beta_5 \Delta\ w_{it}^{rel*} + u_{it}$ |

Table 3: Baumol-Bowen and Balassa-Samuelson equations in growth rates.
$I_E, I_W, I_D$ are indicator functions for Eastern, Western and Delta group. It has value 1, if the coefficients for the appropriate group are estimated, otherwise it is 0.

Since we concentrate on the short- and medium-run defining the equations in growth rates, we study the influence of demand variables like gross domestic product per capita growth from previous period ($\Delta GDPPC_{-1}$) or the fraction of government consumption in GDP ($\frac{GOV}{GDP}$) on the results. However, these variables caused wrong signs of variables and have been omitted from the estimation.

The specification of the estimated equations is presented in Table 3. The $\Delta E$-equations are a special case of the $\Delta D$-equations assuming that the coefficients corresponding to the growth rates of relative productivity for home and base country are not the same. In $\Delta E$ equations we tested null hypothesis $\beta_2 = -\beta_3$, which was rejected in $\Delta Ep_2$ and $\Delta Eq_2$, therefore we take the $\Delta C$-equations for wider specification of dependent variable and for two-sectoral specifications $\Delta E$-equations are considered.

The coefficient estimates with corresponding $t$-values are displayed in Tables 4 - Table 7. In the first two tables $\Delta q$ and $\Delta q_2$ are taken as dependent variables, in the next two inflation differentials $\Delta p_{it}^{CPI} - \Delta p_t^{(CPI)*}$ and $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ are dependent variables. Since the poolability of the Eastern, Delta and Western groups has been rejected, we state the results for these groups in separate columns. In Table 6 the coefficient estimates of the Baumol-Bowen variable are presented in $\Delta BBE$ equation with $\Delta p_{it}^{rel}$ as dependent variable. In $\Delta BBE$ equation the poolability of the Eastern, Delta and Western groups has not been rejected, thus we pooled all countries to obtain the coefficient estimates. Estimations of these coefficients are later used for quantification of the Baumol-Bowen and Balassa-Samuelson effects and for projections of evolution of the inflation rates in section 3.3.

In Table 4 and Table 5 the results for equations with $\Delta q$ and $\Delta q_2$ as dependent variables are displayed. All signs of coefficient estimates are in line with theory, except that for insignificant variables. The Balassa-Samuelson variables are significant in all equations for the Eastern group. Comparing the Eastern and Western group variables we can observe that the Eastern variables in all cases are more significant. This corresponds to the graphical representation what can be seen in Figure 2. The situation for Delta group is different. With $\Delta q$ taken as dependent variable, the BS variable is insignificant in all cases.

| Equation | $\Delta Aq$ | | | $\Delta Aq2$ | | | $\Delta Bq$ | | | $\Delta Bq2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | East | Delta | West | East | Delta | West | East | Delta | West | East | Delta | West |
| $\Delta q^T$ | 0.98 | 1.00 | 0.12 | 0.99 | 0.91 | 0.83 | 0.98 | 1.00 | 0.12 | 0.99 | 0.92 | 0.83 |
| | (20.72) | (9.71) | (4.60) | (33.52) | (16.80) | (31.23) | (20.64) | (9.72) | (4.58) | (33.15) | (16.33) | (31.47) |
| $\Delta BSE1$ | -0.36 | 0.02 | -0.10 | -0.22 | -0.67 | -0.19 | | | | | | |
| | (-3.34) | (0.05) | (-1.70) | (-3.11) | (-3.44) | (-3.40) | | | | | | |
| $\Delta BSE2$ | | | | | | | -0.24 | 0.03 | -0.07 | -0.16 | -0.37 | -0.15 |
| | | | | | | | (-3.48) | (0.13) | (-1.95) | (-3.34) | (-3.31) | (-3.83) |
| $Adj.R^2$ | 0.82 | | | 0.90 | | | 0.82 | | | 0.90 | | |

Table 4: Estimation results for equations in growth rates with the real exchange rate variables as dependent variables. In brackets robust $t$-statistics are displayed.

| Equation | $\Delta Cq$ | | | $\Delta Cq2$ | | | $\Delta Dq$ | | | $\Delta Eq2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | East | Delta | West | East | Delta | West | East | Delta | West | East | Delta | West |
| $\Delta q^T$ | 0.95 | 0.92 | 0.15 | 0.96 | 0.83 | 0.60 | 0.95 | 0.93 | 0.15 | 0.98 | 0.96 | 0.59 |
| | (19.81) | (9.01) | (5.53) | (31.30) | (15.32) | (22.71) | (19.88) | (9.14) | (5.84) | (33.13) | (20.49) | (21.70) |
| $\Delta(a^{rel} - a^{rel*})$ | | | | | | | -0.26 | -0.12 | -0.08 | | | |
| | | | | | | | (-4.41) | (-0.63) | (-2.42) | | | |
| $\Delta BS$ | -0.39 | -0.22 | -0.16 | -0.19 | -0.73 | -0.08 | | | | | | |
| | (-4.09) | (-0.68) | (-2.83) | (-2.92) | (-4.39) | (-1.73) | | | | | | |
| $\Delta a^{rel}$ | | | | | | | | | | -0.12 | -0.34 | -0.12 |
| | | | | | | | | | | (-2.97) | (-3.71) | (-3.18) |
| $\Delta a^{rel*}$ | | | | | | | | | | 0.51 | 1.73 | 0.02 |
| | | | | | | | | | | (4.14) | (3.87) | (0.46) |
| $\Delta(w^N - w^{N*})$ | -0.09 | -0.05 | | -0.10 | | -0.35 | -0.09 | -0.05 | | -0.10 | | -0.37 |
| | (-1.72) | (-2.21) | | (-2.90) | | (-12.43) | (-1.76) | (-2.20) | | (-2.92) | | (-12.75) |
| $\Delta w^{rel*}$ | | | | | | | | | | | 1.30 | |
| | | | | | | | | | | | (1.73) | |
| $\Delta w^{rel*}_{-1}$ | | | | | 1.88 | | | | | | | |
| | | | | | (2.90) | | | | | | | |
| $\Delta w^N$ | | | | | | | | | -0.19 | | | |
| | | | | | | | | | (-4.11) | | | |
| $\Delta w^{T*}$ | | | -0.13 | | | | | | | | | |
| | | | (-3.33) | | | | | | | | | |
| | 0.82 | | | 0.88 | | | 0.81 | | | 0.91 | | |

Table 5: Estimation results for equations in growth rates with the real exchange rate variables as dependent variables. In brackets robust $t$-statistics are displayed.

In equations with $\Delta q_2$ as dependent, BS variable is significant for all groups. This is not surprising, since in our application Balassa-Samuelson model is specified for two sectors: tradable and non-tradable. This is also supported by adjusted $R^2$ which is in all cases higher in the narrower specification. The rate of change of the real exchange rate of tradables is significant in all cases.

The equations with $\Delta p_{it}^{CPI} - \Delta p_T^{CPI*}$ and $\Delta p_{it}^{T+N} - \Delta p_t^{(T+N)*}$ as dependent variables are presented in Table 6 and Table 7. In all equations the signs of estimated coefficients are corresponding with the theory. The BS variables are more significant for Eastern group than for Western. For Delta group in all equations with $\Delta p_{it}^{CPI} - \Delta p_T^{CPI*}$ as dependent variable the significance of BS variables has been rejected. Considering only tradable and non-tradable sector all BS variables are significant. The adjusted $R^2$ is higher for the narrower specification, but the difference in the wider and narrower version is not as high as in Table 4 and Table 5. Inflation differentials in tradable sector between the home and base country are significant except for Western group in $\Delta Cp$ and $\Delta Dp$ equations.

The previous equations give the basics for the determination of the Baumol-Bowen and the Balassa-Samuelson effects. We quantify them by mulitplying the estimated coefficient corresponding to Baumol-Bowen or Balassa-Samuelson variable by the average value of the BB or BS variables over the given period. We consider two periods, 1996–2005 and 2001–2005. The results are listed in Table 11 and Table 9.. The BB effect is quantified in percent of dual inflation per year.

We start discussion with the estimates of the Baumol-Bowen effect. During the longer period BB effect is positive in all countries ranging from 0.15% for Bulgaria to 2.5% for Slovakia in CEECs and from 0.09% for Italy to 1.91% for Ireland in Western countries. In the shorter period Baumol-Bowen effect is negative for Bulgaria, Cyprus, Estonia, Croatia, Romania, Portugal, Norway and Switzerland. Estonia, Croatia, Romania, Portugal experienced higher productivity growth rate in non-tradable sector than in the tradable one as can be seen from Table 1, which explains negative BB effect in these countries.

| Equation | BBE | $\Delta Ap$ | | | $\Delta Ap2$ | | | $\Delta Bp$ | | | $\Delta Bp2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | All | East | Delta | West | East | Delta | West | East | Delta | West | East | Delta | West |
| $\Delta(p^T - p^{T*})$ | | 0.79 | 1.04 | 0.04 | 0.92 | 0.98 | 0.74 | 0.80 | 1.04 | 0.04 | 0.92 | 0.98 | 0.74 |
| | | (12.93) | (47.57) | (2.38) | (21.65) | (65.29) | (25.64) | (12.93) | (47.81) | (2.32) | (21.69) | (69.29) | (25.81) |
| $\Delta BSE1$ | | 0.32 | 0.13 | 0.11 | 0.20 | 0.66 | 0.18 | | | | | | |
| | | (3.06) | (0.38) | (2.53) | (2.85) | (3.25) | (3.35) | | | | | | |
| $\Delta BSE2$ | | | | | | | | 0.20 | 0.06 | 0.07 | 0.14 | 0.36 | 0.14 |
| | | | | | | | | (3.12) | (0.30) | (2.76) | (3.05) | (3.12) | (3.83) |
| $\Delta a^{rel}$ | 0.32 | | | | | | | | | | | | |
| | (7.59) | | | | | | | | | | | | |
| $\Delta w^{rel}$ | 0.13 | | | | | | | | | | | | |
| | (-2.63) | | | | | | | | | | | | |
| $Adj.R^2$ | 0.11 | 0.95 | | | 0.97 | | | 0.95 | | | 0.97 | | |

Table 6: Estimation results for equations in growth rates with the real exchange rate variables as dependent variables. In brackets robust $t$-statistics are displayed.

| Equation | $\Delta Cp$ | | | $\Delta Cp2$ | | | $\Delta Dp$ | | | $\Delta Ep2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | East | Delta | West | East | Delta | West | East | Delta | West | East | Delta | West |
| $\Delta(p^T - p^{T*})$ | 0.62 | 0.82 | | 0.78 | 0.98 | 0.48 | 0.62 | 0.82 | | 0.81 | 0.98 | 0.47 |
| | (9.05) | (7.55) | | (16.65) | (61.52) | (22.72) | (9.28) | (7.75) | | (16.58) | (79.49) | (21.68) |
| $\Delta BS$ | 0.35 | 0.01 | 0.08 | 0.18 | 0.64 | 0.09 | | | | | | |
| | (4.28) | (0.04) | (2.21) | (3.04) | (3.37) | (2.32) | | | | | | |
| $\Delta(a^{rel} - a^{rel*})$ | | | | | | | 0.23 | 0.02 | 0.06 | | | |
| | | | | | | | (4.49) | (0.10) | (2.40) | | | |
| $\Delta a^{rel}$ | | | | | | | | | | 0.12 | 0.35 | 0.11 |
| | | | | | | | | | | (3.33) | (3.90) | (3.63) |
| $\Delta a^{rel*}$ | | | | | | | | | | -0.35 | -1.79 | -0.01 |
| | | | | | | | | | | (-2.68) | (-4.34) | (-0.18) |
| $\Delta(w^N - w^{N*})$ | 0.24 | 0.24 | 0.06 | 0.18 | | 0.44 | 0.23 | 0.24 | 0.06 | 0.16 | | 0.45 |
| | (4.27) | (1.99) | (3.17) | (4.48) | | (17.94) | (4.25) | (2.05) | (3.14) | (4.23) | | (18.01) |
| $\Delta w^{rel*}$ | | | | | | | | | | | -1.48 | |
| | | | | | | | | | | | (-2.11) | |
| $Adj.R^2$ | | 0.96 | | | 0.98 | | | 0.96 | | | 0.98 | |

Table 7: Estimation results for equations in growth rates with the real exchange rate variables as dependent variables. In brackets robust $t$-statistics are displayed.

We can see larger Baumol-Bowen effect in the shorter period 2001–2005 than in the period 1996–2005 in Czech Republic, Hungary, Latvia, Slovakia, Poland, Denmark, Greece, Sweden and United Kingdom.

The average values of the Balassa-Samuelson variables from equations $\Delta A$ to $\Delta E$ can be found in Table 9. The definition of the BS variables listed in the table can be found in section 1.3. The BS effect is positive in both periods based on four equations in Hungary, Lithuania, Slovakia, Slovenia, Finland, France, Ireland and Sweden and negative in Croatia, Romania, Italy and Norway. In Denmark and Switzerland positive BS variables during 2001–2005 appear, whereas in the longer period they were all negative. The highest values for CEECs and overall for both periods can be observed in Slovakia (2.75 to 10.3) and the smallest values in CEECs has been observed in Croatia (-3.82 to -0.52) and Romania (-3.96 to -0.10). For the Western countries the highest values for BS values are in Ireland (1.58 to 4.79) and smallest in Italy (-1.83 to -1.11), Portugal (-0.90 to -0.52) and Norway (-1.56 to -0.41).

Table 10 shows the Balassa-Samuelson effect in percents for rate of change of real exchange rates measures. In both periods we can observe similarity of the magnitudes for $\Delta Cq$ and $\Delta Dq$ and also the ordering, with the highest values for Slovakia (1.03%, 1.50%), Slovenia (0.41%, 0.51%) and Lithuania (0.44%, 0.50%) and the smallest values for Croatia (-0.43%, -0.41%), Poland (-0.37%, -0.33%) and Italy (-0.20%, -0.14%). The similarity of $\Delta Bq_2$ and $\Delta Cq_2$ is not present in the magnitudes nor ordering[12].

The Balassa-Samuelson effect in percents for the inflation differentials is presented in Table 21 in the Appendix. The difference in the BS variables between the pair of equations seems to be grater during the shorter time period. During the longer period the values for $\Delta Dp$ are greater than that for $\Delta Cp$ and values for $\Delta Bp_2$ are greater than in $\Delta Cp_2$.

Finally we could conclude that the Balassa-Samuelson effect does not seem to be a strong instrument for explaining the evolution of the real exchange rate and inflation differential between the home and base countries. In the most cases it

[12]Except for that Slovakia is the country with highest BS variables, what is can be seen in all equations.

| | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | 0.99 | 0.54 | 0.76 | 0.64 | 0.15 | 1.16 | 1.27 | 0.53 | 2.50 | 1.28 | 0.24 | 0.48 |
| 2001–2005 | -0.18 | -0.22 | 2.69 | -0.51 | -0.56 | 1.45 | 1.79 | 0.23 | 4.96 | 0.61 | 0.87 | -0.25 |
| | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH |
| 1996–2005 | 0.59 | 0.43 | 1.41 | 0.93 | 0.58 | 1.91 | 0.09 | 0.37 | 1.37 | 0.14 | 0.16 | 0.37 |
| 2001–2005 | 1.24 | 0.05 | 1.13 | 0.57 | 2.21 | 0.66 | 0.08 | -0.35 | 1.84 | 0.59 | -0.12 | -0.15 |

Table 8: Estimates of the Baumol-Bowen effect for the CEECs and Western countries in percent of dual inflation per year.

| Country | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Averages over 1996–2005 | | | | | | | | | | | | |
| $\Delta BSE1$ | 0.95 | 0.23 | 0.15 | 0.72 | -0.53 | 1.51 | 1.57 | 0.48 | 2.75 | 1.09 | 0.22 | -0.34 |
| $\Delta BSE2$ | 1.67 | 0.01 | 0.55 | 1.06 | -0.67 | 2.51 | 2.55 | 0.82 | 5.81 | 2.00 | 0.57 | -0.10 |
| $\Delta BS$ | 0.54 | -0.05 | -0.04 | -0.06 | -1.11 | 0.91 | 1.14 | -0.34 | 2.66 | 1.05 | -0.96 | -0.64 |
| $\Delta a^{rel} - \Delta a^{rel*}$ | 1.05 | -0.36 | 0.32 | -0.05 | -1.60 | 1.59 | 1.93 | -0.40 | 5.83 | 1.99 | -1.30 | -0.56 |
| Averages over 2001–2005 | | | | | | | | | | | | |
| $\Delta BSE1$ | 0.73 | 0.68 | 0.04 | 0.29 | -2.09 | 1.11 | 2.32 | 1.13 | 4.06 | 0.84 | 0.57 | -2.29 |
| $\Delta BSE2$ | 1.36 | 0.55 | 0.38 | 0.44 | -3.23 | 1.97 | 3.80 | 1.60 | 8.89 | 1.63 | 1.14 | -3.96 |
| $\Delta BS$ | -0.06 | 0.45 | -0.08 | -1.31 | -2.40 | 0.05 | 2.15 | 0.37 | 4.74 | 1.05 | -0.30 | -1.99 |
| $\Delta a^{rel} - \Delta a^{rel*}$ | 0.10 | 0.24 | 0.23 | -1.86 | -3.82 | 0.24 | 3.57 | 0.52 | 10.30 | 2.01 | -0.24 | -3.31 |
| Country | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH |
| Averages over 1996–2005 | | | | | | | | | | | | |
| $\Delta BSE1$ | -0.02 | 0.32 | 1.16 | 1.45 | 0.22 | 2.29 | -1.11 | -0.52 | 1.24 | -0.14 | -0.79 | -0.25 |
| $\Delta BSE2$ | -0.11 | 0.36 | 2.50 | 1.83 | 0.17 | 4.79 | -1.47 | -0.76 | 2.37 | -0.61 | -1.49 | -0.43 |
| $\Delta BS$ | -0.06 | -0.41 | 0.98 | 0.76 | -0.05 | 1.79 | -1.29 | -0.61 | 1.10 | -0.69 | -0.79 | -0.57 |
| $\Delta a^{rel} - \Delta a^{rel*}$ | -0.21 | -0.69 | 2.37 | 0.89 | -0.23 | 3.98 | -1.77 | -0.90 | 2.27 | -1.63 | -1.56 | -0.90 |
| Averages over 2001–2005 | | | | | | | | | | | | |
| $\Delta BSE1$ | 0.08 | -0.46 | 1.03 | 0.76 | 1.01 | 1.82 | -1.20 | -1.26 | 0.91 | 0.86 | -0.76 | 0.61 |
| $\Delta BSE2$ | 0.01 | -0.76 | 2.37 | 0.94 | 1.19 | 3.51 | -1.57 | -1.79 | 1.94 | 0.73 | -1.38 | 0.90 |
| $\Delta BS$ | 0.14 | -0.70 | 1.07 | 0.60 | 1.08 | 1.58 | -1.33 | -1.17 | 0.91 | 0.49 | -0.41 | 0.77 |
| $\Delta a^{rel} - \Delta a^{rel*}$ | 0.04 | -1.14 | 2.55 | 0.71 | 1.22 | 3.10 | -1.83 | -1.69 | 2.02 | -0.02 | -0.90 | 1.11 |

Table 9: Average values of the Balassa-Samuelson variables for equations $\Delta A$ to $\Delta E$.

explains below half a percent, except for Slovakia with 0.89% to 2.65% in 2001–2005. This can show that some assumptions of the BS model are not met, i.e. perfect labor mobility or validity of PPP in tadable sector. This can be also seen in Figure 2, where the slope of the trend line is not really high. For Western countries the slope is not even positive implying the importance of other explanatory variables for determination of real exchange rate movements and inflation differential between the home and base country. We thus proceed the inflation projections regarding not only BS but also other explanatory variables.

| | Averages over 1996–2005 | | | | Averages over 2001–2005 | | | |
|---|---|---|---|---|---|---|---|---|
| Country | $\Delta Cq$ | $\Delta Dq$ | $\Delta Bq_2$ | $\Delta Cq_2$ | $\Delta Cq$ | $\Delta Dq$ | $\Delta Bq_2$ | $\Delta Cq_2$ |
| BG | 0.12 | 0.12 | 0.62 | 0.39 | -0.01 | 0.01 | 0.51 | -0.05 |
| CY | -0.02 | -0.09 | 0.00 | -0.01 | 0.17 | 0.06 | 0.09 | 0.08 |
| CZ | -0.02 | 0.08 | 0.09 | -0.01 | -0.03 | 0.06 | 0.06 | -0.02 |
| EE | -0.02 | -0.01 | 0.17 | -0.01 | -0.51 | -0.48 | 0.07 | -0.25 |
| HR | -0.43 | -0.41 | -0.11 | -0.21 | -0.93 | -0.98 | -0.51 | -0.45 |
| HU | 0.35 | 0.41 | 0.39 | 0.17 | 0.02 | 0.06 | 0.31 | 0.01 |
| LT | 0.44 | 0.50 | 0.40 | 0.21 | 0.84 | 0.92 | 0.60 | 0.41 |
| LV | -0.13 | -0.10 | 0.13 | -0.06 | 0.14 | 0.13 | 0.25 | 0.07 |
| SK | 1.03 | 1.50 | 0.91 | 0.50 | 1.84 | 2.65 | 1.40 | 0.89 |
| SL | 0.41 | 0.51 | 0.32 | 0.20 | 0.41 | 0.52 | 0.26 | 0.20 |
| PL | -0.37 | -0.33 | 0.09 | -0.18 | -0.12 | -0.06 | 0.18 | -0.06 |
| RO | -0.14 | -0.07 | -0.04 | -0.46 | -0.43 | -0.39 | -1.48 | -1.44 |
| DK | -0.01 | -0.02 | -0.02 | -0.01 | 0.02 | 0.00 | 0.00 | 0.01 |
| ES | -0.07 | -0.06 | 0.05 | -0.03 | -0.11 | -0.09 | -0.11 | -0.06 |
| FI | 0.16 | 0.19 | 0.37 | 0.08 | 0.17 | 0.21 | 0.35 | 0.09 |
| FR | 0.12 | 0.07 | 0.27 | 0.06 | 0.10 | 0.06 | 0.14 | 0.05 |
| GR | -0.01 | -0.02 | 0.03 | 0.00 | 0.17 | 0.10 | 0.18 | 0.09 |
| IE | 0.28 | 0.32 | 0.71 | 0.15 | 0.25 | 0.25 | 0.52 | 0.13 |
| IT | -0.20 | -0.14 | -0.22 | -0.11 | -0.21 | -0.15 | -0.23 | -0.11 |
| PT | -0.10 | -0.07 | -0.11 | -0.05 | -0.19 | -0.14 | -0.27 | -0.10 |
| SE | 0.17 | 0.18 | 0.35 | 0.09 | 0.14 | 0.16 | 0.29 | 0.07 |
| UK | -0.11 | -0.13 | -0.09 | -0.06 | 0.08 | 0.00 | 0.11 | 0.04 |
| NO | -0.13 | -0.13 | -0.22 | -0.06 | -0.07 | -0.07 | -0.21 | -0.03 |
| CH | -0.09 | -0.07 | -0.06 | -0.05 | 0.12 | 0.09 | 0.13 | 0.06 |

Table 10: The Balassa-Samuelson effect in % for (rate of change of) real exchange rate measures. The Balassa-Samuelson effect is defined as the product of the negative coefficient to the BS-variable in the corresponding equations with the average values of the variables as displayed in Table 22 and Table 23 so its contribution to the inflation differentials is captured.

## 3.3 Inflation simulations

In this section we present the inflation simulations based on equations for the Baumol-Bowen and Balassa-Samuelson effects. The inflation projections based on the Baumol-Bowen effect can be found in section 3.3.1 and that for the Balassa-Samuelson effect are present in section 3.3.2. These simulations are based on Wagner and Hlouskova (2004) which were inspired by Alberola and Tyrväinen (1994). We use not only the Baumol-Bowen and Balassa-Samuelson variables, but also the other variables from estimated equations, since their influence on the inflation is significant too.

### 3.3.1 Inflation simulations based on the Baumol-Bowen model

By the simulation of the inflation rate based on the Baumol-Bowen effect we assume the same inflation in the tradable sector for all countries taken into consideration, like Alberola and Tyrväinen (1998). This assumption makes it possible to calculate the inflation rates in non-tradable sector for each country, when adding the assumption about an aggregate inflation for twenty-four European countries, considered in our empirical application. We specify the assumptions for the agriculture and public sector to obtain the CPI based inflation rate.

The aggregate inflation for EU24 is given as the weighted average of the inflations of the countries, with $\rho_i$ output share of country $i$ taken as the weights, thus

$$\Delta p_{EU24} = \sum_{i=1}^{24} \rho_i \Delta p_i \tag{3.1}$$

where $\Delta p_i$ is the CPI based inflation of country $i$. Since the economy consist of four sectors and $\Delta BBE$ is considered only for the tradable and non-tradable sector, we have to take in consideration that CPI applies for all four sectors. We define the CPI based inflation as the weighted average of inflation in agriculture and the public sector $\Delta p_i^{A+P}$ and inflation in tradable and non-tradable sector $\Delta p_i^{T+N}$ as

$$\Delta p_i = \theta_i^{T+N} \Delta p_i^{T+N} + (1 - \theta_i^{T+N}) \Delta p_i^{A+P}, \tag{3.2}$$

where $\theta_i^j$ is the output share in the sector $j$ of country $i$. From (1.11) and $\Delta BBE$

we obtain the representation of inflation in tradable and non-tradable sector as a function of relative productivity growth and wage growth as

$$\Delta p_i^{T+N} = (1-\delta_i)\Delta p_i^T + \delta_i \Delta p_i^N \tag{3.3}$$
$$= \Delta p_i^T + \delta_i \Delta p_i^{rel} \tag{3.4}$$
$$= \Delta p_i^T + \delta_i(\hat{c}_i + \hat{\beta}_1 \Delta a_i^{rel} + \hat{\beta}_2 \Delta w_i^{rel}). \tag{3.5}$$

For these variables we use the average values over the periods 1996–2005, 2001–2005, 2004–2005.

We denote the aggregate inflation for EU24 as $\Delta p_{EU24}$. By setting (3.5) in (3.1) and using the assumption $\Delta p_i^T = \Delta p^T$ as stated before, we obtain the formula for $\Delta p^T$ as

$$\Delta p^T = \frac{\Delta p_{EU24} - \sum_{i=1}^N \rho_i \left[\theta^{N+T}\delta_i(\hat{c}_i + \hat{\beta}_1 \Delta a_i^{rel} + \hat{\beta}_2 \Delta w_i^{rel}) + (1-\theta_i^{T+N})\Delta p_i^{A+P}\right]}{\sum_{i=1}^N \rho_i \theta_i^{T+N}}.$$

The inflation rate in tradable and non-tradable sector for each country can be calculated using (3.5). The inflation rate in all sectors can be then obtained from (3.2) for each country. We assume, that $\Delta p_{EU24} = 2\%$, which corresponds with the aims of European Central Bank. The results are displayed in Table 11. In the last column the implied inflation rate for tradable sector is displayed for EU24.

We also proceed the inflation simulation for CEECs separately. In this case the assumption $\Delta p_{CEECs} = 2\%$ and different $\rho_i$ are used for inflation rate calculations. For CEECs the implied inflation rate for tradable sector varies from -3.40% in 1996–2005 to -1.23% deflation in 2004–2005. Thus in order to achieve the 2% inflation target for CEECs, substantial deflation in tradable sector is needed if the inflation in agriculture and public sector continues at the historical average values.

This is not the case when taking EU24, there the implied inflation in tradable sector ranges from 1.07% to 3.85%. The inflations varies across countries and CEECs experience higher inflation than the Western countries. Norway is the country with lowest inflation rate in all three periods. We can conclude that the inflation rate difference between the CEECs and Western countries is getting smaller. This effect is possibly due to the CEECs effort of fulfilling the convergence criteria - stated

| Country | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | 12.69 | 1.52 | 2.76 | 3.99 | 3.36 | 4.28 | 3.50 | 4.51 | 3.99 | 4.00 | 5.74 | 12.02 | |
| 2001–2005 | 2.73 | 2.44 | 3.28 | 4.47 | 3.15 | 3.98 | 3.95 | 5.50 | 5.21 | 4.48 | 5.78 | 8.31 | |
| 2004–2005 | 3.24 | 2.54 | 5.68 | 5.86 | 4.69 | 3.64 | 5.78 | 7.19 | 6.34 | 4.85 | 7.41 | 6.01 | |

| Country | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH | $\Delta p^T_{EU24}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | 1.30 | 2.65 | 2.88 | 2.72 | 2.59 | 2.79 | 2.18 | 1.96 | 2.58 | 2.27 | 1.16 | 1.45 | 1.07 |
| 2001–2005 | 2.07 | 3.53 | 3.98 | 3.53 | 3.68 | 3.89 | 2.88 | 2.46 | 3.23 | 3.48 | 1.93 | 2.64 | 2.27 |
| 2004–2005 | 3.33 | 4.61 | 4.93 | 4.25 | 5.18 | 4.77 | 3.83 | 3.34 | 4.23 | 4.74 | 2.89 | 3.26 | 3.85 |

Table 11: The Baumol-Bowen inflation simulations under the assumption of an aggregate inflation in the EU24 of 2% per annum. The implied inflation rate in tradable sector for the EU24 country group is displayed in the last column.

| Country | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO | $\Delta p_{CEEC12}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | 12.68 | 2.49 | 2.76 | 3.41 | 3.18 | 3.91 | 2.52 | 3.13 | 2.69 | 3.10 | 3.26 | 10.81 | 4.13 |
| 2001–2005 | 1.94 | 2.46 | 2.36 | 3.11 | 2.50 | 2.86 | 1.91 | 2.99 | 2.71 | 2.75 | 2.35 | 6.67 | 2.84 |
| 2004–2005 | 1.74 | 2.03 | 2.43 | 3.34 | 2.70 | 1.12 | 2.59 | 3.32 | 2.13 | 2.12 | 2.68 | 3.04 | |

| Country | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH | $\Delta p_{EU24}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | 1.96 | 2.20 | 2.13 | 2.08 | 2.46 | 2.86 | 2.38 | 2.57 | 2.27 | 2.35 | 2.51 | 1.65 | 2.34 |
| 2001–2005 | 1.91 | 2.42 | 2.38 | 2.18 | 2.58 | 3.21 | 2.19 | 2.40 | 2.13 | 2.40 | 2.41 | 1.75 | 2.30 |
| 2004–2005 | 1.68 | 2.33 | 2.19 | 1.88 | 2.25 | 3.16 | 1.87 | 2.27 | 1.60 | 2.20 | 2.35 | 1.72 | 2.05 |

Table 12: The Baumol-Bowen inflation simulations under the assumption of an aggregate inflation in the EU24 in tradable and non-tradable sectors only of 2% per annum. The implied inflation rate for the EU24 country group is displayed in the last column.

in the Maastricht Treaty. The fulfilment of this criteria is the subject of future enterance of CEECs in the EMU.

Since the agriculture and public sector is experiencing a lot of structural reforms and prices regulations in the CEECs, it is maybe too strong to suppose that the inflation of EU24 or CEECs is 2%. We thus narrow the assumption 2% of inflation only in tradable and non-tradable sector. We calculate the inflation rate for all countries from (3.2) using the average inflation rate for agriculture and public sectors. These results can be found in Table 12, where the implied inflation rate for the CEECs and Western group is showed in the last column. The inflation rate is now positive, for CEECs ranging from 2.39% to 4.13% and for EU24 ranging from 2.05% to 2.34%. No deflation appears in these results. Switzerland has the lowest inflation rate.

### 3.3.2 Inflation simulations based on the Balassa-Samuelson model

For the simulations of inflation rates we use the estimated equations $\Delta A$ to $\Delta E$ estimated in section 3.2. Similarly as before inflation rates for EU24 countries can be computed using the assumptions about the inflation rate in the base country. However, there are different dependent variables in the equations. For the computation of inflation simulations based on equations $\Delta q$ and $\Delta q_2$ some assumption about the development of real exchange rate movements has to be done. The real exchange rate movement is defined as $\Delta q_i = \Delta e_i + \Delta p^* - \Delta p_i$. To obtain the inflation differentials, we assume that the nominal exchange rate does not change. We assume the inflation rate for the base country to be 2%.

For the equations with $p_2$ and $q_2$ as dependent variables the assumption of inflation rate for base country as 2% is implied. As in the previous section we use (3.2) and historical averages of the explanatory variables for calculation of the inflation rate.

We consider two cases. In the first one PPP in tradable sector starts to hold from now and the respective variables in the BS equations are set to zero. This could show, that after entrance of CEECs in the European Union the prices for tradable goods should converge towards to PPP. These results can be found in Table 13.

The results are presented for three periods: 1996–2005, 2001–2005, 2004–2005. We could observe that the inflation is highest in the first period, then in the second one it is lower and then in the third one it raises again. The mean inflation projections range from 1.69% for Cyprus to 8.6% for Romania in the first period, from 1.63% for Cyprus to 5.93% for Romania in the second period and from 0.89% for Bulgaria to 5.76% for Latvia in the third period. The mean inflation is higher for CEECs than for Western countries, where Greece experiences the highest inflation (4.78%-4.90%). CEECs mean inflation, where equations with $\Delta p_2$, $\Delta q_2$ are taken as dependent, is greater than the mean inflation from equations with $\Delta p$, $\Delta q$. For Western countries in most cases this is true only for the longest period.

The second scenario is without the presumption that PPP holds in tradable sector and the historical averages for the tradable price differences are used in the inflation projections. Results for this experiment can be found in Appendix in Table 20.

We can conclude that the average inflation in our projections for CEECs is around 5% and for EU24 around 3%.

| Country | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO | CEEC12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | | | | | | | | | | | | | |
| Min | 0.16 | 0.46 | 2.07 | 2.81 | 1.36 | 3.62 | 3.71 | 4.68 | 4.42 | 1.90 | 5.54 | 1.76 | 4.00 |
| Max | 13.81 | 3.51 | 4.81 | 5.36 | 4.32 | 6.71 | 6.32 | 6.82 | 7.20 | 5.22 | 7.75 | 13.32 | 6.53 |
| Mean | 7.86 | 1.69 | 3.16 | 4.42 | 3.06 | 5.14 | 4.65 | 5.40 | 5.00 | 3.96 | 6.47 | 8.60 | 5.49 |
| Std. Dev. | 5.96 | 0.85 | 0.73 | 0.85 | 1.18 | 0.97 | 0.87 | 0.51 | 0.72 | 1.05 | 0.69 | 4.50 | 0.85 |
| Mean $p.\ q$ | 2.05 | 0.98 | 2.16 | 3.05 | 1.60 | 3.80 | 3.99 | 4.23 | 4.09 | 2.53 | 5.06 | 3.78 | 3.78 |
| Std. Dev. $p.\ q$ | 2.63 | 1.01 | 0.90 | 1.03 | 0.88 | 1.31 | 0.90 | 0.70 | 0.85 | 1.10 | 0.90 | 2.45 | 0.89 |
| Mean $p_2.\ q_2$ | 13.35 | 2.16 | 3.52 | 4.81 | 4.04 | 5.19 | 4.09 | 5.27 | 4.60 | 4.61 | 6.26 | 12.62 | 6.04 |
| Std. Dev. $p_2.\ q_2$ | 0.51 | 0.16 | 0.16 | 0.37 | 0.16 | 0.52 | 0.29 | 0.19 | 0.18 | 0.41 | 0.32 | 0.63 | 0.27 |
| 2001–2005 | | | | | | | | | | | | | |
| Min | -1.66 | 0.59 | 1.95 | 2.07 | 0.62 | 2.96 | 3.13 | 4.68 | 4.33 | 1.67 | 4.45 | 1.71 | 3.57 |
| Max | 2.85 | 2.44 | 3.22 | 4.86 | 3.15 | 6.03 | 5.80 | 5.91 | 5.90 | 4.54 | 7.10 | 9.67 | 4.92 |
| Mean | 1.64 | 1.63 | 2.71 | 3.90 | 2.05 | 4.22 | 4.30 | 5.30 | 5.07 | 3.46 | 5.50 | 5.93 | 4.42 |
| Std, Dev, | 4.25 | 0.16 | 0.19 | 0.34 | 0.33 | 0.51 | 0.23 | 0.18 | 0.22 | 0.33 | 0.49 | 1.51 | 0.47 |
| Mean $p.\ q$ | 1.16 | 1.06 | 2.36 | 3.39 | 1.07 | 4.45 | 5.05 | 5.36 | 5.46 | 2.78 | 5.97 | 3.78 | 4.32 |
| Std. Dev. $p.\ q$ | 0.75 | 0.39 | 0.31 | 1.04 | 0.30 | 1.31 | 0.72 | 0.50 | 0.26 | 0.92 | 0.73 | 1.61 | 0.51 |
| Mean $p_2.\ q_2$ | 2.12 | 2.20 | 3.06 | 4.42 | 3.04 | 4.00 | 3.55 | 5.24 | 4.68 | 4.14 | 5.03 | 8.08 | 4.53 |
| Std. Dev. $p_2.\ q_2$ | 1.53 | 0.15 | 0.12 | 0.36 | 0.11 | 0.46 | 0.27 | 0.18 | 0.21 | 0.36 | 0.43 | 0.74 | 0.24 |
| 2004–2005 | | | | | | | | | | | | | |
| Min | -3.44 | -0.74 | 3.06 | 1.24 | 0.31 | 1.47 | 3.47 | 3.85 | 3.94 | 0.86 | 4.46 | 1.70 | 3.31 |
| Max | 2.11 | 1.45 | 3.91 | 5.00 | 3.23 | 5.97 | 5.76 | 7.73 | 6.51 | 3.66 | 6.99 | 5.81 | 4.96 |
| Mean | 0.89 | 0.50 | 3.54 | 3.59 | 1.88 | 3.33 | 4.43 | 5.76 | 5.12 | 2.61 | 5.53 | 3.77 | 4.15 |
| Std. Dev. | 1.35 | 0.73 | 0.24 | 1.16 | 1.20 | 1.51 | 0.71 | 1.04 | 0.90 | 0.91 | 0.69 | 1.09 | 0.46 |
| Mean $p.\ q$ | 0.98 | -0.15 | 3.49 | 2.82 | 0.75 | 4.51 | 4.78 | 5.61 | 5.92 | 2.09 | 5.83 | 3.59 | 4.34 |
| Std. Dev. $p.\ q$ | 0.91 | 0.39 | 0.28 | 1.16 | 0.31 | 1.22 | 0.83 | 1.39 | 0.43 | 1.00 | 0.73 | 1.38 | 0.50 |
| Mean $p_2.\ q_2$ | 0.80 | 1.14 | 3.60 | 4.35 | 3.01 | 2.16 | 4.08 | 5.90 | 4.31 | 3.13 | 5.23 | 3.94 | 3.97 |
| Std. Dev. $p_2.\ q_2$ | 1.75 | 0.18 | 0.19 | 0.45 | 0.20 | 0.46 | 0.34 | 0.59 | 0.30 | 0.43 | 0.53 | 0.78 | 0.36 |

| Country | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH | EU24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996–2005 | | | | | | | | | | | | | |
| Min | 1.55 | 2.54 | 2.22 | 1.78 | 3.04 | 2.57 | 2.54 | 2.69 | 1.57 | 2.75 | 1.19 | 1.12 | 2.84 |
| Max | 2.57 | 3.88 | 3.07 | 3.17 | 7.44 | 4.36 | 3.73 | 5.19 | 2.99 | 3.76 | 2.97 | 2.11 | 3.42 |
| Mean | 2.12 | 3.49 | 2.70 | 2.56 | 4.78 | 3.32 | 3.18 | 3.94 | 2.53 | 3.16 | 2.01 | 1.80 | 3.08 |
| Std. Dev. | 0.35 | 0.34 | 0.27 | 0.58 | 1.87 | 0.58 | 0.44 | 1.03 | 0.48 | 0.29 | 0.59 | 0.35 | 0.19 |
| Mean $p.\ q$ | 1.69 | 2.80 | 1.79 | 1.43 | 5.03 | 2.04 | 2.54 | 3.76 | 1.66 | 2.43 | 1.42 | 1.17 | 2.24 |
| Std. Dev. $p.\ q$ | 0.16 | 0.45 | 0.17 | 0.26 | 1.31 | 0.39 | 0.30 | 0.85 | 0.57 | 0.26 | 0.44 | 0.46 | 0.11 |
| Mean $p_2.\ q_2$ | 1.91 | 3.37 | 2.93 | 3.09 | 3.20 | 3.72 | 3.02 | 3.13 | 2.77 | 3.06 | 2.00 | 1.91 | 3.16 |
| Std. Dev. $p_2.\ q_2$ | 0.37 | 0.13 | 0.09 | 0.06 | 0.15 | 0.46 | 0.50 | 0.24 | 0.17 | 0.31 | 0.74 | 0.14 | 0.22 |
| 2001–2005 | | | | | | | | | | | | | |
| Min | 1.51 | 2.23 | 2.23 | 1.77 | 2.95 | 2.59 | 2.34 | 2.36 | 1.60 | 2.57 | 1.09 | 1.23 | 2.55 |
| Max | 2.44 | 3.74 | 3.31 | 3.11 | 7.40 | 4.11 | 3.53 | 5.08 | 2.80 | 3.66 | 2.55 | 2.19 | 3.11 |
| Mean | 2.03 | 3.42 | 2.83 | 2.51 | 4.81 | 3.29 | 2.93 | 3.66 | 2.28 | 3.14 | 1.85 | 1.91 | 2.94 |
| Std. Dev. | 0.29 | 0.05 | 0.08 | 0.07 | 0.07 | 0.27 | 0.39 | 0.22 | 0.27 | 0.13 | 0.60 | 0.15 | 0.14 |
| Mean $p.\ q$ | 2.31 | 3.50 | 2.48 | 1.97 | 6.40 | 2.80 | 3.28 | 4.63 | 2.20 | 3.31 | 1.99 | 1.80 | 2.94 |
| Std. Dev. $p.\ q$ | 0.11 | 0.52 | 0.18 | 0.21 | 1.41 | 0.26 | 0.39 | 0.93 | 0.53 | 0.32 | 0.35 | 0.46 | 0.17 |
| Mean $p_2.\ q_2$ | 1.76 | 3.33 | 3.18 | 3.05 | 3.22 | 3.77 | 2.59 | 2.69 | 2.37 | 2.98 | 1.71 | 2.03 | 2.95 |
| Std. Dev. $p_2.\ q_2$ | 0.25 | 0.03 | 0.09 | 0.05 | 0.07 | 0.24 | 0.26 | 0.09 | 0.30 | 0.04 | 0.55 | 0.16 | 0.04 |
| 2004–2005 | | | | | | | | | | | | | |
| Min | 1.36 | 2.11 | 2.12 | 1.58 | 3.06 | 2.36 | 1.91 | 2.16 | 1.58 | 2.70 | 0.74 | 0.92 | 2.51 |
| Max | 2.57 | 3.62 | 3.20 | 2.91 | 7.52 | 4.29 | 3.52 | 4.90 | 2.86 | 3.60 | 2.62 | 1.99 | 3.00 |
| Mean | 2.04 | 3.24 | 2.63 | 2.26 | 4.90 | 3.13 | 2.81 | 3.43 | 2.17 | 3.09 | 1.72 | 1.59 | 2.79 |
| Std. Dev. | 0.43 | 0.37 | 0.37 | 0.51 | 2.01 | 0.68 | 0.60 | 1.22 | 0.42 | 0.29 | 0.61 | 0.35 | 0.18 |
| Mean $p.\ q$ | 2.38 | 3.35 | 2.33 | 1.82 | 6.62 | 2.61 | 3.24 | 4.44 | 2.26 | 3.27 | 1.84 | 1.46 | 2.86 |
| Std. Dev. $p.\ q$ | 0.12 | 0.52 | 0.20 | 0.29 | 1.41 | 0.30 | 0.30 | 0.89 | 0.56 | 0.26 | 0.43 | 0.44 | 0.12 |
| Mean $p_2.\ q_2$ | 1.70 | 3.13 | 2.93 | 2.70 | 3.19 | 3.64 | 2.39 | 2.41 | 2.07 | 2.90 | 1.61 | 1.72 | 2.72 |
| Std. Dev. $p_2.\ q_2$ | 0.35 | 0.03 | 0.23 | 0.20 | 0.09 | 0.56 | 0.51 | 0.19 | 0.20 | 0.19 | 0.77 | 0.16 | 0.20 |

Table 13: The Balassa-Samuelson inflation simulations under the assumption $\Delta p^*$ equals 2% and with the inflation differentials in tradables set to zero. The values for the other variables are at the average values for the periods specified.

# Summary and conclusion

The thesis deals with the econometric analysis of the Baumol-Bowen and Balassa-Samuelson effects for twenty-four European countries vis-á-vis the base country consisting of Germany, Austria, Belgium, The Netherlands and Luxembourg.

The extended Baumol-Bowen and Balassa-Samuelson models without the assumption of perfect labor mobility has been presented in section 1.3. The difference between the Baumol-Bowen and Balassa-Samuelson effects has been explained and some results from the related literature are stated in section 1.2 and section 1.4 respectively.

We graphically examined the wage homogeneity in the tradable and non-tradable sector, which was found only in small number of countries. In the empirical application we quantified the Baumol-Bowen and Balassa-Samuelson effects in Western, Eastern and Delta countries with respect to the base country using the fixed effects for panel data with one-way error component. The Balassa-Samuelson effect has been found more significant in the Western, than in the Eastern countries as expected.

We specified more types of Balassa-Samuelson variables presented in section 1.2. and found in period 1996–2005 highest average values of Balassa-Samuelson variables with $BSE1$ and $BSE2$, thus the importance of relative wages addition in the estimation of BS effect is evident.

We observed the differences between the Balassa-Samuelson model specified in the tradable and non-tradable sector vis-á-vis the model specified with consumer price index based inflation and the corresponding real exchange rate. A better fit is present in the narrower two-sectoral specification, which corresponds with the theoretical model.

We find the evidence of the Balassa-Samuelson effect being present. With an average value less than half a percent per annum, it is however too small to explain observed inflation differentials between twenty-four European countries and the base country. Hence, other explanatory variables are used in the simulations using the historical averages over several periods. We provide two different projections based on different assumptions about the deviations from PPP in tradable sector which are in the first case set to zero and in the second case based on historical average values. We set the inflation rate for the base country to 2%. The mean prediction for the aggregate inflation of Central and Eastern European Countries is 5.49% and for EU24 3.08%.

We could finally note, that this empirical work can be in future extended with additional inflation simulations with other assumptions. Some other demand variables influence could be examined too. The quantification of the Balassa-Samuelson effect for accession countries vis-á-vis euro land could be an interesting matter.

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# Appendix

| Symbol | Country |
|---|---|
| East | |
| CY | Cyprus |
| CZ | Czech Republic |
| EE | Estonia |
| HR | Croatia |
| HU | Hungary |
| LV | Latvia |
| LT | Lithuania |
| PL | Poland |
| SK | Slovak Republic |
| SL | Slovenia |
| Delta | |
| BG | Bulgaria |
| RO | Romania |
| West | |
| DK | Denmark |
| FI | Finland |
| FR | France |
| UK | Great Britain |
| GR | Greece |
| IE | Ireland |
| IT | Italy |
| NO | Norway |
| PT | Portugal |
| ES | Spain |
| SE | Sweden |
| CH | Switzerland |
| Base countries | |
| AT | Austria |
| BE | Belgium |
| DE | Germany |
| LU | Luxembourg |
| NL | The Netherlands |

Table 14: List of countries used and abbreviations.

| NACE code | NACE category | Sector |
|---|---|---|
| A | Agriculture | AGR |
| B | Fishing | AGR |
| C | Mining and quarrying | T |
| D | Manufacturing | T |
| E | Electricity, gas and water supply | T |
| F | Construction | N |
| G | Wholesale and retail trade | N |
| H | Hotels and restaurants | N |
| I | Transport, storage and communication | N |
| J | Financial intermediation | N |
| K | Real estate and business activities | N |
| L | Public administration and defence | PUB |
| M | Education | PUB |
| N | Health and social work | PUB |
| O | Other communal, social and indiv. services | PUB |
| P | Private households with employed persons | PUB |

Table 15: Aggregation of NACE categories to the 4 sectors agriculture (AGR), tradable (T), non-tradable (N) and public sector (PUB) as defined.

| Symbol | Variable |
|---|---|
| CPI | Consumer price index, |
| | 1995 prices, Euro |
| $P_Z$ | Deflators, 1995 = 100, based on local currencies |
| $L_X$ | Employment, annual average |
| $W_X$ | Annual gross wages per employee, current prices, Euro |
| $LC_X$ | Annual labor costs per employee, current prices, Euro |
| | Labor cost is the sum of gross wages and social security contributions |
| $E$ | Nominal exchange rate, Local currency/EUR(ECU) |

Table 16: List of variables. The sub-script $X$ indicates the sector $\{T, N, AGR, PUB\}$, and the sub-script $Z$ for the price indices of $\{T, N, AGR, PUB, CPI\}$. Local currency is meant for CEECs, Denmark, Great Britain, Sweden, Switzerland and the Euro for countries of the base country.

| Variable | Country | Source |
|---|---|---|
| $Y^T$, $Y^N$, $Y^{AGR}$, $Y^{PUB}$, $P^T$, $P^N$, $P^{AGR}$, $P^{PUB}$ | EU15 | EUROSTAT, MEI, STAN |
| | BG, HR, HU, RO, SL | EUROSTAT, WIIW |
| | CY, CZ, EE, LT, LV, PL, SK, NO | EUROSTAT |
| | CH | EUROSTAT, AMECO |
| $P^{CPI}$ | EU15, CEEC12, NO, CH | ILO |
| $L^T$, $L^N$, $L^{AGR}$, $L^{PUB}$ | EU15, NO, CH | AMECO, EUROSTAT, STAN |
| | BG, HR, RO | EUROSTAT, WIIW |
| | CY, CZ, HU, EE, LT, LV, PL, SK, SL | EUROSTAT |
| $W^T$, $W^N$ | EU15, NO, CH | EUROSTAT |
| | BG, HR, HU, RO, SL | EUROSTAT, WIIW |
| | CY, CZ, EE, LT, LV, PL, SK | EUROSTAT |
| $LC^T$, $LC^N$ | EU15, NO, CH | EUROSTAT, STAN |
| | RO | EUROSTAT, WIIW |
| | BG, CY, CZ, EE, HR, HU, LT, LV, PL, SK, SL | EUROSTAT |
| $E$ | CEEC12, DK, SE, UK, NO, CH | EUROSTAT |

Table 17: Description of data sources. AMECO denotes Annual Macro-Economic Database of the European Commission's Directorate General for Economic and Financial Affairs, ILO denotes the International Labour Organization, MEI denotes the OECD Main Economic Indicators, STAN denotes the OECD Structural Analysis Statistics, WIIW denotes the database of the Vienna Institute for Economic Comparative Studies. EU15 is AT, BE, DK, FI, FR, DE, UK, GR, IE, IT, LU, NL, PT, ES, SE

| Symbol | Definition |
|---|---|
| Prices | |
| $p^{CPI}$ | $ln(P^{CPI})$ |
| $\delta$ | $\frac{Y^N}{Y^T+Y^N}$ |
| $P^{T+N}$ | $(1-\delta)P^T + \delta P^N$ |
| $p^{T+N}$ | $ln(P^{T+N})$ |
| $p^{rel}$ | $ln(P^N/P^T)$ |
| $p^T$ | $ln(P^T)$ |
| $p^N$ | $ln(P^N)$ |
| $p^{AGR}$ | $ln(P^{AGR})$ |
| $p^{PUB}$ | $ln(P^{PUB})$ |
| Labor shares in tradables and non-tradables sectors | |
| $\alpha^T$ | $LC^T L^T / Y^T$ |
| $\alpha^N$ | $LC^N L^N / Y^N$ |
| Labor productivities | |
| $A^T$ | $Y^T/L^T$ |
| $A^N$ | $Y^N/L^N$ |
| $a^{rel}$ | $ln(A^T/A^N)$ |
| $a^T$ | $ln(A^T)$ |
| $a^N$ | $ln(A^N)$ |
| Wages and labor costs | |
| $w^{rel}$ | $ln(W^N/W^T)$ |
| $w^T$ | $ln(W^T)$ |
| $w^N$ | $ln(W^N)$ |
| $w^{N,rel}$ | $ln(W^N/(EW^{N*}))$ |
| Real exchange rates | |
| $Q$ | $EP^{CPI*}/P^{CPI}$ |
| $q$ | $ln(Q)$ |
| $Q_2$ | $EP^{(T+N)*}/P^{T+N}$ |
| $q_2$ | $ln(Q_2)$ |
| $Q^T$ | $EP^{T*}/P^T$ |
| $q^T$ | $ln(Q^T)$ |

Table 18: Detailed description of variable transformation employed in the empirical analysis.

| | |
|---|---|
| Gross value added, 1995 producer prices, EURO | |
| $Y^{T*} = \sum_{i \in BASE} Y_i^T$ | $Y^{N*} = \sum_{i \in BASE} Y_i^N$ |
| Employment | |
| $L^{T*} = \sum_{i \in BASE} L_i^T$ | $L^{N*} = \sum_{i \in BASE} L_i^N$ |
| Sectoral value added weights | |
| $c_i^T = \frac{Y_i^T}{Y^{T*}}$, $i \in BASE$ | $c_i^N = \frac{Y_i^N}{Y^{N*}}$, $i \in BASE$ |
| Deflators, 1995=100 | |
| $P^{T*} = \sum_{i \in BASE} c_i^T P_i^T$ | $P^{N*} = \sum_{i \in BASE} c_i^N P_i^N$ |
| Labor productivities | |
| $A^{T*} = Y^{T*}/L^{T*}$ | $A^{N*} = Y^{N*}/L^{N*}$ |
| Annual gross wages per employee, current prices, Euro | |
| $W^{T*} = \frac{\sum_{i \in BASE} W_i^T L_i^T}{L^{T*}}$ | $W^{N*} = \frac{\sum_{i \in BASE} W_i^N L_i^N}{L^{N*}}$ |
| Annual labor costs per employee, current prices, Euro | |
| $LC^{T*} = \frac{\sum_{i \in BASE} LC_i^T L_i^T}{L^{T*}}$ | $LC^{N*} = \frac{\sum_{i \in BASE} LC_i^N L_i^N}{L^{N*}}$ |

Table 19: Details of construction of the variables for the base country which is the aggregate of Germany, Austria, Belgium, The Netherlands, Luxembourg.

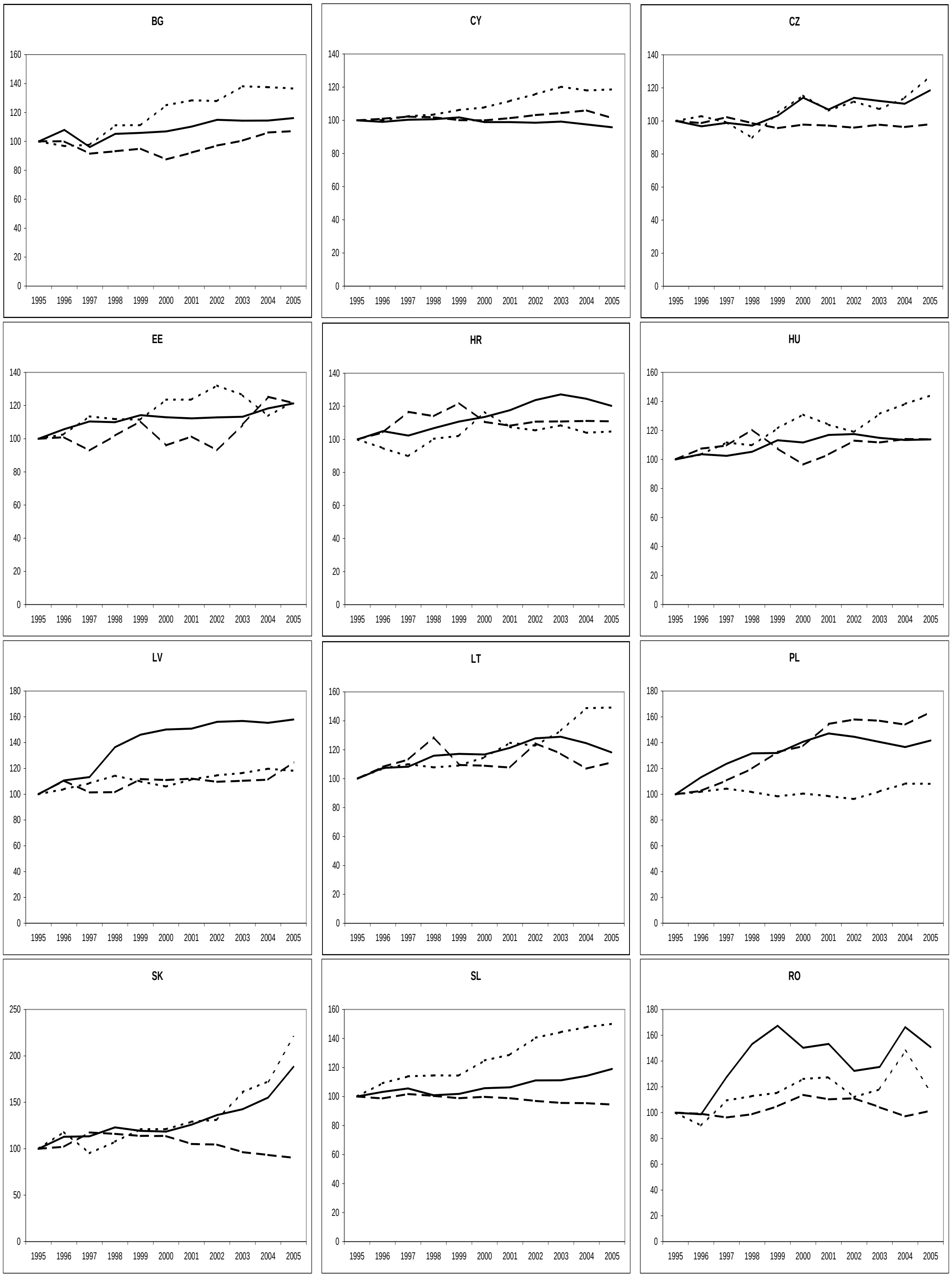


Figure 3: Solid lines: relative prices of non-tradable to tradable goods (N/T); fine dashed lines: relative productivities in tradable and non-tradable sector (T/N); dashed lines: relative wages in non-tradable and tradable sector (N/T). All quantities normalized to 100 in 1995.

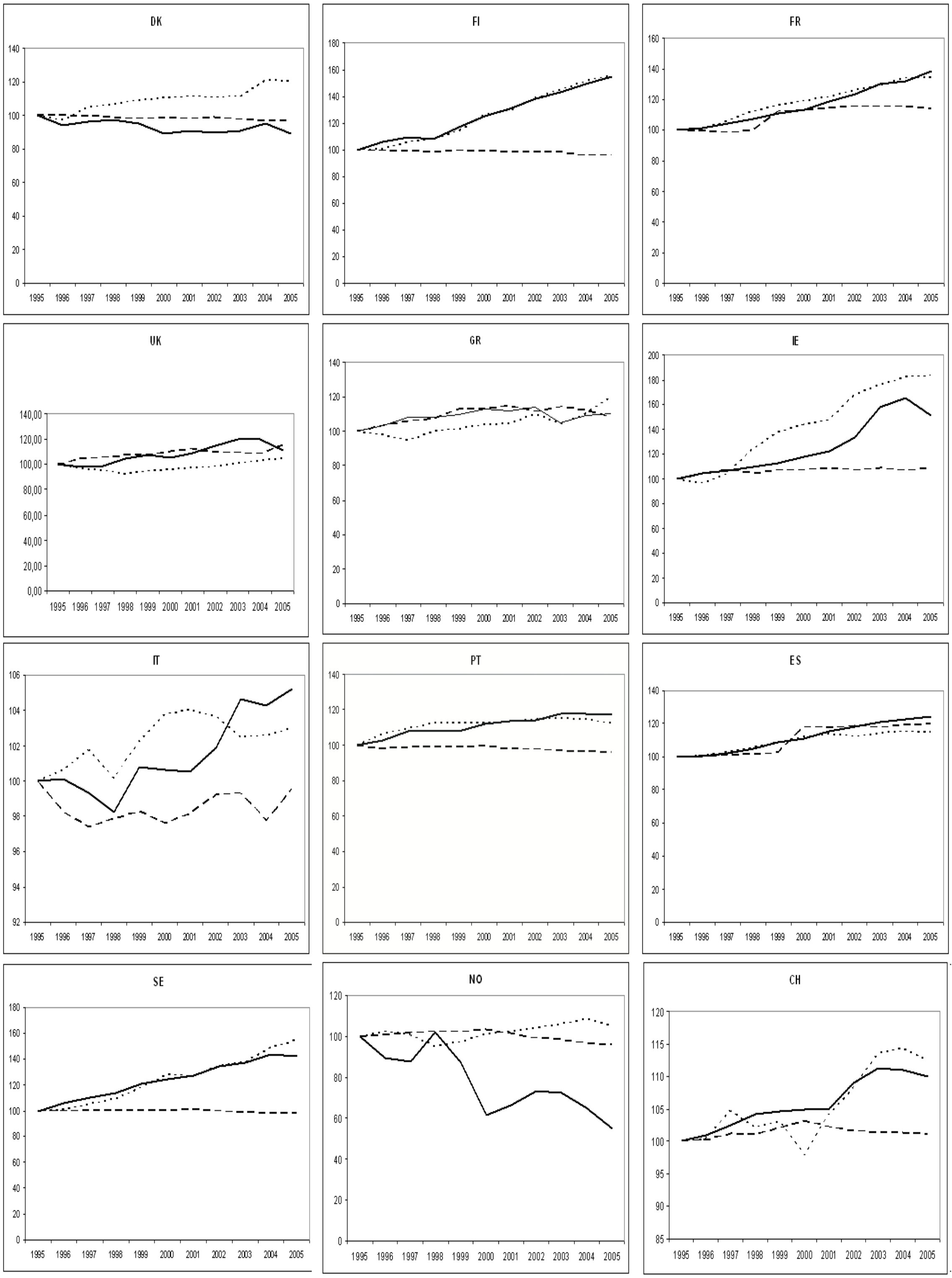


Figure 4: Solid lines: relative prices of non-tradable to tradable goods (N/T); fine dashed lines: relative productivities in tradable and non-tradable sector (T/N); dashed lines: relative wages in non-tradable and tradable sector (N/T). All quantities normalized to 100 in 1995.

| | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO | CEEC12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1996–2005 | | | | | | | |
| Min | 5.44 | 3.13 | 4.76 | 7.53 | 3.20 | 7.55 | 6.30 | 6.67 | 5.87 | 2.88 | 7.39 | 8.12 | 6.96 |
| Max | 38.34 | 6.34 | 9.02 | 9.64 | 5.89 | 11.92 | 13.30 | 8.99 | 9.03 | 8.61 | 10.47 | 36.22 | 11.99 |
| Mean | 23.86 | 3.88 | 6.13 | 8.35 | 4.75 | 9.65 | 8.83 | 7.18 | 6.46 | 6.24 | 8.82 | 23.77 | 9.67 |
| Std, Dev, | 13.23 | 0.80 | 1.11 | 0.52 | 1.06 | 1.85 | 2.10 | 0.55 | 0.78 | 2.13 | 1.23 | 11.51 | 1.99 |
| Mean $p$, $q$ | 16.88 | 2.81 | 4.57 | 6.30 | 3.02 | 7.58 | 7.54 | 5.71 | 5.30 | 4.40 | 7.00 | 17.21 | 7.36 |
| Std, Dev, $p$, $q$ | 15.96 | 1.10 | 1.45 | 0.70 | 0.85 | 2.09 | 2.17 | 0.66 | 0.84 | 2.36 | 1.36 | 13.31 | 2.31 |
| Mean $p_2$, $q_2$ | 26.17 | 4.12 | 6.31 | 8.42 | 5.59 | 9.30 | 7.77 | 6.89 | 5.94 | 6.78 | 8.45 | 25.59 | 9.76 |
| Std, Dev, $p_2$, $q_2$ | 10.39 | 0.10 | 0.67 | 0.27 | 0.32 | 1.64 | 1.50 | 0.14 | 0.06 | 1.87 | 1.04 | 9.96 | 1.78 |
| | | | | | | 2001–2005 | | | | | | | |
| Min | -0.48 | 2.03 | 2.70 | 2.90 | 2.50 | 6.99 | 4.18 | 2.93 | 3.38 | 1.45 | 5.15 | 7.81 | 5.71 |
| Max | 4.03 | 3.39 | 6.07 | 5.41 | 5.00 | 8.65 | 6.66 | 7.93 | 5.80 | 6.37 | 7.90 | 22.19 | 7.51 |
| Mean | 3.06 | 2.79 | 4.41 | 4.59 | 3.89 | 7.83 | 5.47 | 5.38 | 4.56 | 4.30 | 6.25 | 15.48 | 6.43 |
| Std, Dev, | 4.94 | 0.35 | 1.61 | 1.11 | 0.33 | 0.27 | 1.62 | 1.71 | 0.91 | 1.30 | 0.72 | 4.83 | 0.69 |
| Mean $p$, $q$ | 2.86 | 2.32 | 4.22 | 4.12 | 3.07 | 8.45 | 6.34 | 5.37 | 4.95 | 3.63 | 6.78 | 14.74 | 6.56 |
| Std, Dev, $p$, $q$ | 0.81 | 0.24 | 1.59 | 0.92 | 0.40 | 0.30 | 0.23 | 2.40 | 0.70 | 2.07 | 0.73 | 5.95 | 0.66 |
| Mean $p_2$, $q_2$ | 3.25 | 3.25 | 4.61 | 5.05 | 4.71 | 7.20 | 4.59 | 5.39 | 4.18 | 4.96 | 5.72 | 16.23 | 6.30 |
| Std, Dev, $p_2$, $q_2$ | 1.52 | 0.10 | 1.44 | 0.32 | 0.27 | 0.17 | 0.38 | 1.81 | 0.68 | 1.41 | 0.45 | 5.18 | 0.37 |
| | | | | | | 2004–2005 | | | | | | | |
| Min | -2.07 | 2.16 | 1.48 | 0.08 | 2.59 | 4.25 | 8.39 | 5.86 | 1.41 | -0.87 | 5.85 | 7.42 | 4.67 |
| Max | 4.06 | 3.89 | 4.32 | 4.22 | 5.93 | 7.77 | 10.52 | 11.58 | 5.67 | 3.30 | 11.67 | 13.63 | 8.21 |
| Mean | 2.45 | 3.19 | 2.97 | 2.62 | 4.42 | 5.98 | 9.48 | 8.85 | 3.50 | 1.62 | 8.70 | 10.17 | 6.43 |
| Std, Dev, | 1.41 | 0.55 | 1.14 | 1.29 | 1.13 | 1.55 | 0.81 | 2.05 | 1.41 | 1.47 | 2.05 | 1.70 | 1.08 |
| Mean $p$, $q$ | 2.84 | 2.81 | 2.95 | 1.80 | 3.49 | 7.47 | 10.22 | 8.85 | 4.25 | 1.00 | 9.33 | 11.01 | 6.90 |
| Std, Dev, $p$, $q$ | 0.98 | 0.50 | 1.16 | 1.33 | 0.69 | 0.28 | 0.32 | 2.42 | 1.22 | 1.70 | 2.22 | 2.03 | 1.06 |
| Mean $p_2$, $q_2$ | 2.06 | 3.57 | 2.99 | 3.44 | 5.36 | 4.50 | 8.74 | 8.85 | 2.74 | 2.24 | 8.06 | 9.32 | 5.96 |
| Std, Dev, $p_2$, $q_2$ | 1.71 | 0.28 | 1.20 | 0.51 | 0.50 | 0.22 | 0.26 | 1.77 | 1.21 | 0.92 | 1.79 | 0.66 | 0.94 |

| | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH | EU24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1996–2005 | | | | | | | |
| Min | 2.19 | 2.54 | 1.45 | 1.61 | 3.18 | 2.61 | 2.69 | 2.69 | 1.30 | 2.88 | 2.21 | 1.12 | 3.19 |
| Max | 3.36 | 4.28 | 2.66 | 2.67 | 7.76 | 5.04 | 5.00 | 5.39 | 2.91 | 4.90 | 6.71 | 2.11 | 4.08 |
| Mean | 2.86 | 3.97 | 2.01 | 2.20 | 5.37 | 3.87 | 4.20 | 4.30 | 1.99 | 3.90 | 4.49 | 1.76 | 3.68 |
| Std, Dev, | 0.39 | 0.42 | 0.36 | 0.36 | 1.52 | 0.90 | 0.69 | 0.83 | 0.52 | 0.65 | 1.89 | 0.33 | 0.33 |
| Mean $p$, $q$ | 1.84 | 2.90 | 1.66 | 1.36 | 5.15 | 2.14 | 2.74 | 3.84 | 1.55 | 2.60 | 1.92 | 1.16 | 2.53 |
| Std, Dev, $p$, $q$ | 0.24 | 0.50 | 0.18 | 0.29 | 1.39 | 0.40 | 0.45 | 0.88 | 0.67 | 0.43 | 0.31 | 0.45 | 0.13 |
| Mean $p_2$, $q_2$ | 3.20 | 4.21 | 1.74 | 2.47 | 4.22 | 4.68 | 4.79 | 3.76 | 1.84 | 4.30 | 6.30 | 1.84 | 3.98 |
| Std, Dev, $p_2$, $q_2$ | 0.12 | 0.05 | 0.29 | 0.17 | 0.08 | 0.27 | 0.17 | 0.10 | 0.28 | 0.60 | 0.27 | 0.13 | 0.10 |
| | | | | | | 2001–2005 | | | | | | | |
| Min | 2.20 | 2.23 | 0.97 | 1.50 | 2.95 | 2.42 | 2.34 | 2.36 | 0.06 | 1.98 | 2.12 | 1.21 | 2.68 |
| Max | 2.65 | 4.32 | 2.65 | 2.43 | 7.85 | 3.67 | 3.76 | 5.13 | 2.72 | 3.47 | 3.93 | 2.11 | 3.18 |
| Mean | 2.41 | 3.87 | 1.81 | 1.87 | 5.65 | 2.94 | 3.37 | 3.94 | 1.37 | 2.98 | 3.06 | 1.74 | 2.99 |
| Std, Dev, | 0.36 | 0.19 | 0.44 | 0.31 | 0.41 | 0.75 | 0.60 | 0.24 | 0.78 | 0.98 | 0.92 | 0.17 | 0.44 |
| Mean $p$, $q$ | 2.42 | 3.63 | 2.21 | 1.79 | 6.63 | 2.72 | 3.39 | 4.71 | 1.91 | 3.21 | 2.31 | 1.75 | 3.05 |
| Std, Dev, $p$, $q$ | 0.17 | 0.57 | 0.21 | 0.27 | 1.52 | 0.27 | 0.44 | 0.95 | 0.78 | 0.28 | 0.15 | 0.44 | 0.17 |
| Mean $p_2$, $q_2$ | 2.41 | 4.12 | 1.40 | 1.94 | 4.67 | 3.16 | 3.35 | 3.17 | 0.82 | 2.74 | 3.80 | 1.73 | 2.93 |
| Std, Dev, $p_2$, $q_2$ | 0.12 | 0.19 | 0.40 | 0.20 | 0.38 | 0.37 | 0.10 | 0.06 | 0.75 | 0.68 | 0.11 | 0.15 | 0.19 |
| | | | | | | 2004–2005 | | | | | | | |
| Min | 2.26 | 2.11 | 0.19 | 1.24 | 3.16 | 2.49 | 2.55 | 2.28 | 0.10 | 2.73 | 2.11 | 0.79 | 2.72 |
| Max | 3.09 | 4.23 | 2.66 | 2.49 | 7.76 | 5.00 | 3.71 | 4.96 | 2.82 | 5.49 | 10.34 | 1.89 | 3.51 |
| Mean | 2.72 | 3.77 | 1.43 | 1.66 | 5.34 | 3.68 | 3.19 | 3.80 | 1.38 | 4.27 | 6.11 | 1.28 | 3.21 |
| Std, Dev, | 0.23 | 0.49 | 0.78 | 0.37 | 1.76 | 1.01 | 0.38 | 0.99 | 0.93 | 0.82 | 3.30 | 0.32 | 0.21 |
| Mean $p$, $q$ | 2.57 | 3.49 | 2.03 | 1.66 | 6.73 | 2.75 | 3.34 | 4.54 | 2.04 | 3.59 | 2.99 | 1.36 | 3.10 |
| Std, Dev, $p$, $q$ | 0.21 | 0.56 | 0.30 | 0.36 | 1.47 | 0.30 | 0.34 | 0.92 | 0.75 | 0.48 | 0.60 | 0.38 | 0.22 |
| Mean $p_2$, $q_2$ | 2.88 | 4.04 | 0.84 | 1.65 | 3.95 | 4.61 | 3.04 | 3.06 | 0.72 | 4.94 | 9.22 | 1.20 | 3.32 |
| Std, Dev, $p_2$, $q_2$ | 0.12 | 0.17 | 0.64 | 0.41 | 0.22 | 0.37 | 0.37 | 0.05 | 0.53 | 0.38 | 0.88 | 0.26 | 0.13 |

Table 20: The Balassa-Samuelson inflation simulations under the assumption $\Delta p^*$ equals 2% and with the inflation differentials in tradables set at the historical values. The values for the other variables are at the average values for the periods specified.

| | Averages over 1996–2005 | | | | Averages over 2001–2005 | | | |
|---|---|---|---|---|---|---|---|---|
| Country | $\Delta Cp$ | $\Delta Dp$ | $\Delta Bp_2$ | $\Delta Cp_2$ | $\Delta Cp$ | $\Delta Dp$ | $\Delta Bp_2$ | $\Delta Cp_2$ |
| BG | 0.01 | 0.02 | 0.60 | 0.34 | -0.03 | -0.07 | -0.91 | -1.65 |
| CY | -0.02 | -0.08 | 0.00 | -0.01 | -0.96 | -0.88 | -0.60 | -0.49 |
| CZ | -0.01 | 0.07 | 0.08 | -0.01 | 0.94 | 1.21 | 0.79 | 0.47 |
| EE | -0.02 | -0.01 | 0.15 | -0.01 | -1.17 | -1.09 | -0.27 | -0.59 |
| HR | -0.39 | -0.37 | -0.10 | -0.20 | -1.15 | -1.13 | -0.65 | -0.58 |
| HU | 0.32 | 0.36 | 0.36 | 0.16 | 0.25 | 0.32 | 0.32 | 0.13 |
| LT | 0.40 | 0.44 | 0.36 | 0.20 | 0.49 | 0.57 | 0.24 | 0.25 |
| LV | -0.12 | -0.09 | 0.12 | -0.06 | -0.57 | -0.56 | 0.02 | -0.29 |
| SK | 0.94 | 1.33 | 0.82 | 0.47 | 1.68 | 2.85 | 1.69 | 0.85 |
| SL | 0.37 | 0.45 | 0.28 | 0.19 | -0.35 | -0.29 | -0.18 | -0.18 |
| PL | -0.34 | -0.30 | 0.08 | -0.17 | -0.19 | -0.10 | 0.09 | -0.09 |
| RO | -0.01 | -0.01 | -0.04 | -0.41 | -0.03 | -0.08 | -1.47 | -1.66 |
| DK | -0.01 | -0.01 | -0.02 | -0.01 | 0.07 | 0.04 | 0.11 | 0.07 |
| ES | -0.03 | -0.04 | 0.05 | -0.04 | -0.16 | -0.17 | -0.34 | -0.17 |
| FI | 0.08 | 0.13 | 0.36 | 0.08 | -0.02 | 0.02 | 0.01 | -0.02 |
| FR | 0.06 | 0.05 | 0.26 | 0.07 | -0.07 | -0.08 | -0.21 | -0.07 |
| GR | 0.00 | -0.01 | 0.02 | 0.00 | 0.30 | 0.21 | 0.49 | 0.31 |
| IE | 0.15 | 0.22 | 0.68 | 0.15 | 0.03 | -0.06 | -0.14 | 0.03 |
| IT | -0.11 | -0.10 | -0.21 | -0.11 | -0.17 | -0.17 | -0.39 | -0.17 |
| PT | -0.05 | -0.05 | -0.11 | -0.05 | -0.25 | -0.24 | -0.60 | -0.25 |
| SE | 0.09 | 0.13 | 0.34 | 0.09 | 0.08 | 0.15 | 0.40 | 0.08 |
| UK | -0.06 | -0.09 | -0.09 | -0.06 | -0.03 | -0.07 | 0.03 | -0.03 |
| NO | -0.07 | -0.09 | -0.21 | -0.07 | -0.16 | -0.20 | -0.56 | -0.17 |
| CH | -0.05 | -0.05 | -0.06 | -0.05 | -0.20 | -0.21 | -0.49 | -0.21 |

Table 21: The Balassa-Samuelson effect in % in equations for the inflation differentials. The Balassa-Samuelson effect is defined as the product of the coefficient to the BS-variable in the corresponding equations with the average values of the variables as displayed in Table 22 and Table 23

| Country | BG | CY | CZ | EE | HR | HU | LT | LV | SK | SL | PL | RO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\Delta w^{rel}$ | | | | | | | | | | | | |
| 1996–2005 | 0.69 | 0.13 | -0.20 | 1.95 | 1.03 | 1.30 | 1.07 | 2.21 | -1.02 | -0.56 | 4.93 | 0.15 |
| 2001–2005 | 4.06 | 0.27 | 0.04 | 4.72 | 0.06 | 3.32 | 0.41 | 2.33 | -4.61 | -1.09 | 3.53 | -2.29 |
| 2004–2005 | 3.20 | -1.48 | 0.14 | 5.70 | 0.03 | 0.97 | -2.67 | 6.13 | -3.23 | -0.55 | 2.12 | -1.29 |
| $\Delta w^{N,rel}$ | | | | | | | | | | | | |
| 1996–2005 | 35.40 | 3.28 | 6.22 | 12.80 | 7.42 | 12.45 | 10.31 | 12.49 | 7.99 | 8.29 | 11.75 | 35.03 |
| 2001–2005 | 8.03 | 3.04 | 4.79 | 12.18 | 4.90 | 10.87 | 7.80 | 11.18 | 2.60 | 5.67 | 3.23 | 21.63 |
| 2004–2005 | 8.17 | 2.05 | 5.42 | 13.21 | 4.80 | 9.55 | 9.32 | 22.45 | 4.31 | 6.00 | 2.85 | 17.24 |
| $\Delta w^{T,rel}$ | | | | | | | | | | | | |
| 1996–2005 | 0.34 | 0.02 | 0.06 | 0.10 | 0.06 | 0.10 | 0.08 | 0.09 | 0.08 | 0.08 | 0.06 | 0.34 |
| 2001–2005 | 0.03 | 0.02 | 0.04 | 0.07 | 0.04 | 0.07 | 0.07 | 0.08 | 0.06 | 0.06 | -0.01 | 0.23 |
| 2004–2005 | 0.04 | 0.02 | 0.04 | 0.06 | 0.03 | 0.07 | 0.11 | 0.15 | 0.06 | 0.05 | -0.01 | 0.17 |
| $\Delta w^{N}$ | | | | | | | | | | | | |
| 1996–2005 | 0.36 | 0.04 | 0.07 | 0.14 | 0.08 | 0.13 | 0.11 | 0.13 | 0.09 | 0.09 | 0.13 | 0.36 |
| 2001–2005 | 0.09 | 0.04 | 0.06 | 0.13 | 0.06 | 0.12 | 0.09 | 0.12 | 0.04 | 0.07 | 0.04 | 0.23 |
| 2004–2005 | 0.09 | 0.03 | 0.06 | 0.14 | 0.05 | 0.10 | 0.10 | 0.23 | 0.05 | 0.07 | 0.03 | 0.18 |
| $\Delta q^{T}$ | | | | | | | | | | | | |
| 1996–2005 | -5.28 | -2.98 | -4.42 | -4.90 | -1.87 | -4.13 | -7.34 | -2.28 | -1.92 | -1.03 | -2.00 | -5.79 |
| 2001–2005 | -1.83 | -1.47 | -3.72 | -0.87 | -2.67 | -5.18 | -2.11 | 1.84 | -0.22 | 0.23 | -0.94 | -5.76 |
| 2004–2005 | -1.94 | -3.80 | -0.77 | 1.22 | -3.75 | -4.00 | -6.50 | -2.12 | 0.47 | 1.81 | -6.07 | -8.78 |
| $\Delta p^{T} - \Delta p^{T*}$ | | | | | | | | | | | | |
| 1996–2005 | 36.31 | 2.72 | 2.89 | 5.34 | 2.66 | 8.23 | 3.19 | 2.38 | 1.85 | 5.39 | 4.38 | 31.89 |
| 2001–2005 | 1.87 | 1.57 | 0.15 | 0.87 | 2.02 | 4.23 | 0.76 | 2.54 | -1.75 | 2.73 | 1.01 | 17.71 |
| 2004–2005 | 2.11 | 3.17 | -2.58 | -1.22 | 2.62 | 2.89 | 6.50 | 6.27 | -4.08 | -0.60 | 1.59 | 6.96 |
| $\Delta p^{A+P}$ | | | | | | | | | | | | |
| 1996–2005 | 34.18 | 3.50 | 4.04 | 4.35 | 3.73 | 9.37 | 1.75 | 3.44 | 5.01 | 6.17 | 5.75 | 36.49 |
| 2001–2005 | 1.19 | 3.86 | 2.04 | 1.85 | -0.99 | 6.22 | -3.07 | 2.41 | 2.58 | 4.76 | 3.17 | 25.45 |
| 2004–2005 | -0.24 | 0.64 | -1.42 | 1.99 | 0.82 | 1.61 | 0.13 | 4.02 | -1.40 | 2.56 | 1.75 | 14.00 |
| $\Delta a^{T} - \Delta a^{T*}$ | | | | | | | | | | | | |
| 1996–2005 | -0.20 | 0.05 | 1.75 | 6.13 | 2.57 | 2.21 | 5.99 | 4.20 | 4.42 | 3.23 | 2.40 | 2.17 |
| 2001–2005 | 1.33 | -0.86 | 2.40 | 5.31 | 2.34 | 2.23 | 6.93 | 5.57 | 7.33 | 2.51 | 1.85 | 1.14 |
| 2004–2005 | -0.98 | -4.38 | 6.62 | 3.28 | -0.36 | 2.84 | 4.50 | 4.33 | 8.32 | 0.50 | 0.85 | 4.69 |

Table 22: Period averages of explanatory variables used in the inflation simulations for CEECs.

| Country | DK | ES | FI | FR | GR | IE | IT | PT | SE | UK | NO | CH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $\Delta w^{rel}$ | | | | | | |
| 1996–2005 | -0.34 | 1.79 | -0.43 | 1.31 | 0.84 | 0.85 | -0.04 | -0.42 | -0.20 | 1.40 | -0.42 | 0.11 |
| 2001–2005 | -0.37 | 0.23 | -0.65 | 0.04 | -0.74 | 0.29 | 0.40 | -0.75 | -0.42 | 0.86 | -1.47 | -0.42 |
| 2004–2005 | -0.58 | 0.62 | -1.19 | -0.80 | -2.48 | 0.00 | 0.13 | -0.60 | -0.21 | 2.70 | -1.39 | -0.14 |
| | | | | | | $\Delta w^{N,rel}$ | | | | | | |
| 1996–2005 | 2.47 | 2.45 | 2.22 | 2.30 | 5.06 | 5.46 | 3.33 | 3.12 | 3.29 | 4.11 | 3.87 | 0.68 |
| 2001–2005 | 1.67 | 1.24 | 2.15 | 1.65 | 3.75 | 4.04 | 1.87 | 1.92 | 1.76 | 2.42 | 2.54 | 0.06 |
| 2004–2005 | 2.22 | 1.20 | 2.70 | 2.42 | 4.01 | 5.17 | 3.03 | 2.20 | 2.83 | 3.42 | 3.47 | 0.40 |
| | | | | | | $\Delta w^{T,rel}$ | | | | | | |
| 1996–2005 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.00 |
| 2001–2005 | 0.01 | 0.00 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 | 0.02 | 0.01 | 0.01 | 0.03 | 0.00 |
| 2004–2005 | 0.01 | -0.01 | 0.03 | 0.02 | 0.05 | 0.04 | 0.02 | 0.01 | 0.02 | -0.01 | 0.04 | -0.01 |
| | | | | | | $\Delta w^{N}$ | | | | | | |
| 1996–2005 | 0.03 | 0.03 | 0.03 | 0.03 | 0.06 | 0.06 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.01 |
| 2001–2005 | 0.03 | 0.02 | 0.03 | 0.03 | 0.05 | 0.05 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.01 |
| 2004–2005 | 0.03 | 0.02 | 0.03 | 0.03 | 0.05 | 0.06 | 0.04 | 0.03 | 0.03 | 0.04 | 0.04 | 0.01 |
| | | | | | | $\Delta q^{T}$ | | | | | | |
| 1996–2005 | -2.66 | -1.71 | 2.37 | 1.28 | -2.11 | -1.83 | -3.49 | -1.28 | 1.85 | -3.27 | -8.75 | 0.15 |
| 2001–2005 | -1.39 | -1.58 | 3.46 | 2.26 | -2.95 | 1.14 | -1.50 | -0.98 | 3.95 | 1.51 | -4.27 | 0.56 |
| 2004–2005 | -2.44 | -1.82 | 4.01 | 2.13 | -1.55 | -1.80 | -1.28 | -1.31 | 3.07 | -4.17 | -15.04 | 1.48 |
| | | | | | | $\Delta p^{T} - \Delta p^{T*}$ | | | | | | |
| 1996–2005 | 2.83 | 1.71 | -2.37 | -1.28 | 2.11 | 1.83 | 3.49 | 1.28 | -1.91 | 1.35 | 8.41 | -0.14 |
| 2001–2005 | 1.39 | 1.58 | -3.46 | -2.26 | 2.95 | -1.14 | 1.50 | 0.98 | -2.06 | 0.79 | 4.01 | -0.69 |
| 2004–2005 | 2.58 | 1.82 | -4.01 | -2.13 | 1.55 | 1.80 | 1.28 | 1.31 | -2.21 | 3.58 | 15.08 | -0.59 |
| | | | | | | $\Delta p^{A+P}$ | | | | | | |
| 1996–2005 | 1.41 | 2.52 | -0.05 | 1.28 | 2.70 | 2.08 | 3.81 | 3.69 | 1.38 | 2.52 | 3.13 | 0.33 |
| 2001–2005 | 2.00 | 3.32 | 1.74 | 2.16 | 4.26 | 5.95 | 3.30 | 4.19 | 1.76 | 3.67 | 3.40 | 1.41 |
| 2004–2005 | 1.00 | 2.83 | 0.66 | 1.25 | 4.48 | 4.30 | 2.80 | 3.74 | -1.80 | 2.26 | 2.37 | -0.35 |
| | | | | | | $\Delta a^{T} - \Delta a^{T*}$ | | | | | | |
| 1996–2005 | 0.04 | -2.56 | 2.49 | 0.63 | 0.65 | 4.38 | -3.05 | -0.92 | 2.84 | 0.10 | -0.38 | -0.57 |
| 2001–2005 | -0.21 | -2.61 | 2.39 | 0.44 | 1.26 | 3.75 | -3.73 | -2.15 | 2.65 | 1.04 | 0.19 | -0.05 |
| 2004–2005 | 0.47 | -4.64 | 1.27 | -0.32 | 0.96 | -0.51 | -4.22 | -4.58 | 4.62 | 0.22 | -1.82 | -2.00 |

Table 23: Period averages of explanatory variables used in the inflation simulations for Western countries.