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Abstract

The paper focuses on the developments of real exchange rates and their fundamental determinants in the five new EU Member States (Czech Republic, Hungary, Poland, Slovakia, and Slovenia). First, the approaches that can be used for estimation of equilibrium real exchange rates are briefly discussed. Then, we use well-established determinants of real exchange rates associated with the behavioral equilibrium exchange rate (BEER) approach to assess misalignments of the real exchange rates for the five new EU Member States. The estimates of the equilibrium exchange rates are obtained by means of both purely statistical approaches (HP filter, band-pass filter) and applying several multivariate estimation methods to our reduced-form BEER model. The results obtained indicate that the tendency towards appreciation of real exchange rates in the economies under consideration have been driven primarily by fundamental determinants.

Keywords: Exchange rate misalignments, equilibrium exchange rates, ERM II, Central European Countries

JEL Classification: C52, C53, E58, E61, F31

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1. Introduction

Both policy makers and market participants have a strong interest in appropriate estimates of equilibrium real exchange rates and their prospective movements. They have also a keen interest in understanding determinants of the equilibrium real exchange rate and the factors behind implied misalignments of the actual rate from its equilibrium level. The real exchange rate is viewed as a key indicator of external competitiveness. Hence, a real appreciation of the exchange rate is often interpreted as a loss of price competitiveness. Nevertheless, this applies only if the real exchange rate becomes overvalued in relation to the equilibrium one. At the same time, real exchange rate appreciation can simply reflect improved competitiveness thanks to an increase in productivity. In this sense, the study of the determinants of the real exchange rates may shed some light on whether a real appreciation causes a loss in competitiveness or reflects the improvements in it[1].

The real exchange rate misalignments may be rather costly. Both overvalued and undervalued currencies have their negative implications. From policymakers' perspective, the risks implied by the overvaluation are more important. There is an empirical support for the view that an overvalued currency leads to lower economic growth, especially via the impact on the manufacturing (see e.g. Razin and Collins, 1997). Additionally, an overvalued currency may lead to an unsustainable current account deficit, increasing external debt and the risk of possible speculative attacks (see e.g. Kaminski, Lizondo and Reinhart, 1997). An undervalued currency seems to have an equivocal effect, though the risk should not be underestimated too.

The potential misalignment is one of the most important policy issues faced by the new EU Member States that are supposed to adopt the euro in the future. The challenges constitute the participation in the exchange rate mechanism, ERM II, which is part of the criterion related to exchange rate stability, with a chosen central parity, and the future announcement of their euro-locking rate. ECB (2003) recommends in its position documents related to ERM II participation that *"… the central rate should reflect the best possible assessment of the equilibrium exchange rate at the time of entry into the mechanism. This assessment should be based on a broad range of economic indicators and developments while also taking account for the market rate."* In broad terms, the "equilibrium" exchange rate refers to the rate, which is consistent with medium-term macroeconomic fundamentals. The medium term, usually defined as two to six years, is often chosen as a benchmark in order to assess the level towards which the actual exchange rate is meant to gravitate to.

The overall objective of this paper is the evaluation of the real exchange rate misalignments by purely statistical as well as behavioural approaches applied to the five new EU Member States

[1] See also Frait and Komárek (1999, 2001).

(EU5), namely in the Czech Republic, Hungary, Poland, Slovakia and Slovenia. In Section 2, we focus on the development of real exchange rates and its determinants in EU5. The long-term trends leading to real exchange rate appreciation are described while pointing to the differences in the individual countries. We also provide a survey of existing empirical literature on the real exchange rates in transitional countries. In Section 3, we briefly mention various approaches that can be used for the estimation of the equilibrium real exchange rates. From the available options we decided to build on the main determinants of the real exchange rate movements considered by the BEER approach (Behavioral Equilibrium Exchange Rate). The advantage is a simple structure suitable for looking at a number of countries with a problematic data sources. Nevertheless, the drawback of the approach is the ad hoc specification. Section 4 then presents the results of the estimations of the misalignments of the real exchange rates in the individual countries. The estimations were made by means of the purely statistical (Hodrick-Prescott and Band-Pass filter) as well as the BEER-like approaches, which were estimated by two single equation techniques (Engle-Granger and ARDL). In the concluding part we report that the real exchange rates have generally evolved in line with the determinants that are believed to be fundamental. The differences among the individual countries can sometimes be explained by different development of their fundamentals.

2. Development and Determinants of the Real Exchange Rates

2.1. The Real Exchange Rate Developments in the New EU Member States

The real convergence of all post-socialistic new EU Member States (NMS) accompanied by sustained appreciation of the real exchange rate[2]. The left hand side of Figure 1 shows that all EU5 countries experienced significant real exchange rate appreciation between 1993 and 2004. At the same time, on average the real exchange rate appreciation was slower during 2000-04 compared to 1993-99, but surprisingly not so much.

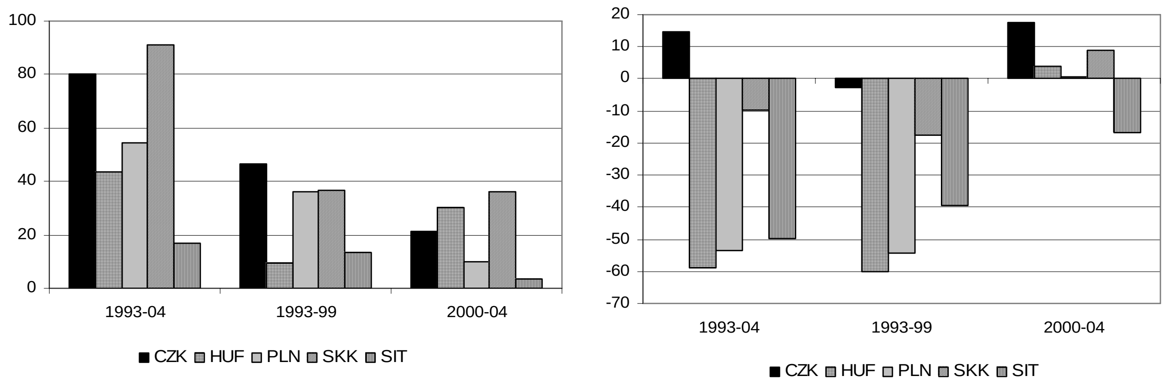
There is also a trend regarding the relative importance of the exchange rate and inflation channels in the process of real exchange ate appreciation. The right hand side of Figure 1 brings evidence that during 1993-99 the economies relied on nominal exchange rate depreciation and real exchange rate appreciation was achieved via much higher inflation. The outlier is the Czech Republic that experienced nominal exchange rate appreciation and low inflation over the whole period. However, at the end of decade nominal exchange rate appreciation ceased to be the preferred solution, and nominal exchange rates became rather stable or even appreciating also in the other economies. This reflects their ambitions to bring the inflation close to the inflation

[2] We sort the NMS into two groups: *Group A* – countries with relatively fixed exchange rate regimes and *Group B* – countries following a more flexible regime (see also Appendix 4). The countries in these groups will be compared with the development of the former EU catching up countries – *Group C*.

criterion required for the euro adoption as well as the world-wide preference for a very low inflation.

Figure 1: Real Exchange Rate and ERDI of the EU5 Countries

a) real appreciation in the EU5 (%) b) nominal appreciation in the EU5 (%)



Note: (+) appreciation, (-) depreciation

Sources: Eurostat, IMF-IFS CD-ROM and authors' calculations.

Table 1[3] shows the results of the decomposition of the real exchange rates on nominal exchange rates[4] and inflation differentials for all NMS and the group of "old" Members States comprised of the catching up countries (Spain, Portugal, Ireland and Greece). The appreciation of real exchange rates can be generally found during the two or five years preceding the end of sample evaluation period (group A and B) or factual acceptance to the euro area (group C). The variability of the real exchange rate, which we monitor by normalized standard deviations, was lower during the shorter (two years) than longer (five years) period, as might be expected.

[3] Table 1 presents average means and standard deviations of year-over-year percentage changes for the nominal and the CPI-based real exchange rates and also for inflation differential. We take the two periods for the NMS, i.e. 2-year (July 2002 – June 2004) and 5-year (July 1999 – June 2004) intervals from the end of the evaluation period. We compare these results with the similar periods, i.e. 2 and 5 years backwards from the entry date of selected current euro area members (Ireland, Spain, Portugal and Greece).

[4] The countries' nominal exchange rate paths against the euro can be broken down, according to the common features of their nominal exchange rate indices, into those which, between the start of 1993 and the present, have predominantly appreciated, depreciated or have been (by definition of their exchange rate regime) stable against the DEM/EUR or ECU/EUR rates.

Table 1: The Average Changes in Exchange Rates and Inflation Differentials

Country / Variable		REAL EXCHANGE RATE				NOMINAL EXCHANGE				INFLATION DIFFERENTIAL			
		2y backwards		5y backwards		2y backwards		5y backwards		2y backwards		5y backwards	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A	Estonia (EEK)	-0.633	0.967	-1.963	1.397	0.000	0.000	0.000	0.000	0.646	0.980	1.985	1.436
	Lithuania (LTL)	1.126	1.728	-3.778	6.284	-0.917	1.744	-4.855	5.870	-2.019	0.589	-1.090	1.039
	Latvia (LVL)	6.018	4.151	-1.005	7.948	7.940	3.483	0.678	4.756	1.848	1.417	1.360	1.195
	Cyprus (CYP)	-1.154	1.375	-1.298	1.599	0.843	0.933	0.192	0.914	2.037	1.524	1.529	1.448
	Malta (MTL)	3.032	2.720	-0.963	4.329	3.010	1.916	-0.258	3.678	0.002	1.156	0.746	1.220
Group B	Czechia (CZK)	0.497	5.878	-3.152	5.891	0.162	5.898	-2.122	5.304	-0.332	0.933	1.109	1.469
	Hungary (HUF)	-1.673	4.582	-5.072	4.643	2.201	5.039	0.336	8.076	3.933	1.140	6.089	2.351
	Poland (PLN)	12.040	4.873	-0.141	11.849	12.093	4.490	2.848	9.756	0.064	0.794	3.308	3.603
	Slovakia (SKK)	-7.693	3.869	-7.150	5.140	-2.343	2.325	-0.700	4.558	5.886	2.643	7.075	3.946
	Slovenia (SIT)	-0.864	0.910	-1.010	0.951	3.389	0.673	4.632	1.483	4.302	1.441	5.706	1.573
Group C	Spain (ESP)	-0.034	0.569	-0.856	5.630	0.455	0.491	2.156	4.881	0.491	0.554	1.578	1.034
	Portugal (PTE)	-1.048	1.814	-0.533	3.663	-0.041	1.793	1.163	4.170	1.023	1.048	1.694	0.972
	Ireland (IEP)	-2.372	6.448	0.564	4.558	-1.737	7.298	-0.478	6.073	0.598	1.073	0.360	0.832
	Greece (GRD)	4.886	3.989	0.088	6.081	1.199	2.867	1.314	4.049	-3.355	5.146	1.469	5.244

Notes: a) calculations based on average monthly market exchange rate against DEM/EUR and monthly CPI indexes.

b) (-) national currency appreciation/decrease, (+) national currency depreciation/increase; the numbers thus express the appreciation or depreciation of the euro against national currencies, not vice versa. Shadow parts alert to appreciation periods.

c) calculation for 2 and 5 years before the hypothetical (group A,B) and real (group C) euro area entry, i.e. for group A and B: end of June 2004 and 2 (5) years backwards, for Spain, Portugal and Ireland: January1997- December1998, (January1994 - December 1999) and for Greece: January 1999-December 2000 (January 1996 - December 2000).

Sources: Eurostat, IMF-IFS CD-ROM and authors' calculations

Despite a slowdown in real appreciation in recent years, there still must be a scope for further real appreciation in some countries as evidenced by calculations of the Exchange Rate Deviation Index (ERDI) - the ratios of the nominal exchange rate over the PPP-implied exchange rate (see Figure 2). In principle, equally developed countries have similar price levels expressed in the same currency unit ($E.P^*=P$)[5]. Consequently, in the steady state, the ERDI of countries with the same GDP per capita should equal to 1 ($EP^*/P=1$)[6]. Regarding transition countries with much lower GDP per capita, their exchange rates are normally undervalued relative to those of more developed countries implying that the ERDI is higher than one[7]. However, if the price level of a

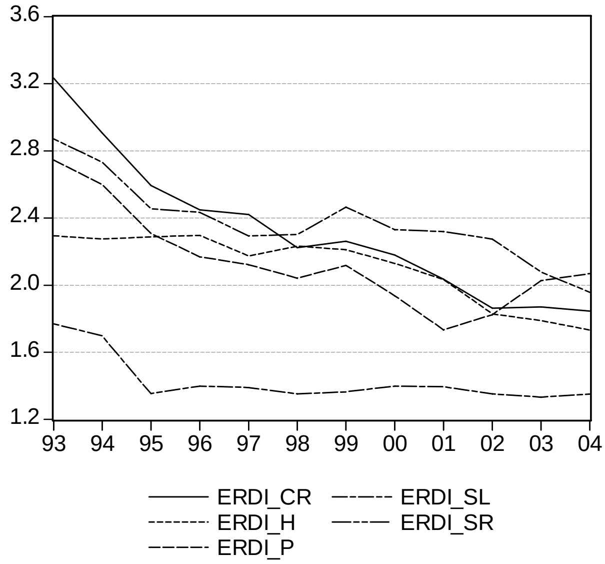
[5] E = nominal exchange rate, P = domestic price level, P* = foreign price level.

[6] Of course, there are factors which may cause the price level to deviate on from another, such as different taxation, direct and indirect trade barriers and in particular transportation costs.

[7] The exchange rate must be defined as units of domestic currency per one unit of foreign currency.

transition country is in line with its productivity level, this undervaluation can be viewed as an equilibrium undervaluation in PPP terms. In addition, there may be a gap between the actual ERDI and the one implied by GDP per capita. This particular gap should close during the initial phase transition to a large extent thanks to the elimination of the inefficiencies and structural distortions. A successful catch-up process should thus cause the real exchange rate to appreciate first towards the ERDI values implied by GDP per capita and then, in the very long run, towards the ERDI value of 1, representing the PPP "target" value.

Figure 2: Exchange Rate Deviation Index of the EU5 Countries



Note: ERDI= Exchange rate deviation index, CR=Czech Republic, H=Hungary, P=Poland, SL=Slovenia, SR=Slovakia.
Sources: Eurostat, IMF-IFS CD-ROM and authors' calculations.

The calculations of the ERDI show that their values for the EU5 countries have been relatively far from the steady state value of 1, but also from the average "entrance" value of countries of group C defined above. This value was for all these countries on average 1.3 – from the lowest value 1.23 (Spain) to the highest value 1.45 (Portugal). The only exception is the ERDI for Slovenia which is not so far from the average the Group C countries. However, other four countries have still significantly higher values of ERDI, but with a clear long-run trend towards the lower number. Real exchange rate appreciation thus should continue in the years prior the euro adoption. Admittedly, there is a major uncertainty as to the speed of the real appreciation in the more advanced phases of transition.

2.2 The Fundamental Factors Affecting the Real Exchange Rate

According to the abundant empirical literature on the determinants of real exchange rate[8], the key variables which drive real exchange rates development are productivity or productivity differentials, net foreign assets, terms of trade, real interest rates differentials, foreign debts and foreign direct investment to GDP ratios. Higher growth of *average productivity* at home compared to the foreign country is believed to lead unambiguously to real exchange rate appreciation. Next, an increase in the *net foreign asset position*, by augmenting the amount of foreign assets owned by the residents, is expected to increase the value of domestic currency and contribute to real exchange rate appreciation. The *terms of trade*, the ratio of export to import prices, are implicitly linked with the price component of the real exchange rate. If the terms of trade improve, then relative domestic prices rise, which leads to real exchange rate appreciation. The *real interest rate differential*, as an indicator of attractiveness of domestic currency on international markets, may also have at least positive short-term impact on the real exchange rate. Conversely, high ratio of *foreign debt to GDP* undermines the confidence in the currency and contributes to nominal or subsequently a real depreciation. Other possible explanatory variables are the degree of openness or the shares of investment, government or private consumption on GDP. We note that the individual theories and models may view the impact of the fundamentals differently. Especially time horizon is what matters. Some determinants are believed to cause the real exchange rate appreciation in the short run and depreciation in the medium- or long-run, and vice versa. This is a crucial challenge for the estimates of equilibrium real exchange rates[9].

Regarding the transition countries, Frait and Komárek (2001) split the factors affecting the real exchange rate into two broad groups: those that affect the tradables sector and those that affect the non-tradables sector. They sort the main factors affecting the real exchange rate, and which cause real appreciation of the exchange rate in transition economies, into two groups - the supply and demand factors. The supply factors include the Balassa–Samuelson effect, the relative factor endowment hypothesis, the costs of developing the network and regulated sectors, and the “Dutch disease”. The demand factors include the income elasticity of demand for non-tradables and capital inflows following liberalisation of the financial (capital) account.

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[8] See, for example, the classic studies by Faruqee (1995), MacDonald (1997), Clark and MacDonald (1998), and a more recent overview by Frait and Komárek (1999, 2001) and Égert (2003).

[9] The determinants of real exchange rates can be distributed also over time in the following way. In the short run, movements in the real exchange rate are determined by changes in the nominal exchange rate. This means that the correlation between the nominal and real exchange rate is very high in the short run. In the medium run the real exchange rate is determined chiefly by factor associated with the balance of payments (real interest rates, which determine developments on the financial account; the current account position, which determines net foreign assets; and aggregate labour productivity) and by “real shocks” to the economy (significant technological changes, significant changes in the terms of trade, and significant changes in state finances, for example rises or falls in expenditure on arms or infrastructure investment). In the very long run, the real exchange rates of advanced nations that are near to steady state can be more or less constant, unless they exhibit different trends in the overall productivity or thrift.

Égert (2003) provides an extensive survey of empirical studies that lists a vast number of variables that are believed to have a lasting impact on real exchange rate. Productivity or a proxy of it appears to enter almost always the real exchange rate equation. There is a strong evidence that an increase in productivity leads to an appreciation of the real exchange rate. However, the findings of the literature regarding the signs of the other variables are mixed. Approximately a third of the papers find that government expenditures in GDP, the openness ratio, net foreign assets, the foreign real interest rate or the real interest differential and the terms of trade have had a significant impact on the real exchange of the NMS. Besides, a couple of other variables such as foreign debt, private expenditures and investment relative to GDP have also been detected in a handful of papers to exert an influence on the real exchange rate. Mixed results with respect to other variables except for the productivity are sometimes due to the difference in time horizon (e.g. use of 3-month versus 10-year real interest rates), methodological differences and also because the theoretical explanation itself is unambiguous (see Appendix 2).

3. The Equilibrium Real Exchange Rate Concepts

As far as the future steps towards adopting the euro are concerned, the central parity chosen by a particular country should reflect the best possible assessment of the equilibrium real exchange rate at the time of the entry into the ERM II. From the literature presented, see for example Égert (2003), MacDonald (2000), it is clear that a wide variety of approaches for estimating the equilibrium exchange rates could be applied.

3.1 Methods Based on an Economic Theory[10]

The analysis of the real equilibrium exchange rate could be divided into two main categories, the fundamental (normative) and behavioral (positive) ones.[11] Nevertheless, a common starting point to infer about the equilibrium exchange rate is to use the purchasing power parity approach. However, there is a strong consensus in the literature that PPP (Purchasing Power Parity) is not an appropriate measure for the developing and transition economies. Countries in a catch-up process may experience a trend appreciation of the real exchange rate, for which simple version of PPP theory cannot account for.[12]

A more medium-term concept, and thus more useful for policy purposes is the fundamental equilibrium exchange rate *(FEER)* developed by Williamson (1994), which defines the

[10] This is only a brief sketch of the methods. For a more-in-depth analysis, see MacDonald (2000) and Égert (2003).
[11] For more details see Frait and Komárek (1999, 2001).
[12] A well-known phenomenon explaining trend appreciation is the Balassa-Samuelson effect, which is based on market-based non-tradable price inflation driven by fast productivity gains. However, there are two other factors that can contribute to the trend appreciation of the real exchange rate: (1) the trend appreciation of the tradable price-based real exchange rate for example due to the improvements in terms of trade (2) administered/regulated prices changes. For more detail, see Égert and Lommatzsch (2003) and Égert (2003).

equilibrium exchange rate as the real exchange rate that satisfies simultaneously internal and external balances. The cornerstone of this approach is current account sustainability, i.e. the level of current account deficits/surpluses that matches long-term capital inflows/outflows. The FEER approach needs a normative judgment regarding the size of long-term capital flows. This is a very important and also sometimes tricky aspect, especially for small, open and transition economies, such as NMS. Also, FEER estimates are usually derived from large scale macroeconometric models or partial trade blocks of a given economy. To circumvent normativity and the use of macro models, the macroeconomic balance *(MB)* approach, which has been sharpened and widely used by the IMF[13], estimates directly the sustainable level of current account deficits (surpluses) based on the saving and investment balance.

Similar in spirit to these approaches is the *NATREX* (Natural Rate of Exchange) model advocated by Stein[14] in that it is also based on the notions of internal and external balances. However, contrary to FEER, it does not only consider the medium term, but also the long run, when capital stock and foreign debt are assumed to converge to their long-run steady state.

The behavioral equilibrium exchange rate *(BEER)* put forth by Macdonald (1997) and Clark and MacDonald (1998) draws on the real interest parity through which the real exchange rate can be connected to the fundamentals. However, this approach is rather a statistical one, linking the real exchange rate to a set of macroeconomic variables through a single equation setting. Thus, the choice of the fundamentals is more ad hoc than based on a theory. The fitted value of the estimated equation, which may be derived either on the basis of observed series or using long-term values of the fundamentals, represents the estimated equilibrium exchange rate.

The permanent equilibrium exchange rate *(PEER)*, a variant of BEER refers to the approach that aims to decompose the long-term cointegration vector (fitted value) into a permanent and transitory component[15] with the permanent component being interpreted as the equilibrium exchange rate. This means that the PEER method filters out the disturbance of the fundamentals. Wadhwani (1999) presents a relatively similar BEER type model, which was named the intermediate term model-based equilibrium exchange rate *(ITMEER)*.

Another approach explains the persistence in real exchange rates, and also derives well-defined measures of the equilibrium exchange rate. The capital enhanced equilibrium exchange rate *(CHEER)*, as it is called, involves exploiting the vector which consists of the nominal exchange rate, price level and interest rates in domestic and foreign country. The main idea of the approach is that the exchange rate may be away from its PPP determined rate because of non-zero interest rate differential – this is in accordance with the basic Casselian view of the PPP. CHEER

[13] See Isard and Faruqee (1998) for an overview.

[14] See Stein (1994, 1995, 2002).

[15] See Gonzalo and Granger (1995).

approach has been popularized for example by Johansen and Juselius (1992). According to MacDonald (2000), the CHEER is a medium-run concept in a sense that it does not impose stock-flow consistency.

3.2 Outline of the Behavioral Model for EU5 Countries

The popularity of the behavioral models is brought about by the observation that they can explain well the real exchange rate movements even when estimated in a reduced form. The behavioral models do not approach the equilibrium real exchange rate from the point of view of internal and external equilibria, but rather from the point of view of consistency with relevant fundamentals. We start building the BEER model for the NMS using the equation for the actual real exchange rate based on real uncovered interest parity (UIP):

$$q_t = E_t(q_{t+k}) - (r_t - r_t^*) + \omega_t \qquad (1)$$

where q_t is the actual real exchange rate (RER), r_t and r_t^* are the domestic and foreign real interest rates with a maturity $t + k$, $E_t(q_{t+k})$ is the conditional expectation of the $t + k$ period real exchange rate and ω_t is the time-varying risk premium. Further, $r_t = i_t - E_t(\pi_{t+k})$, is the *ex ante* real interest rate, where i_t is the nominal interest rate with a maturity $t + k$ and $E_t(\pi_{t+k})$ is the conditional expectation of inflation, π_t, in period $t + k$. An increase in the risk premium ω_t is deemed to induce a depreciation of the RER which, given the model structure, generates an expected appreciation. The risk premium can be written out in full as:

$$\omega_t = \mu + \lambda_t + e_t \qquad (2)$$

where μ is a constant, λ_t is some proxy for the unobserved risk premium and e_t is a white noise process. Following Clark and McDonald (1998) the proxy is assumed to be a positive function of the relative fiscal stance fs_t / fs_t^*:

$$\lambda_t = f^+\left(fs_t / fs_t^*\right) \qquad (3)$$

hereafter the function $f(\cdot)$ is restricted to be linear. For instance, an increase in the relative supply of the outstanding domestic debt increases the risk premium on the domestic currency and induces a depreciation of the current real exchange rate.

Now, consider again equation (1). The conditional expectation is also restricted to be a linear function of the information set we will condition upon. It is convenient at this point to elaborate on the conditional expectation of the $t + k$ period RER given that we deal with some specifics related to an economy in transition. For this reason, let us decompose the expectation into two parts:

$$E\left(q_{t+k} \mid I_t\right) = E\left(q_{t+k} \mid I_t^*\right) + E\left(q_{t+k} \mid I_t^T\right) \qquad (4)$$

where I_t^* involves the traditional determinants of RER of developed economies (see e.g. McDonald, 1997), and I_t^T is a set of determinants that are effective only during transition periods and their effect on the RER ceases to be significant as the countries accomplish their transitions (convergence to developed economies). Applying the assumption of linearity and using equations (2)-(4), (1) can be expressed as:

$$q_t = \mu + \theta_1 X_{1,t} + \theta_2 X_{2,t} + \theta_3 (r_t - r_t^*) + \theta_4 (fs_t - fs_t^*) + e_t \qquad (5)$$

where $X_{1,t}$ is a subset of I_t^* and similarly $X_{2,t}$ is a subset of I_t^T, θ_1 is expected to be non-zero, $\theta_2 \to 0$ as t approaches the end of the transition period, θ_3 is expected to be equal to negative one if the real UIP holds, and θ_4 is expected to be positive.

4. Empirical Evaluation and Evidence for the EU5 Countries

4.1 Empirical Techniques

By using a combination of statistical and reduced form methods to estimate the equilibrium RER we aim to address difficulties concerning regarding the data availability for CEE countries, i.e. 1) a lack of time series for some variables recommended by the theory and 2) short time span. Quarterly time series were used covering the period from 1995Q1 to 2004Q1 (37 observations). The time series were transformed into logarithms, except for the real interest rate differential. The relevant series were seasonally adjusted by means of Tramo/Seats method, where it was not possible by X12 procedure. All the data used are described in the Appendix 1. The simplest, purely statistical method of estimation of exchange rate misalignments is to detrend the RER series. We employ two types of filters for this purpose – Hodrick-Prescott filter (HP) and Band-Pass filter (BP). Subsequently, we apply two cointegration methods of Engle-Granger (EG) and the ARDL method to the reduced-form BEER model. Both types of techniques are then compared.

Hodrick-Prescott Filter

The assumption of this approach, used for example in Csajbók (2003), is that in the sample period as a whole, the real exchange rate has been on average in equilibrium. The shorter the sample period, the less plausible this assumption is, as there are examples of long-lasting misalignments. Fitted values are obtained by applying the HP-filter with the generally recommended smoothing parameter $\lambda = 1600$ for the quarterly time series (see part b in Figures 3-7).

Band-Pass Filter

Another method, which can be used in this context, is to compute several forms of Band-Pass (frequency) filters. This method identifies the cyclical component of the time series given a pre-specified range for its duration. The band-pass filter is a linear filter that passes a limited range of frequencies between the specified lower and upper bounds. The band-pass filter is then computed by weighting the resulting two-sided moving average filters. We use the full-length asymmetric filter introduced by Christiano and Fitzgerald (1999, 2003) to construct the misalignments presented in Figures 3-7 (part b).

Engle-Granger Method

As a starting point, we use the Engle-Granger methodology exposited in e.g. Enders (2004, pp. 335-339). According to this approach, a dependent variable Y_t and exogenous variables $X_{i,t}$ form a long-term relationship (6) if all variables are integrated of the same order and the residuals e_t are stationary.

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + e_t \qquad (6)$$

Stationarity of the regression residuals e_t is tested by applying the augmented Dickey-Fuller (ADF) unit root test:

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \sum_{i=1}^{n} a_{i+1} \Delta \hat{e}_{t-i} + \varepsilon_t \qquad (7)$$

Since the actual distribution of regression residuals $\hat{e}_t$ is not known, special critical values of the ADF statistics should be used to assess stationarity. Critical values are obtained using the following formula: $C_k(p,T) = \beta_\infty + \beta_1 T^{-1} + \beta_2 T^{-2}$ where p and T are the significance level and the sample size respectively, and the betas are parameters of response surface estimates provided in MacKinnon (1991). The results are presented in Figures 3-7, parts c and d.

ARDL Method

The error correction form of the ARDL model is given by equation (8) where the dependent variable in first differences is regressed on the lagged values of the dependent and independent variables in levels and first differences.

$$\Delta Y_t = \beta_0 + \rho(Y_{t-1} + \beta_1 X_{t-1}) + \sum_{j=1}^{l_1} \eta_j \Delta Y_{t-j} + \sum_{j=0}^{l_2} \gamma_{i,j} \Delta X_{i,t-j} + e_t \qquad (8)$$

Pesaran (2001) employ a bound testing approach. Using conventional F-tests, the null of $H_0 : \rho = \beta_1 = ... = \beta_n = 0$ is tested against the alternative hypothesis of $H_1 : \rho \neq 0, \beta_1 \neq 0, ..., \beta_n \neq 0$. Pesaran et al. (2001) tabulate two sets of critical values, one for the case when all variables are I(1), i.e. the upper-bound critical values and another one when all variables are I(0), i.e. the lower-bound critical values. Critical values are provided for five different models, of which model (8) with restricted intercept and no trend is used in this paper. If the test statistic is higher than the upper bound critical value the null of no cointegration is rejected in favour of the presence of cointegration. The results are presented in Figures 3-7, parts c and d.

4.2 Misalignments of the EU5 Countries' Currencies

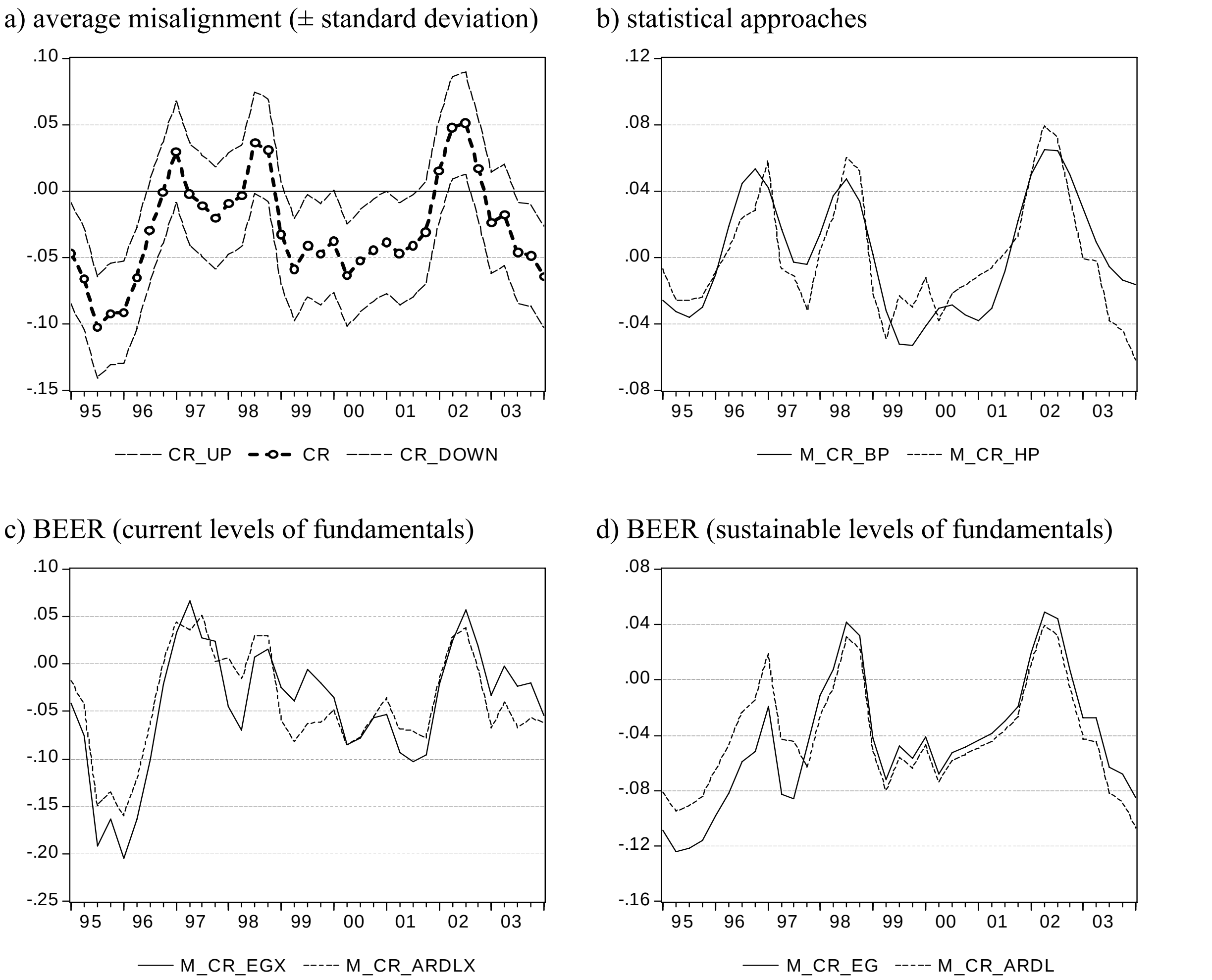
When employing the behavioral approach, it is possible to distinguish between two types of misalignments, i.e. deviations of the actual exchange rate from an estimate of its equilibrium values. The first deviation of interest is the *current (speculative) misalignment*, which is defined as the deviation of the actual real exchange rate from the estimated equilibrium real exchange rate given by the conditioning set of actual fundamentals. This kind of misalignment measures the actual deviations from the equilibrium exchange rate of the EU5 countries in the short-run (see part c in Figures 3-7).

The second deviation is the *total (cyclical plus speculative) misalignment* defined as the deviation of the actual real exchange rate from the estimated equilibrium real exchange rate based on the sustainable values of the fundamentals. The sustainable values of the estimated equilibrium exchange rate are obtained by applying some cyclical filter to the latter estimates; one example being the Hodrick-Prescott (HP) filter to the original time series (see part d in Figures 3-7). This misalignment measures the equilibrium exchange rate in the medium-run perspective. Below we comment on the estimations for each of EU5 countries with the emphasis on the result at the end of the period (first quarter of 2004). Finally, we average – with respect to standard deviations – over statistical and econometrical approaches to take a broad view upon the estimated misalignments. These average misalignments are presented in Figures 3-7 (part a) together with ± standard deviation.

Czech Republic

Both the EG and ARDL methods find the productivity differential, net foreign direct investment and terms of trade as significant determinants of the real exchange rate (see Appendix 5). All variables were significant at the 1% level and had the expected sign. Both sets of results were tested for serial correlation in residuals, appropriate functional form, non-normality and heteroscedasticity and all these test produce satisfactory results. The error correction equation also works out well. The error correction term has a negative sign at the 1% significance level. This coefficient indicates that the Czech koruna in real terms returns to its equilibrium level approximately in two quarters. The average misalignment (the average of all six estimations) of the Czech koruna was roughly 6%; i.e. real exchange rate was 6% undervalued compare to the equilibrium exchange rate at the end of the first quarter of 2004. The results of both statistical methods support the outcomes from cointegration analysis.

Figure 3: Real Exchange Rate Misalignments of the Czech Koruna



Note: Misalignment = fitted – actual values. Positive values correspond to overvaluation. Current levels of fundamentals measure short-run misalignment, sustainable levels of fundamentals medium-run misalignment. CR = the Czech Republic. Part (a): CR_UP = average misalignment + standard deviation, CR_DOWN = average misalignment – standard deviation, CR = average misalignment; part (b) M_CR_BP = misalignment based on Band-Pass filter, M_CR_HP = misalignment based on Hodrick-Prescott filter; part (c) M_CR_EGX = short-run misalignment based on Engle-Granger method, M_CR_ARDLX = short-run misalignment based on ARDL method; part (d): M_CR_EG: middle-run misalignment based on Engle-Granger method, M_CR_ARDL: middle-run misalignment based on ARDL method.

Source: Authors' calculations based on Eurostat and IMF-IFS data.

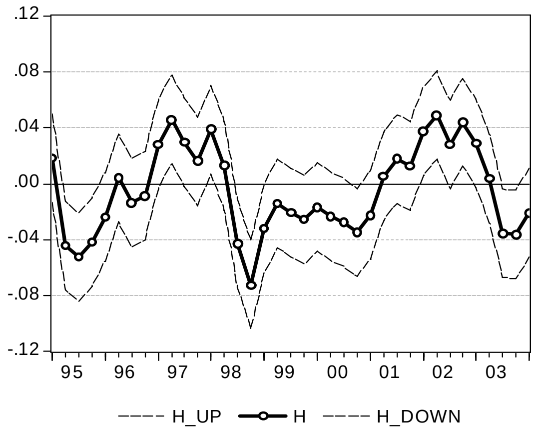
Hungary

The EG method finds the productivity differential, net foreign assets, openness and foreign direct investment as significant determinants of the real exchange rate of the Hungarian forint (see Appendix 6). All these explanatory variables bear the expected sign. The ARDL method identifies similar determinants of the forint's exchange rate except for the net foreign direct investment which appear to be insignificant at the 10% level. All diagnostic tests are satisfied.

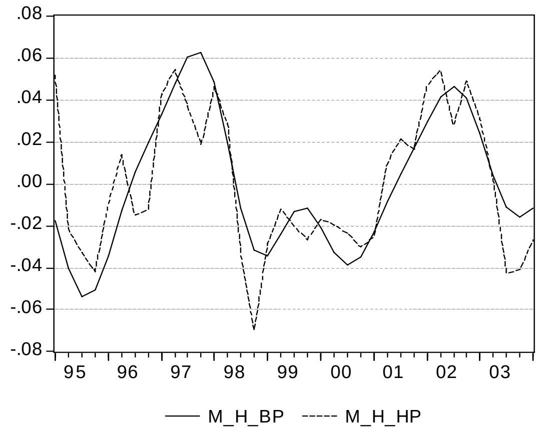
The error correction term was significant but relatively high, which indicates relatively quick movement of the real exchange rate to its equilibrium level. The forint was – in real terms – approximately 2.5% undervalued at the end of the first quarter of 2004. The results for both statistical methods are similar to the cointegration outcomes.

Figure 4: Real Exchange Rate Misalignments of the Hungarian Forint

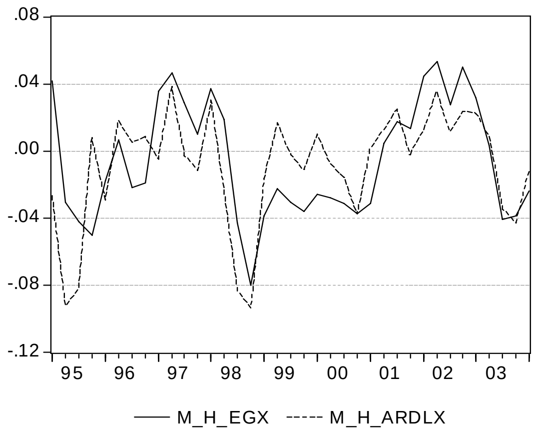
a) average misalignment (± standard deviation)



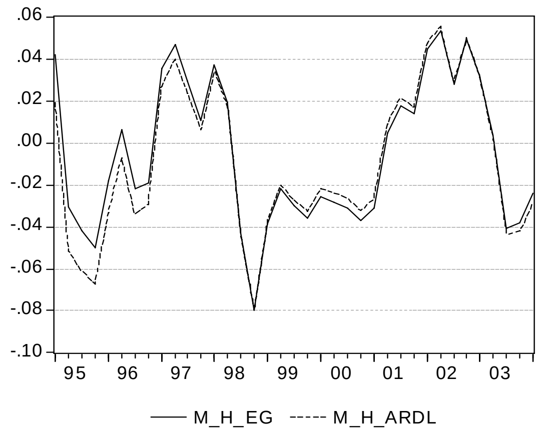
b) statistical approaches



c) based on current level of fundamentals



d) based on sustainable levels of fundamentals



Note: H = Hungary. Further description is similar to Figure 3.

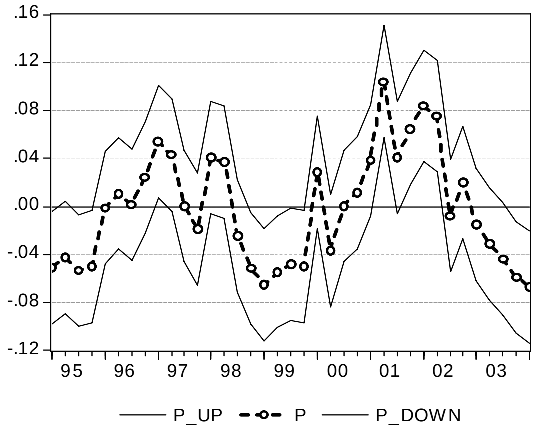
Source: Authors' calculations based on Eurostat and IMF-IFS data.

<u>Poland</u>

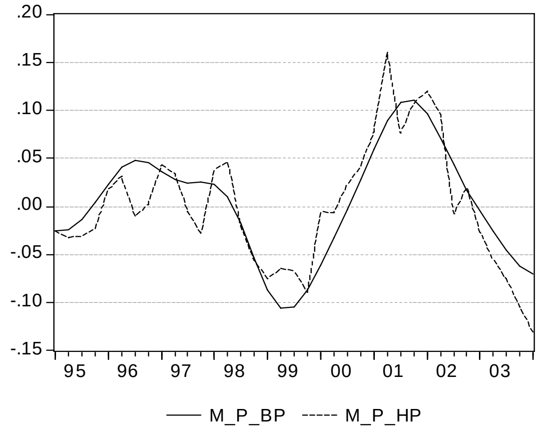
The results of the EG and ARDL methods (Appendix 7) show that the degree of openness, the productivity differential, and real interest rates are significant in explaining the real exchange behavior of the Polish zloty. All these explanatory variables have the expected sign. The change of the exchange rate regime in Poland was also tested – the dummy variable was significant. Other explanatory variables, i.e. approximation of the B-S effect, net foreign assets, government spending and terms of trades were not significant at the 10% level. The results of diagnostic tests rule out the presence of serial correlation, non-normality, inappropriate functional form and heteroscedasticity. Also the error correction term has the expected negative sign and its level indicates that the real exchange rate regresses to its equilibrium level within two quarters. The zloty was – in real terms - approximately 7.5% undervalued at the end of the first quarter of 2004. The results for both statistical methods are in line with the cointegration outcomes.

Figure 5: Real Exchange Rate Misalignments of the Polish Zloty

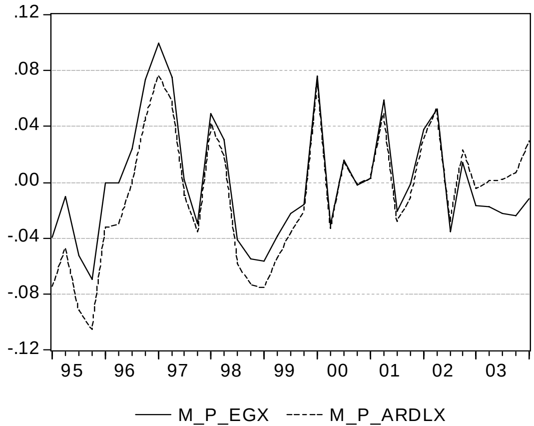
a) average misalignment (± standard deviation)



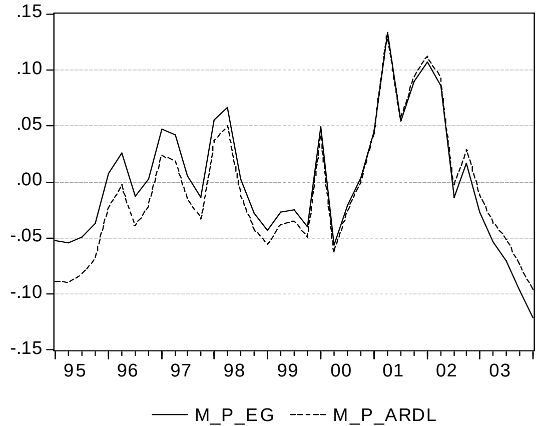
b) statistical approaches



c) BEER (current levels of fundamentals)



d) BEER (sustainable levels of fundamentals)

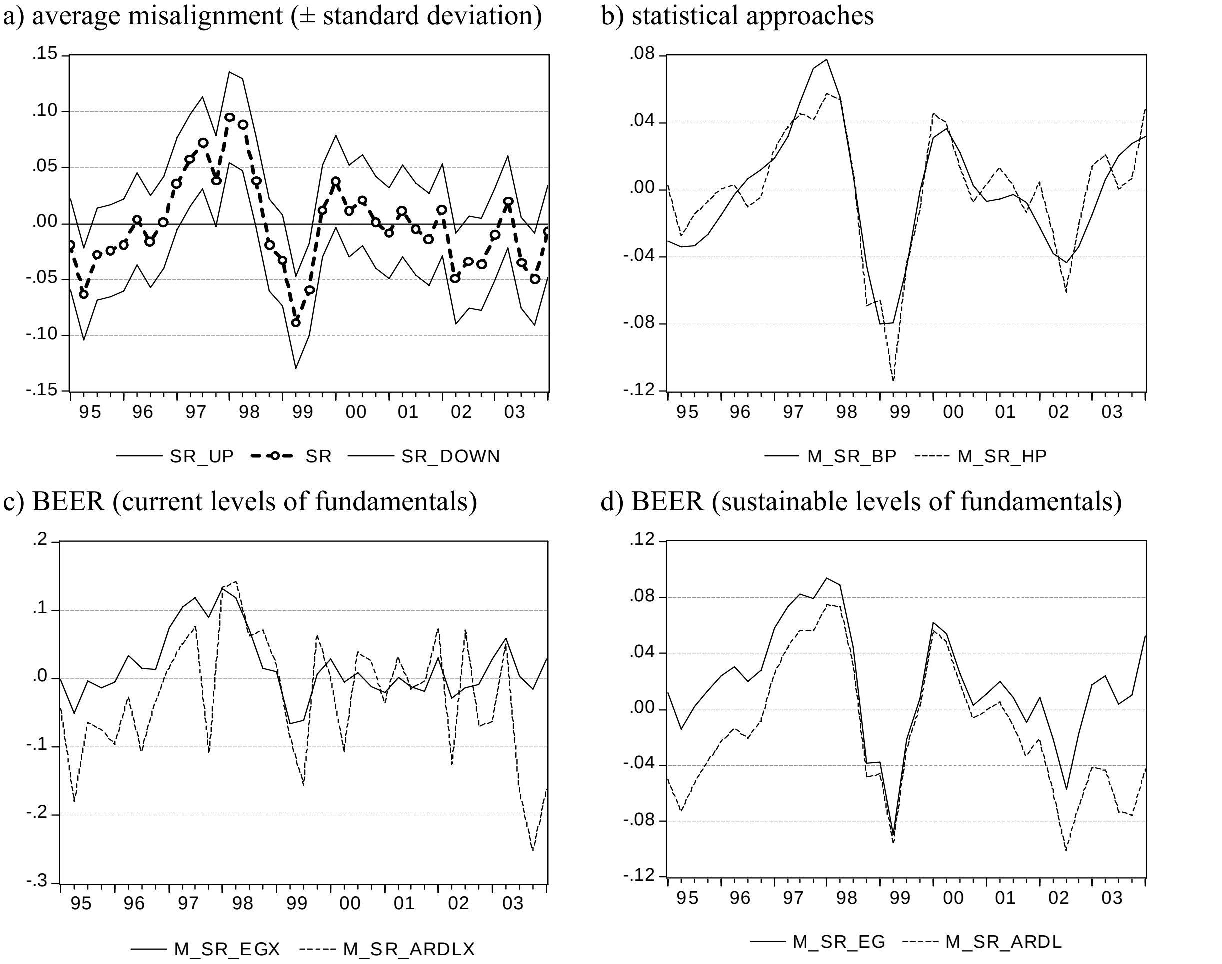


Note: P = Poland. Further description is similar to Figure 3.
Source: Authors' calculations based on Eurostat and IMF-IFS data.

<u>Slovakia</u>

The results of the EG and ARDL methods (Appendix 8) show that the productivity differential, the productivity differential and foreign direct investment are significant determinants of Slovak koruna's real exchange rate. The EG method also finds openness as relatively significant variable (at the 12% level). Nevertheless, the FDI variable has the opposite sign than was expected. The other explanatory variables, i.e. the real interest rates differential, net foreign assets, terms of trades and government spending cannot explain the movements in the Slovak koruna. In addition, the Russian and Asian crises had an important effect on the koruna. Overall, the estimated outcomes and their diagnostic tests work quite well and also the error correction term is significantly negative. The overall conclusion about the over/under valuation of the Slovak koruna is ambiguous. Purely statistical results indicate a 3% overvaluation of the Slovak koruna at the end of the period. However, there are striking differences between both methods and between the current and total misalignments. The volatility of FDI seems to be the main reason for these differences. Due to the developments of other fundamental factors in the Slovak economy, we emphasize the results obtained using the sustainable levels of the fundamentals. The Slovak koruna was appreciating really fast in line with recent economic reforms.

Figure 6: Real Exchange Rate Misalignments of the Slovak Koruna



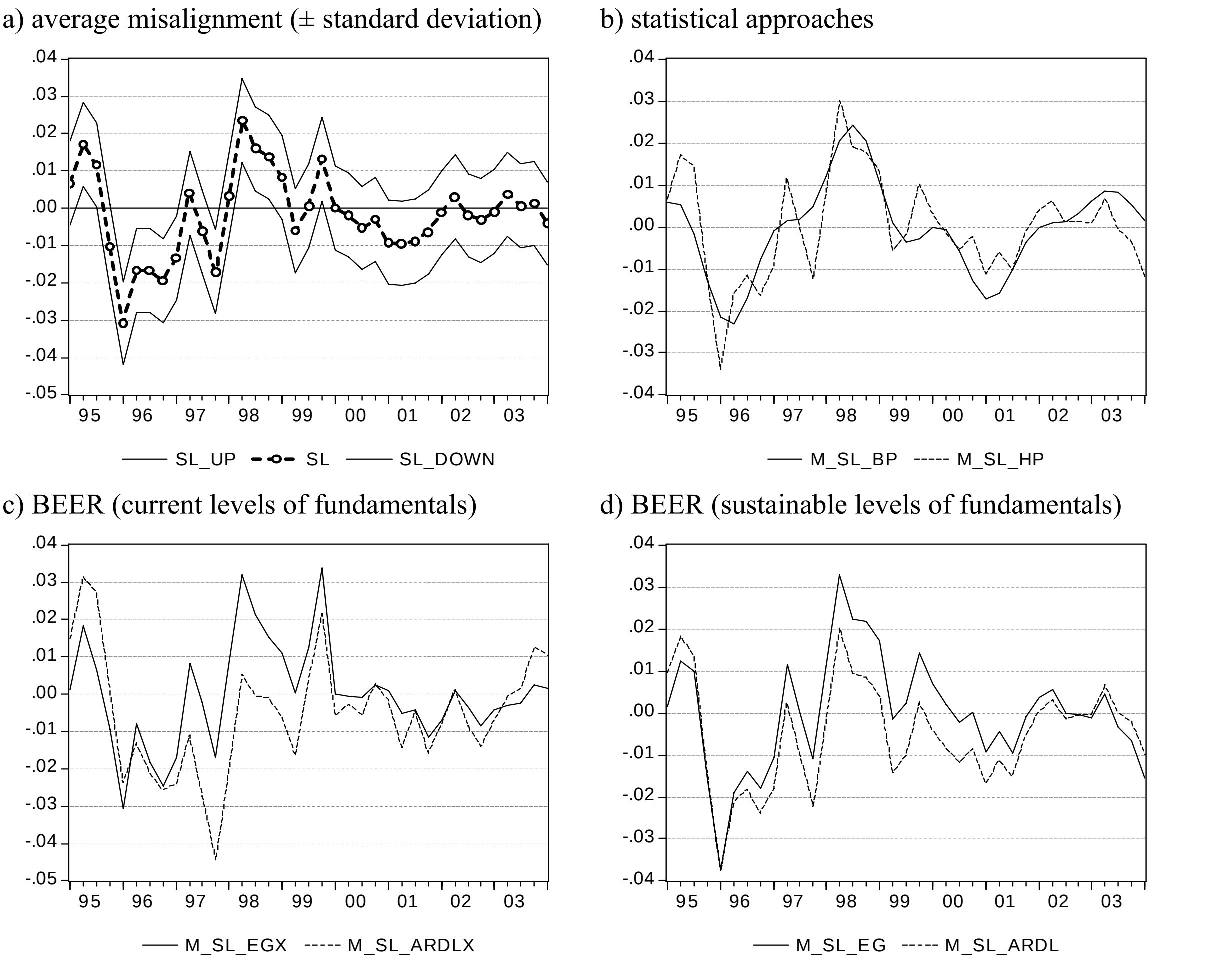
Note: SR = Slovakia. Further description is similar to Figure 3.

Source: Authors' calculations based on Eurostat and IMF-IFS data.

Slovenia

Both EG and ARDL methods are in line with purely statistical approaches and show that Slovenia has a stable currency in real terms. Tolar was approximately 0.5% undervalued at the end of the first quarter of 2004. Both methods find that the productivity differential, net foreign assets and government spending are the significant determinants of the tolar real exchange rate (see Appendix 9). The results for the ARDL method show better diagnostic properties as the tests reject the hypothesis of serial correlation, inappropriate functional form, non-normality and heteroscedasticity. In addition, the error correction term was relatively high (0.665) and significant.

Figure 7: Real Exchange Rate Misalignment of the Slovenian Tolar



Note: SL = Slovenia. Further description is similar to Figure 3.

Source: Authors' calculations based on Eurostat and IMF-IFS data.

5. Conclusion

The real convergence of the new EU Member States has been accompanied by sustained appreciation of the real exchange rate. This was closing the gap between the PPP exchange rates and the actual exchange rates in such a way that the ERDI (Exchange Rate Deviation Index) were approaching more reasonable levels. This trend is supposed to continue in the years prior the euro adoption. However, there is a major uncertainty as to the speed of the real appreciation in the more advanced phases of transition. Understanding determinants of the equilibrium real exchange appreciation is therefore very important from the policymakers' perspective, not only because misalignments of the actual rate from its equilibrium level may turn rather costly. In particular, an overvalued currency may lead to an unsustainable current account deficit, and in the long run, to lower economic growth. Besides that, potential misalignment is an important policy issue faced by the new EU Member States that are supposed to participate in the exchange rate mechanism, ERM II, and then adopt the euro in the future. That will require first setting a central parity in ERM II and later the euro-locking rate for the final conversion.

The primary objective of this paper was to analyze the misalignment of the real exchange rate in five New EU Member States (Czech Republic, Hungary, Poland Slovakia, Slovenia) with the use of purely statistical as well as behavioral approaches. The behavioral model of the equilibrium exchange rate in the tradition of MacDonald (1997, 2000) was employed in this paper and the actual and sustainable misalignments were calculated accordingly. Besides the behavioral model, the statistical techniques like the Hodrick-Prescott and Band-Pass filter were utilized to answer similar questions.

The results of the paper indicate that the tendency towards real exchange rates' appreciation in the economies under consideration have been driven primarily by fundamental determinants. They also signal that at the beginning of 2004, which was the ultimate date of our sample, the currencies of the EU5 countries were generally undervalued in real terms. The subsequent appreciation of some of these countries' currencies may thus be viewed as natural phenomenon. Besides that the dynamics of misalignments suggest that all currencies behave similarly, probably because they are being affected by similar factors. In addition, the under/over valuation periods had roughly similar timing, expect for the existence of periods of bubbles (which resulted in the strong appreciation followed by the correcting depreciation) or turbulences. These results will have to be confirmed by the future research since the problems with the availability and shortness of time series call for their cautious interpretation.

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Appendix 1: Construction and Stationarity of Data[16]

The real exchange rate (rer) - the index of the nominal exchange rate against DEM (EUR) deflated by the consumer price index (CPI) in the given economy and in Germany. The decrease in this index denotes the real exchange rate appreciation of. The quarterly indices were obtained by averaging the monthly indexes. Data source: IMF IFS database. All time series were integrated in order one.

Productivity differential (dprod) - the differential between productivity in the EU5 countries and Germany calculated as the ratio of the real GDP over employment in both countries. Data source: IMF IFS and Eurostat, New Cronos databases (seasonal adjustment by authors). All time series were integrated in order one.

Approximation of the Balassa-Samuelson effect (bs) – this is a ratio calculated as the relative price of non-tradable goods to tradable goods. An increase in this ratio should induce an appreciation of the real exchange rate. Clark and MacDonald (1998) approximate the Balassa-Samuelson effect as the ratio of CPI to WPI (PPI) in the home country relative to the foreign country.[17] In this paper, the modification of this ratio is used in a form of the service component of the consumer price index to the producer price index (PPI) in the home country over the same ratio in foreign country (Germany). Data source: IMF IFS database (seasonal adjustment by authors). All time series were integrated in order one.

Foreign direct investment (fdi) - the ratio of net foreign direct investments over nominal GDP calculated from the four quarters moving averages, both denominated in national currency. The increase in this ratio leads to the appreciation of the real exchange rate. Data source: IMF IFS database (seasonal adjustment by authors). All time series were integrated in order one. All time series were integrated in order one.

Terms of trade (tot) - the standard ratio of the export and import indices in each economy. The increase in this ratio leads to the appreciation of the real exchange rate. Data source: Eurostat, New Cronos database (seasonal adjustment by authors). All time series were integrated in order one.

Openness (open) - the ratio of the sum of exports and imports relative to nominal GDP, all denominated in national currency. The effect of openness to the real exchange rate is ambiguous. Data source: Eurostat, New Cronos databases (seasonal adjustment by authors). All time series were integrated in order one, expect for Slovenia, for which is openness type I(0).

[16] We used data in logarithmic form expect the time series for the real interest differential.

[17] There might be a problem that the dependent variable (real exchange rate) is also defined by means of CPI indexes, which might produce problems in the estimations.

Net foreign assets (nfa) - The percentage ratio of the net foreign assets relative to nominal GDP, both denominated in national currency. The increase of this ratio leads to the appreciation of the real exchange rate. Data source: IMF IFS database (seasonal adjustment by authors).

Government spending (gs) - due to lack of data the total government consumption over nominal GDP was used as a proxy for non-tradable government consumption, both denominated in national currency. The decrease of this ratio leads to the appreciation of the real exchange rate (though theme may be rather specific dynamics originally leading to depreciation). Data source: IMF IFS and Eurostat, New Cronos databases (seasonal adjustment by authors). All time series were integrated in order one, expect for Hungary, for which is openness type I(0).

Real interest rate differential (dlrr) - The differential of the home and foreign (German) lending rates deflated by both home and foreign (German) inflation rates. The decrease of this ratio leads to the appreciation of the real exchange rate. Generally, one intends to use long-term interest rates but time series like this are not available for the whole period and for all EU5 countries. Data source: IMF IFS database. All time series were integrated in order one.

Appendix 2: Overview of the Real Exchange Rate Determinants from the Empirical Studies

STUDY	PROD	GOV	OPEN	NFA	RIRD	TOT	INV	FD	PC (S)	RP	FDI	variab.
Alberola (2003)	–			–/+								2
Alonso-Gamo et al. (2002)	–			+								2
Avallone and Lahrèche-Révil (1999)	–	–	+			–			–			5
Begg et al. (1999)	–	–	–									3
Beguna (2002)		–	–			–					–	4
Bitans (2002)	–	+	+									3
Bitans and Tillers (2003)	–			–		+						3
Burgess et al. (2003)	–			+								3
Coricelli and Jazbec (2001)	–	–							–			3
Coudert (1999)	–							+				2
Csajbók (2003)	–	–	–	–	–	–						6
Darvas (2001)	–			–	–/+							3
De Broeck and Sløk (2001)	–		+									2
Dobrinsky (2003)	–	–										2
Égert and Lahrèche-Révil (2003)	–											1
Égert and Lommatzsch (2003)	–		+		–			–/+		–		5
Filipozzi (2000)	–						–					2
Fischer (2002)	–	–			–/+	+						4
Frait and Komárek (1999, 2001)	–				+	–			(–)		–	4
Halpern and Wyplosz (1997)	–	–										2
Hinnosar et al. (2003)	–			–		–						3
IMF (1998)	–	+	–				+					4
Kazaks (2000)	–		+									2
Kim and Korhonen (2002)	–	–	+				–					4
Krajnyák and Zettelmeyer (1998)	–											1
Lommatzsch and Tober (2002b)	–			+	–							3
MacDonald and Wójcik (2002)	–			–/+	–					–		4
Maurin (2001)	–	–			–			+				4
Rahn (2003)	–			–								3
Randveer and Rell (2002)	–					–						2
Rawdanowicz (2003)	–				–	–						3
Rubaszek (2003)				–	–							2
Vetlov (2002)	–		+		+							3
Number of '–'	31	10	4	8	9	7	2	1	2	2	2	X
Number of '+'	0	2	7	5	3	2	1	3	0	0	0	X
Total number of studies	31	12	11	11	10	9	3	3	2	2	2	X

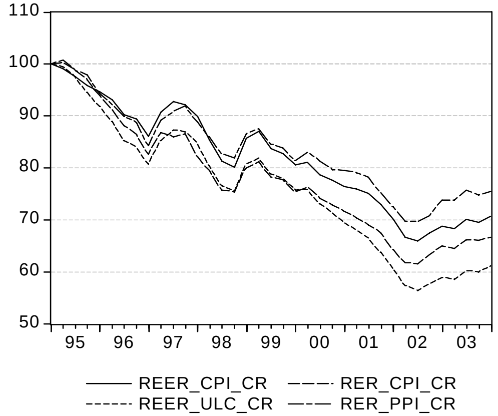
Notes: – means that an increase in the given variable leads to an appreciation of the real exchange rate;
+ stands for depreciation respectively.

PROD = productivity or a proxy for it like the CPI-to-PPI ratio or per capita GDP; GOV = share of government consumption in GDP; OPEN = exports + imports over GDP; NFA = net foreign assets; RIRD = real interest differential, the foreign real interest rate or a "synthetic" world interest rate; TOT = terms of trade = export prices / import prices; INV = share of investment in GDP; FD = foreign debt to GDP; PC = share of private consumption in GDP; RP = regulated prices (or the differential towards the benchmark economy), FDI = foreign direct investment over GDP, S = national savings over GDP.

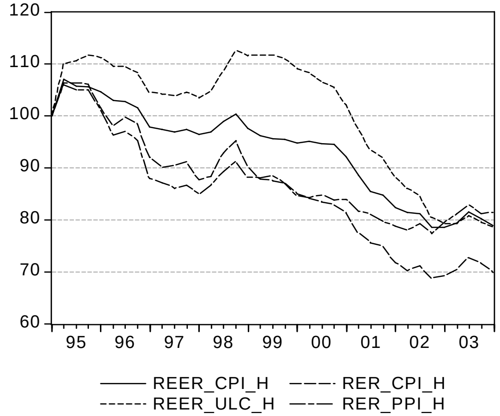
Source: Based on Égert (2003) and authors update.

Appendix 3: The Development of the Different Real Exchange Rates in the EU5 countries

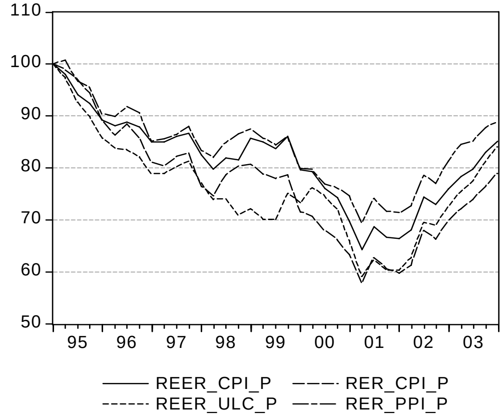
(i) Czech Republic



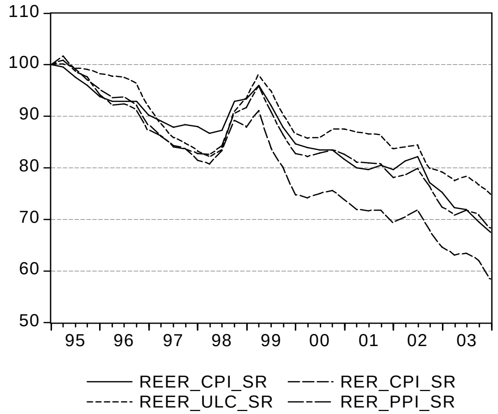
(ii) Hungary



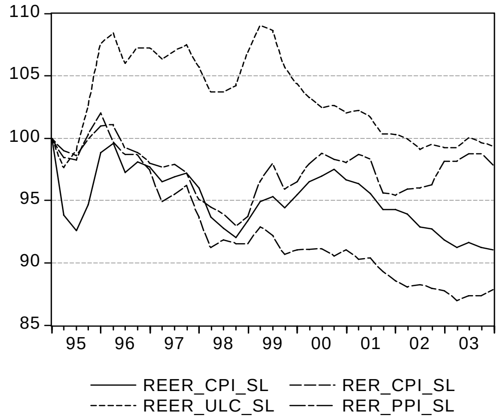
(iii) Poland



(iv) Slovakia



(v) Slovenia



Notes:

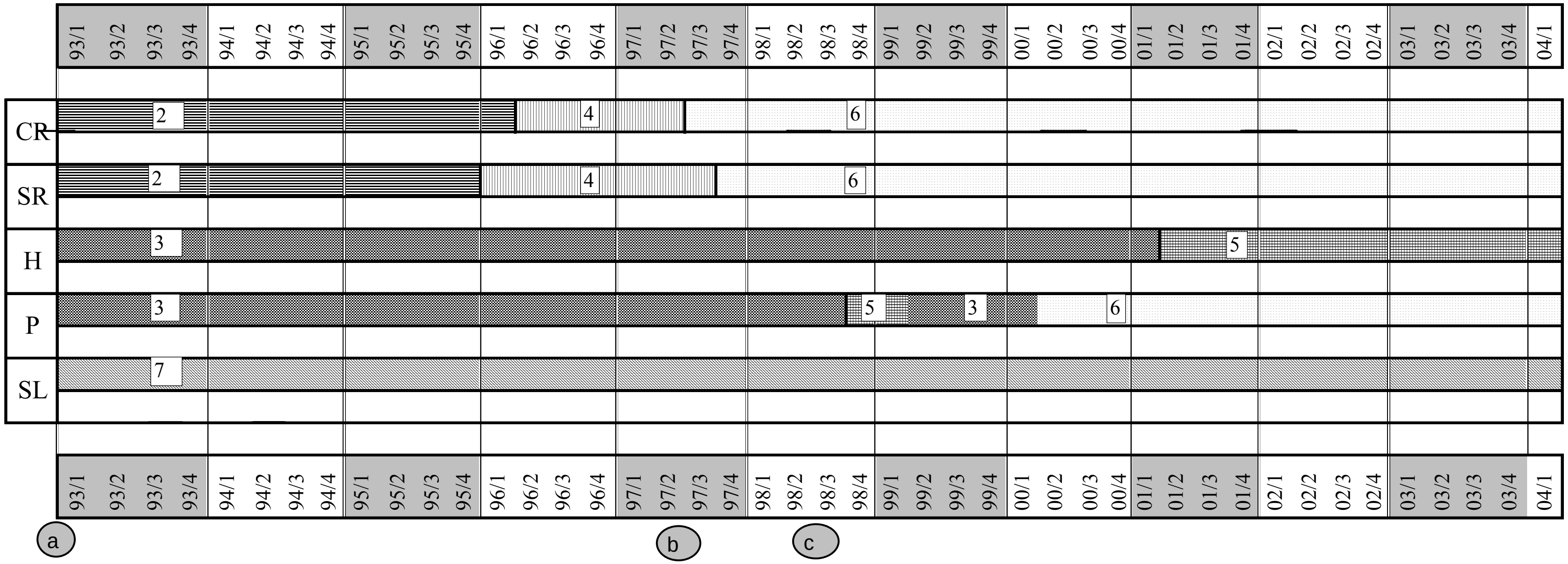
a) The decrease in the index of the real and nominal exchange indicate the real and nominal appreciation.

b) 1995:Q1=100

c) REER_CPI = real effective exchange rate deflated by CPI indexes, REER_ULC = real effective exchange rate deflated by the unit labour costs.

Source: Authors calculations based on IMF International Monetary Statistic. Eurostat, New Cronos database.

Appendix 4: Exchange Rate Regimes in EU5 Countries from 1993



1 = currency board, fixed exchange rate with band +/- (0 - 0.5] from the central parity
2 = fixed exchange regime with ban +/- with band +/- [0.5 - 2.5) from the central parity
3 = crawling peg regime
4 = fixed exchange regime with "midle" size band, i.e. +/- with band +/- [2.5 - 7.5) from the central parity
5 = fixed exchange regime with "broad" band, i.e. +/- [7.5 - 15] from the central parity
6 = free float, managed float (with irregular FX intervention)
7 = free float & targeting of (un)anouced composite indicator

a = ERM turbulences

b = Asian crises

c = Russian crises

Appendix 5: The Czech Republic

a) EG method

Ordinary Least Squares Estimation

****

Dependent variable is RERCR

37 observations used for estimation from 1995Q1 to 2004Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INTC	24.5896	1.5037	16.3523[.000]
DPRODCR	-2.8765	.21931	-13.1161[.000]
FDICR	-.093063	.013695	-6.7954[.000]
DCR	-.089603	.019605	-4.5705[.000]
TOTCR	-1.5283	.25584	-5.9738[.000]

****

R-Squared	.92337
R-Bar-Squared	.91379
F-stat. F(4,32)	96.3966[.000]
DW-statistic	1.1129

****

Diagnostic Tests

****

* Test Statistics * LM Version * F Version *

****

* A:Serial Correlation*CHSQ(4)=9.3406[.053]*F(4,28)=2.3639[.077] *

* B:Functional Form *CHSQ(1)=.28206[.595]*F(1,31)= .23814[.629] *

* C:Normality *CHSQ(2)=.66095[.719]* Not applicable *

* D:Heteroscedasticity*CHSQ(1)=2.5074[.113]*F(1, 35)= 2.5443[.120] *

****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

b) ARDL method

Autoregressive Distributed Lag Estimates

ARDL(1,2,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is RERCR

34 observations used for estimation from 1995Q4 to 2004Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
RERCR(-1)	.55557	.094874	5.8558[.000]
DPRODCR	.45811	.46268	.99012[.331]
DPRODCR(-1)	-.18614	.63376	-.29370[.771]
DPRODCR(-2)	-1.6171	.57372	-2.8186[.009]
FDICR	-.038679	010023	-3.8590[.001]
INTC	9.8463	2.5295	3.8925[.001]
TOTCR	-.37759	.17565	-2.1496[.041]

****

R-Squared	.97594
R-Bar-Squared	.97059
F-stat. F(6, 27)	182.5373[.000]
Durbin's h-statistic	.077767[.938]

****

Diagnostic Tests

****

* Test Statistics * LM Version * F Version *

****

* A:Serial Correlation*CHSQ(4)=3.7758[.437]*F(4,23)= .71832[.588] *

* B:Functional Form *CHSQ(1)=2.7255[.099]*F(1,26)= 2.2658[.144] *

* C:Normality *CHSQ(2)=.75803[.685]* Not applicable *

* D:Heteroscedasticity*CHSQ(1)=1.0371[.309]*F(1, 32)= 1.0068[.323] *

****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Error Correction Representation for the Selected ARDL Model

ARDL(1,2,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is dRERCR

34 observations used for estimation from 1995Q4 to 2004Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dDPRODCR	.45811	.46268	.99012[.331]
dDPRODCR1	1.6171	.57372	2.8186[.009]
dFDICR	-.038679	.010023	-3.8590[.001]
dINTC	9.8463	2.5295	3.8925[.001]
dTOTCR	-.37759	.17565	-2.1496[.040]
ecm(-1)	-.44443	.094874	-4.6844[.000]

****

ecm = RERCR +3.0266*DPRODCR +.087030*FDICR+
-22.1546*INTC +.84959*TOTCR

****

R-Squared	.48786
R-Bar-Squared	.37405
F-stat. F(5, 28)	5.1439[.002]
DW-statistic	1.9778

Estimated Long Run Coefficients using the ARDL Approach

ARDL(1,2,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is RERCR

34 observations used for estimation from 1995Q4 to 2004Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODCR	-3.0266	.28674	-10.5555[.000]
FDICR	-.087030	.016061	-5.4187[.000]
INTC	22.1546	1.9726	11.2309[.000]
TOTCR	-.84959	.30761	-2.7619[.010]

****

Appendix 6: Hungary

a) EG method

```
Ordinary Least Squares Estimation
*************************************************************
 Dependent variable is RERH
 37 observations used for estimation from 1995Q1 to 2004Q1
*************************************************************
 Regressor        Coefficient    Standard Error    T-Ratio[Prob]
 INTC                14.0754          1.4533        9.6853[.000]
 DPRODH              -2.3669          .20016      -11.8248[.000]
 DRC                 .068575         .018886        3.6309[.001]
 OPENH               -.45712          .19720       -2.3181[.027]
 FDIH              -.0096421        .0056476       -1.7073[.098]
 NFAH                .091603         .038223        2.3965[.023]
*************************************************************
 R-Squared                  .96287
 R-Bar-Squared              .95688
 F-stat.   F(5,31)     160.7717[.000]
 DW-statistic               1.4239
*************************************************************
                    Diagnostic Tests
*************************************************************
*   Test Statistics  *      LM Version      *       F Version       *
*************************************************************
* A:Serial Correlation  *CHSQ(4)=4.2614[.372]*F(4,27)= .87862[.490]   *
* B:Functional Form   *CHSQ(1)= .39811[.528]*F(1,30)= .32630[.572]   *
* C:Normality            *CHSQ(2)= 1.5423[.462]*    Not applicable       *
* D:Heteroscedasticity*CHSQ(1)=  1.7717[.183]*F(1,35)=  1.7602[.193]*
*************************************************************
  A:Lagrange multiplier test of residual serial correlation
  B:Ramsey's RESET test using the square of the fitted values
  C:Based on a test of skewness and kurtosis of residuals
  D:Based on the regression of squared residuals on squared fitted values
```

b) ARDL method

```
              Autoregressive Distributed Lag Estimates
     ARDL(2,0,0) selected based on Schwarz Bayesian Criterion
*************************************************************
Dependent variable is RERH
35 observations used for estimation from 1995Q3 to 2004Q1
*************************************************************
Regressor        Coefficient    Standard Error    T-Ratio[Prob]
RERH(-1)             .81592          .12029        6.7828[.000]
RERH(-2)            -.45967          .13558       -3.3904[.002]
DPRODH              -1.4474          .31514       -4.5930[.000]
NFAH                .053459         .026320        2.0311[.052]
INTC                 9.0339          2.0278        4.4551[.000]
OPENH               -.19463          .12931       -1.5052[.143]
DRC                 .050367         .011566        4.3547[.000]
*************************************************************
R-Squared                  .98613
R-Bar-Squared              .98315
F-stat.   F(6,28)     331.7055[.000]
DW-statistic               1.9898
*************************************************************
                    Diagnostic Tests
*************************************************************
*   Test Statistics  *      LM Version      *       F Version          *
*************************************************************
* A:Serial Correlation*CHSQ(4)=7.4812[.113]*F(4, 24)=1.6312[.199]        *
* B:Functional Form   *CHSQ(1)=.053024[.818]*F(1,27)=.040966[.841]       *
* C:Normality           *CHSQ(2)= .85216[.653]*       Not applicable        *
* D:Heteroscedasticity*CHSQ(1)=.0065225[.936]*F( 1, 33)= .0061509[.938] *
*************************************************************
  A:Lagrange multiplier test of residual serial correlation
  B:Ramsey's RESET test using the square of the fitted values
  C:Based on a test of skewness and kurtosis of residuals
  D:Based on the regression of squared residuals on squared fitted values
```

```
   Error Correction Representation for the Selected ARDL Model
     ARDL(2,0,0) selected based on Schwarz Bayesian Criterion
*************************************************************
Dependent variable is dRERH
35 observations used for estimation from 1995Q3 to 2004Q1
*************************************************************
Regressor        Coefficient    Standard Error    T-Ratio[Prob]
dRERH1               .45967          .13558        3.3904[.002]
dDPRODH             -1.4474          .31514       -4.5930[.000]
dNFAH               .053459         .026320        2.0311[.052]
dINTC                9.0339          2.0278        4.4551[.000]
dOPENH              -.19463          .12931       -1.5052[.143]
dDRC                .050367         .011566        4.3547[.000]
ecm(-1)             -.64375          .12604       -5.1076[.000]
*************************************************************
 ecm=RERH+2.2484*DPRODH-.083044*NFAH-14.0334*INTC+
.30233*OPENH-.078241*DRC
*********************************************************
R-Squared                  .62363
R-Bar-Squared              .54297
F-stat.   F(6,28)     7.7324[.000]
DW-statistic               1.9898
*************************************************************
R-Squared and R-Bar-Squared measures refer to the dependent variable
dRERH and in cases where the error correction model is highly restricted,
these measures could become negative.
```

```
   Estimated Long Run Coefficients using the ARDL Approach
     ARDL(2,0,0) selected based on Schwarz Bayesian Criterion
*********************************************************
Dependent variable is RERH
35 observations used for estimation from 1995Q3 to 2004Q1
*************************************************************
Regressor        Coefficient    Standard Error    T-Ratio[Prob]
DPRODH              -2.2484          .17609      -12.7685[.000]
NFAH                .083044         .035161        2.3618[.025]
INTC                14.0334          1.3512       10.3862[.000]
OPENH               -.30233          .19349       -1.5625[.129]
DRC                 .078241         .021856        3.5798[.001]
*************************************************************
```

Appendix 7: Poland

a) EG method

Ordinary Least Squares Estimation

Dependent variable is RERP

37 observations used for estimation from 1995Q1 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODP	-.77562	.22838	-3.3963[.002]
INTC	8.6394	1.1289	7.6530[.000]
DLRRP	-.021136	.0029728	-7.1099[.000]
OPENP	.46099	.13323	3.4600[.002]
DERRP	-.11167	.029920	-3.7324[.001]

R-Squared	.91560
R-Bar-Squared	.90505
F-stat. F(4,32)	86.7845[.000]
DW-statistic	1.1962

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)=6.9711[.137]	F(4, 28)=1.6250[.196]
B:Functional Form	CHSQ(1)= 4.1006[.043]	F(1,31)=3.8639[.058]
C:Normality	CHSQ(2)= 2.6508[.266]	Not applicable
D:Heteroscedasticity	CHSQ(1)=3.7018[.054]	F(1,35)= 3.8910[.056]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

b) ARDL method

Autoregressive Distributed Lag Estimates
ARDL(1,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is RERP
36 observations used for estimation from 1995Q2 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
RERP(-1)	.51633	.16523	3.1249[.004]
DPRODP	-.38046	.23515	-1.6180[.116]
DLRRP	-.0099590	.0043216	-2.3045[.028]
INTC	4.2528	1.6948	2.5093[.018]
OPENP	.29384	.12959	2.2674[.031]
DERRP2	-.054273	.033301	-1.6298[.114]

R-Squared	.93102
R-Bar-Squared	.91952
F-stat. F(5, 30)	80.9756[.000]
Durbin's h-statistic	3.2348[.001]

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)=2.2548[.689]	F(4,26)=.43431[.783]
B:Functional Form	CHSQ(1)=.13769[.711]	F(1,29)=.11134[.741]
C:Normality	CHSQ(2)=1.0700[.586]	Not applicable
D:Heteroscedasticity	CHSQ(1)=.30835[.579]	F(1,34)= .29373[.591]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Error Correction Representation for the Selected ARDL Model
ARDL(1,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is dRERP
36 observations used for estimation from 1995Q2 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dDPRODP	-.38046	.23515	-1.6180[.116]
dDLRRP	-.0099590	.0043216	-2.3045[.028]
dINTC	4.2528	1.6948	2.5093[.018]
dOPENP	.29384	.12959	2.2674[.031]
dDERRP2	-.054273	.033301	-1.6298[.114]
ecm(-1)	-.48367	.16523	-2.9272[.006]

ecm = RERP +.78661*DPRODP +.020591*DLRRP-8.7928*INTC-.60753*OPENP+.11221*DERRP2

R-Squared	.32407
R-Bar-Squared	.21142
F-stat. F(5,30)	2.8767[.031]
DW-statistic	1.8588

R-Squared and R-Bar-Squared measures refer to the dependent variable dRERP and in cases where the error correction model is highly restricted, these measures could become negative.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is RERP
36 observations used for estimation from 1995Q2 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODP	-.78661	.42095	-1.8687[.071]
DLRRP	-.020591	.0055490	-3.7107[.001]
INTC	8.7928	2.0836	4.2199[.000]
OPENP	.60753	.26171	2.3214[.027]
DERRP2	-.11221	.055410	-2.0251[.052]

Appendix 8: Slovakia

a) EG method

Ordinary Least Squares Estimation

Dependent variable is RERSR
37 observations used for estimation from 1995Q1 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODSR	-.74933	.28472	-2.6318[.013]
BSSRX	-.57559	.12493	-4.6075[.000]
FDISRBP	.061357	.018345	3.3446[.002]
INTC	10.9462	1.0232	10.6984[.000]
DRAC	-.093044	.020002	-4.6517[.000]
OPENSR	-.13986	.088331	-1.5834[.123]

R-Squared	.95405
R-Bar-Squared	.94664
F-stat. F(5,31)	128.7301[.000]
DW-statistic	1.5631

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 4.9867[.289]	F(4,27)= 1.0514[.399]
B:Functional Form	CHSQ(1)=3.1605[.075]	F(1,30)= .8019[.105]
C:Normality	CHSQ(2)=.80459[.669]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .66149[.416]	F(1, 5)= .63713[.430]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

b) ARDL method

Autoregressive Distributed Lag Estimates
ARDL(1,0,0,2) selected based on Schwarz Bayesian Criterion

Dependent variable is RERSR
35 observations used for estimation from 1995Q3 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
RERSR(-1)	.72230	.088832	8.1311[.000]
DPRODSR	-.32634	.22845	-1.4285[.164]
BSSRX	-.37662	.083035	-4.5356[.000]
FDISRBP	.016781	.014244	1.1781[.249]
FDISRBP(-1)	.017762	.014605	1.2162[.234]
FDISRBP(-2)	.047602	.016124	2.9522[.006]
INTC	4.8272	1.3940	3.4629[.002]

R-Squared	.97715
R-Bar-Squared	.97225
F-stat. F(6, 28)	199.5208[.000]
Durbin's h-statistic	.84417[.399]

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 3.9925[.407]	F(4,24)=.77257[.554]
B:Functional Form	CHSQ(1)= 2.6382[.104]	F(1,27)= 2.2011[.149]
C:Normality	CHSQ(2)= .20124[.904]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .01707[.896]	F(1,33)= .016105[.90]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Error Correction Representation for the Selected ARDL Model
ARDL(1,0,0,2) selected based on Schwarz Bayesian Criterion

Dependent variable is dRERSR
35 observations used for estimation from 1995Q3 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dDPRODSR	-.32634	.22845	-1.4285[.164]
dBSSRX	-.37662	.083035	-4.5356[.000]
dFDISRBP	.016781	.014244	1.1781[.248]
dFDISRBP1	-.047602	.016124	-2.9522[.006]
dINTC	4.8272	1.3940	3.4629[.002]
ecm(-1)	-.27770	.088832	-3.1261[.004]

ecm = RERSR +1.1752*DPRODSR +1.3562*BSSRX-.29581*FDISRBP - 17.3828*INTC

R-Squared	.50433
R-Bar-Squared	.39811
F-stat. F(5, 29)	5.6977[.001]
DW-statistic	1.7572

R-Squared and R-Bar-Squared measures refer to the dependent variable dRERSR and in cases where the error correction model is highly restricted, these measures could become negative.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,0,0,2) selected based on Schwarz Bayesian Criterion

Dependent variable is RERSR
35 observations used for estimation from 1995Q3 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODSR	-1.1752	.66008	-1.7804[.086]
BSSRX	-1.3562	.46880	-2.8930[.007]
FDISRBP	.29581	.10625	2.7841[.010]
INTC	17.3828	3.1262	5.5603[.000]

..

Appendix 9: Slovenia

a) EG method

Ordinary Least Squares Estimation

Dependent variable is RERSL
37 observations used for estimation from 1995Q1 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INTC	6.6284	.17975	36.8762[.000]
NFASL	-.052446	.022426	-2.3386[.026]
GSSL	.12112	.048166	2.5146[.017]
DPRODSL	-.33572	.052675	-6.3734[.000]

R-Squared .92211
R-Bar-Squared .91503
F-stat. F(3, 33) 130.2258[.000]
DW-statistic .99182

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)=12.4534[.014]	F(4,29)= 3.6782[.015]
B:Functional Form	CHSQ(1)=13.1525[.000]	F(1,32)= 17.6488[.000]
C:Normality	CHSQ(2)= .25945[.878]	Not applicable
D:Heteroscedasticity	CHSQ(1)= 10.9630[.001]	F(1,35)= 14.7369[.000]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

b) ARDL method

Autoregressive Distributed Lag Estimates
ARDL(3,0,2,1) selected based on Schwarz Bayesian Criterion

Dependent variable is RERSL
34 observations used for estimation from 1995Q4 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
RERSL(-1)	.53336	.14060	3.7935[.001]
RERSL(-2)	-.54783	.15466	-3.5422[.002]
RERSL(-3)	.35016	.11096	3.1557[.004]
DPRODSL	-.13627	.052903	-2.5758[.017]
NFASL	-.028588	.022264	-1.2840[.211]
NFASL(-1)	.019518	.025343	.77017[.449]
NFASL(-2)	-.074340	.023617	-3.1477[.004]
GSSL	-.14711	.16014	-.91863[.367]
GSSL(-1)	.25128	.14965	1.6791[.106]
INTC	4.0788	.83011	4.9136[.000]

R-Squared .98224
R-Bar-Squared .97559
F-stat. F(9, 24) 147.5174[.000]
DW-statistic 2.4166

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)=9.7196[.045]	F(4,20)=2.0015[.133]
B:Functional Form	CHSQ(1)= .28952[.591]	F(1,23)=.19754[.661]
C:Normality	CHSQ(2)= .54813[.760]	Not applicable
D:Heteroscedasticity	CHSQ(1)= 1.5991[.206]	F(1,32)=1.5794[.218]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Error Correction Representation for the Selected ARDL Model
ARDL(3,0,2,1) selected based on Schwarz Bayesian Criterion

Dependent variable is dRERSL
34 observations used for estimation from 1995Q4 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dRERSL1	.19767	.11982	1.6497[.111]
dRERSL2	-.35016	.11096	-3.1557[.004]
dDPRODSL	-.13627	.052903	-2.5758[.016]
dNFASL	-.028588	.022264	-1.2840[.210]
dNFASL1	.074340	.023617	3.1477[.004]
dGSSL	-.14711	.16014	-.91863[.367]
dINTC	4.0788	.83011	4.9136[.000]
ecm(-1)	-.66431	.12696	-5.2326[.000]

ecm = RERSL+.20513*DPRODSL +.12556*NFASL-.15681*GSSL-6.1399*INTC

R-Squared .74128
R-Bar-Squared .64427
F-stat. F(7, 26) 9.8237[.000]
DW-statistic 2.4166

R-Squared and R-Bar-Squared measures refer to the dependent variable dRERSL and in cases where the error correction model is highly restricted, these measures could become negative.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(3,0,2,1) selected based on Schwarz Bayesian Criterion

Dependent variable is RERSL
34 observations used for estimation from 1995Q4 to 2004Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DPRODSL	-.20513	.052696	-3.8926[.001]
NFASL	-.12556	.023754	-5.2858[.000]
GSSL	.15681	.053936	2.9073[.008]
INTC	6.1399	.21999	27.9101[.000]

Appendix 10: List of Main Abbreviations

COUNTRIES / GROUP OF COUNTRIES		VARIABLES	
BG	Bulgaria	**FX**	Foreign exchange market
CEEC	Central and Eastern European countries (CR, H, P, SL, SR)	**CPI**	Consumer price index
CR	the Czech Republic	**PPI**	Producer price index
E	Estonia	**WPI**	Wholesale price index
EU 15	The members of the EU before 1st May 2004	**RER, REER**	Real exchange rate, real effective exchange rate
EU5	5 new Member States of the EU	**OPEN**	Openness
FSU	Former Soviet Union countries	**PROD**	Productivity differential
H	Hungary	**RER**	Real exchange rate
HR	Croatia	**NER**	Nominal exchange rate
LA	Latvia	**ID**	Inflation differential
LI	Lithuania	**TOT**	Terms of trade
P	Poland	**NFA**	Net foreign assets
RO	Romania	**FDI**	Foreign direct investment
RU	Russia	**GS**	Government consumption
SL	Slovenia	**CA**	Current account
SR	Slovakia	**RIRD**	Real interest rates differential