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Exploring the Correlation between Real Exchange Rate Misalignment and Economic Growth in the CEE Countries

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Outline.

I. Introduction.

The main goal of this paper is to investigate the existence of any kind of relationship between real exchange rate misalignment and economic growth in four Central and Eastern European countries (CEEC): the Czech Republic, Hungary, Poland and Romania. Taking as a basic idea the classical textbook relation between exchange rate movements and economic growth, respectively the fact that exchange rate undervaluation could stimulate growth, the paper presents a series of results using time series and panel analysis.

The first part of the paper contains a literature review of that part of the growth literature which has investigated the correlation between exchange rate evolution and economic growth.

The second part is dedicated to the estimation of the equilibrium exchange rate of the Czech koruna, the Hungarian forint, the polish Zloty and the Romanian lei against the euro in order to compute the real exchange rate misalignment. Even though the literature proposes a series of methodologies for estimating equilibrium exchange rate, in this paper BEER (Behavioral Equilibrium Exchange Rate) is used, since other methodologies cannot be implemented due to the lack of some macroeconomic indicators. Johansen's cointegration techniques are applied to determine a long-term relationship between real exchange rate and its fundamental factors, and then a vector error correction (VEC) analysis is conducted to find out the speed of adjustment of the real exchange rates to their equilibrium value of the four CEEC's currencies.

The third part of the paper has a technical character and it focuses on the exploration of the correlation between exchange rate misalignment and economic growth (quantified by the growth rate of the real gross domestic product) in the four CEE countries, by using both, time series and panel data analysis. Since there could appear some issues of endogeneity, generalized method of moments (GMM) is used as estimation method in the panel (dynamic GMM) and time series regression analysis. Furthermore, it has been investigated the impact of currency over- and undervaluation on the growth rate of the real gross domestic product by also including in the analysis two dummy variables: over- and undervaluation variables besides the real exchange rate misalignment. At the same time, I control for the cyclical reversion of the real GDP by including the output gap in the growth regression model. This was estimated by using two filtering techniques with different characteristics: the Hodrick-Prescott filter and the Kalman filter. In addition, I use the degree of trade openness as proxy for structural policies and the terms of trade indicator in order to capture the effect of external shocks on economic growth.

The findings in the case of the country-by-country analysis are conflicting with those of the panel data analysis. In both case, the estimation results emphasize those suggested by the literature, respectively an increase in the real exchange rate misalignment can easily slow economic growth. But, after dividing the RER misalignment into over- and undervaluation indicator in order to control for their individual effect on growth, it has been found a negative relation between the overvaluation indicator and the growth rate of the real GDP in the four CEEC, whereas it has been difficult to highlight any direct correlation between the undervaluation indicator and economic growth. In other words, the undervaluation of the national currencies negatively influence economic growth in the Czech Republic, Hungary and Poland, while I did not found any statistically significant coefficient in the case of Romania, respectively after performing panel data analysis.

II. Literature Review.

1. Exchange Rate Misalignment and Economic Growth.

The real exchange rate misalignment is a key macroeconomic policy variable, particularly in the case of developing countries, being used to predict future exchange rate shifts among floaters and to evaluate the need to adjust the exchange rate among countries with less flexible regimes. On the one hand, sustained exchange rate overvaluation could constitute a warning sign of adjustment of relative prices and a possible decline in the aggregate growth rate of the economy. On the other hand, since the real exchange rate fluctuations determine production and consumption choices between domestic and foreign goods, the real exchange rate misalignment could be used as a tool to influence the actual state of the economy. Thus, there were countries which had tried to maintain their currencies undervalued in order to stimulate growth through the channel of exports. Dooley et al. (2003) points out that the control of capital flows and undervalued national currency (excess depreciation with respect to the equilibrium rate) has been the main elements of the recent growth success of China and other East Asian Countries.

In addition, setting the most suitable exchange rate regime and keeping exchange rate at a correct level will be the biggest challenge of the accession countries to the European Economic and Monetary Union, like the Central and Eastern European Countries included in the present study, which, at the same time, try to catch up with the Euro Zone. These countries must keep their exchange rate fluctuating around a predetermined central parity with +/- 15 per cent maximum deviations during a two year period before euro adoption. Moreover, the social and financial impact of the euro changeover will depend on the level of the conversion rate; if this rate is different from the market rate it can hurt economic performances. In under these circumstances, looking for any correlation between economic growth (as policy indicator for real convergence) and the real exchange rate misalignment (exchange rate criteria) could be essential. Knowing the way in which exchange rate misalignment influences economic performances (i.e. the sign of correlation; the transmission mechanisms) could allow decision makers to identify the effect of the possible real exchange rate deviations on the process of reaching real convergence.

As it is mentioned in the literature, a wrong level of the real exchange rate may transmit incorrect sings to the economic agents, creating distortions and instability in the economy. Nevertheless, a certain undervaluation may promote growth by encouraging exporters to boost their activity.

Papers trying to explore this correlation can be analyzed in line with five criteria (as they are summarized in Table 3.): the nature of the study (country-by-country or panel data analysis), the dependent variable applied, the real exchange rate misalignment indicator, estimation technique and the sign of correlation between the real exchange rate misalignment and economic growth.

Firstly, the performance indicator included in the analysis is considered. A series of studies consider economic growth quantified by the growth rate of the growth domestic product (Dollar, 1992; Easterly, Loayza and Montiel, 1997; Razin and Collins, 1999; Johnson, Ostry and Subramanian, 2007; Rodrik, 2007), while others apply components of the gross domestic product, for example the growth rate of investment, export growth (Cottani, Cavalo and Khan, 1990; Ghura and Grennes, 1993; Bleany and Greenaway, 2001).

Table 1. Real Exchange Rate Misalignment and Economic Growth (quantified by different economic performance indicators). Literature Summary.

Authors		**Performance Indicator (Dependent Variable)**	**Real Exchange Rate Misalignment indicator**	**Estimation Technique**	**The sign of the correlation**
Cottani, Cavalo and Khan (1990)	PL	Economic Growth, Investment, Export Growth	PPP; MODEL based on fundamentals	Cross Section OLS	negative
Dollar (1992)	PL	Economic Growth	MODEL based on fundamentals	Cross Section OLS	negative
Ghura and Grennes (1993)	PL	Economic Growth, Export/GDP, Investment/GDP	PPP	GMM	negative
Easterly (1993)	PL	Economic Growth	PPP	Cross Section OLS	negative
Easterly, Loayza and Montiel (1997)	PL	Economic Growth	PPP	GMM IV Difference	negative
Chadha and Prasad (1997)	PL	Economic Growth	PPP	3SLS	negative
Razin and Collins (1999)	PL	Economic Growth	MODEL based on fundamentals	GMM, Fixed Effect IV	negative
Domac and Shabsigh1 (1999)	PL	Economic Growth		PPP; MODEL	negative
Easterly (2001)	PL	Economic Growth	MODEL; PPP	SUR	negative
Bleany and Greenaway (2001)		Economic Growth, Domestic Investment	MODEL; standard deviation of RERM	GMM, Fixed Effect IV	negative
Loayza, Fajnzylber and Calderon (2004)	PL	Economic Growth	FEER	GMM IV System	negative
Hausman, Pritchett and Rodrik (2004)	PL	Economic Growth	PPP	Probit	negative
Easterly (2004)	PL	Economic Growth	FEER	SUR	negative
Aguirre and Calderon (2006)	PL, TS	Economic Growth	Single equation model	GMM	negative
Johnson, Ostry, Subramanian (2007)	PL	Economic Growth	PPP	GMM	negative
Prasad, Rajan and Subramanian (2007)	PL	Economic Growth, Investment	PPP	GMM	negative
Eichengreen (2007)	PL	Economic Growth	FEER	GMM	negative
Rodrik (2007)	PL	Economic Growth	PPP eliminating the BS effect	GMM IV	negative

Concerning the real exchange rate misalignment indicator there the followings can be noticed: papers apply the PPP (Purchasing Power Parity) (Easterly, 1993; Chadha and Prasad, 1997; Hausman, Pritchett and Rodrik, 2004) approach and general equilibrium model (Easterly, 2001; Easterly. 2001; Loayza, Fajnzylber and Calderon, 2004). There are two important drawbacks regarding the previous: generally speaking the PPP approach is not empirically applicable due to the poor data availability and specific structural issues in the case of developing countries; general equilibrium model is a complex approach, it supposes modeling the whole economy and, in this way, it becomes difficult to apply. Furthermore, I found only two studies estimating the real exchange rate misalignment by using single equation approach. (Razin and Collins, 1999; Aguirre and Calderon, 2006). As it will be proved in the next chapter, the most suitable approach to estimate the real exchange rate misalignment is the BEER approach (single equation approach) in the case of the countries included in the present analysis.

The estimation technique applied is the fourth element which makes the difference between studies. Researchers use cross section OLS and dynamic GMM due to the panel data character of the analysis, but there are studies which use seemingly unrelated regression (SUR) and three stage least square (3SLS).

As far as it concerns the correlation between the real exchange rate misalignment and economic growth, all the studies reveal a negative correlation, empirically proving that an undervalued currency can enhance economic growth finding different channels of transmission. For example, Collins and Razin (1997) investigate the relation between economic growth and real exchange rate misalignment considering that there are two channels through which the former can influence one country's economic growth. On the one hand, it could act through domestic and foreign investments, by influencing the capital accumulation process which is a well known engine of growth. On the other hand, real exchange rate which deviates from its equilibrium value could affect the tradable goods' sector and the competitiveness of this sector in respect of the rest of the world. They split the misalignment indicator in two, under- and overvaluation, indicators and they conduct their panel data analysis by using a large sample (93 developed and developing countries), in total 1450 observations. Fitting them on real GDP growth, find that only very high overvaluation has a negative and statistically significant effect on growth. Surprisingly, they do not find any statistically significant relationship between economic growth and RER undervaluation, but they notice harmful influence of the volatility of exchange rate misalignment on economic growth.

Aguirre and Calderon (2006) use a sample of 60 countries and 2280 annual observations. They estimate panel cointegration relation between the real exchange rate and economic fundamentals, and then they perform a panel dynamic regression analysis by looking also for possible non-linearity in the researched correlation. Since they find a negative and significant relationship between growth and the real exchange rate misalignment, they try to explore the existence of asymmetries on the one hand between growth and undervaluation, correspondingly between growth and overvaluation on the other hand. They distinguish two important effects: both large over- and undervaluation negatively affect growth in developing countries, while a moderate undervaluation (up to 12 percent) would increase growth between 3 and 11 basis points.

Nevertheless, Rodrik (2007) empirically demonstrates that an increase in undervaluation facilitates growth just as well as a decrease in overvaluation but only in developing countries. He also shows, in agreement with Bhalla (2007) and Gala (2007), that the real exchange rate (as the relative price of tradable to non-tradable) plays a more fundamental role in growth process than as it has been thought before. Including 184 countries in the analysis and a 5-year period for each one (from 2000 to 2004) he obtains that episodes of undervaluation are followed by higher economic growth periods.

In the second part of the next chapter the model specification, data issues and the estimation results are discussed concerning the empirical analysis (both country-by-country or time series analysis and panel data analysis are performed) between economic growth and the real exchange rate misalignment.

2. Exchange Rate Misalignment.

2.1. The Concept of the Equilibrium Exchange Rate.

The concept of the equilibrium exchange rate, and especially the misalignment of the real exchange rate from its equilibrium value, has created the core concept of the recent researches and debates in the literature on economic development, economic growth, structural adjustment and economic development.

Computing the true value of the real exchange rate misalignment is complicated due to the fact that the equilibrium real exchange rate is an unobserved variable, like potential output or the non-accelerating inflation rate of unemployment (NAIRU). In these circumstances, this concept should be treated as an elusive one as it was once mentioned by

J. Robinson (1947) [1]: *"It is now obvious that there is no one rate of exchange that is the equilibrium rate corresponding to a given state of world demands and techniques. In any given situation there is an equilibrium rate corresponding to each rate of interest and level of effective demand, and any rate of exchange can be turned into the equilibrium rate by altering the rate of interest appropriately. Moreover, any rate of exchange can be made compatible with any rate of interest provided that money wages can be sufficiently altered. The notion of the equilibrium exchange rate is a chimera. The rate of exchange, the rate of interest, the level of effective demand and the level of money wages react upon each other like the balls in Marshall's bowl, and no one is determined unless all the rest are given."*

Furthermore, the researchers have shown a lot of skepticism concerning the efforts of building up a model which might determine the equilibrium level of the exchange rate, particularly after the fail of the PPP theory. Nurkse (1945), Balassa (1964), Samuelson (1964)[2] proved the inability of the PPP theory to provide the definition of the equilibrium exchange rate. They agreed that there are a series of other internal and external factors (fundamental factors) than foreign and domestic prices which visibly influence the level of the exchange rate. At the same time they showed that the equilibrium exchange rate is not a constant, steady-state value, but it changes gradually over time since fundamental factors evolve at different levels in different countries. Thus, there are a few categories of arguments which imply that the equilibrium exchange rate should be perceived as a trend path of the real exchange rate rather than a constant level. On the one hand, if the Balassa-Samuelson effect works (associated with changes in economic structure) it can be noticed a decreasing trend of the equilibrium real exchange rate. In addition, countries facing external deficit should accumulate foreign liabilities which will generate services of the foreign debt; but also, in order to maintain the current account balance it will be necessary a real depreciation. On the other hand, any permanent change in the terms of trade or alteration in the structure or in the basic policies on the international capital market might generate a change in the path of the equilibrium real exchange rate.

Taking into account the above mentioned concerns about the computation of the equilibrium exchange rate a series of approaches have been developed during the past two decades. However, all the approaches agree about a basic issue respectively about the fact

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[1] Robinson, Joan. (1947) "The Foreign Exchanges."

[2] Balassa (1964) and Samuelson (1964) noted that the productivity differential between to countries conducts to the appreciation of the currency in the faster growing country. Nowadays, heir theory is used to explain the trend appreciation of the real exchange rate in the developing countries which are catching up with a more developed country and it appears in the literature as *"the Balassa-Samuelson effect"*.

that not only have fundamental factors which influence on the exchange rate to be taken into account but also the interaction between them can generate changes in the trajectory of the ERER. In this way, a series of complex models have been proposed providing different theoretical frameworks to the definition of the ERER, and also the empirical implementation of the statistical and econometrical tools for the estimation of this unobserved value. The next section is dedicated to short description of the main characteristics of the most frequently applied approaches in the case of the CEECs.

2.2.Theoretical Equilibrium Exchange Rate Models.

As much as it may concern the literature, it contains a series of approaches which deal with the determination of the equilibrium value of the exchange rate. The present section contains a short literature review presenting the main four categories of models of the ERER.

2.2.1. The Purchasing Power Parity (PPP)

Being the first approach in the literature, it was formulated for the first time by Cassel (1918) who defined the theoretical nominal exchange rate as a report between national and foreign prices: $E^{PPP} = \frac{P}{P*}$. But the market value of the exchange rate could present deviations from the former value, deviations which are considered as over-or under-valuations of the national currency. In this way, the real exchange rate according to the PPP theory is the report between the market and theoretical value of the national currency expressed in other currency : $Q = \frac{E}{E^{PPP}}$. Therefore, a real exchange rate higher than one reflects the under-valuation of the national currency, while it is less than one it can be said that the national currency is over-valued.

Formulating the PPP theory, Cassel (1918) used a series of hypothesis which should be fulfilled in order that the theory could be valid. This theory is based on the law of one price which supposes that a given good costs the same in two different countries when the price is expressed in the same currency. Thus, the international arbitrage mechanism should work, perfect competition must prevail both in home and foreign markets, capital movements and trade should be free without any barrier (taxes) or restriction. Taking into account the above mentioned hypothesis, there are a series of reasons due to which PPP might be a wrong and misleading indicator for equilibrium exchange rate, especially in developing countries.

First of all, there are significant differences between the compositions of the price basket because of the fact that consumers' preferences and the structure of the manufacture production differ from one country to the another.

Secondly, if the perfect competition is not working (the costs of transportation are different), the LOOP does not hold. At the same time, the presence of non-tradable goods in the price basket can distort the level of the theoretical exchange rate and leads to systematic deviations. (Driver and Westaway, 2004; Haskel and Wolf, 2001). This problem is present especially in the case of developing countries where governments control the level of regulated prices, subsidies certain categories of services, like public transportation, telecommunication and others. Consequently, the price of non-tradable goods in developing countries will be lower than that in developed countries.

The most important econometric techniques used to empirically verify this approach are cointegration tests, unit root tests (testing for the presence of the unit root in the data generating process of the real exchange rate) and estimations using the method of the ordinary least square (Froot and Rogoff, 1995; Rogoff, 1997; Breuer, 1994). According to the empirical results in the literature, the most widely used methods are cointegration techniques, which give statistically significant results just in the presence of large samples (a sample between thirty and one hundred years). Thus, it is quite risky to use this approach for developing countries (Central and Eastern European Countries) due to the weak data availability.

2.2.2. Reduced form equation approach.

Balassa (1964) and Samuelson (1964) were the first who proved that the PPP approach is not binding in practice. They considered economy split into two sectors tradable and non-tradable. Also, they supposed that: market forces are at work in both sectors; wages are linked to the level of productivity in the open sector; tradable prices are equals in each country, so PPP holds in this the open sector; while the increase of labour productivity is higher in the tradable sector than in the non-tradable sector; wages tend to equalize between sectors. Next, they considered the home counrty (developing country) having lower productivity level in the open sector than the foreign country (developed country).

Considering the above mentioned hypothesis, if the home country is in a catching-up process with the developed economy, productivity tends to rise in the open sector, so there is a possibility of wage increase in tradable sector without any inflationary effect. But, due to the wage equalization assumption between sectors, the productivity gain in the open sector will create inflationary pressures in the non-market based sector. In this way, the overall price level will rise faster in the home country (creating a positive inflation differential vis-à-vis the foreign country) than in the foreign country because of the positive productivity differential between sectors in the home country, which in turn will generate a real appreciation of the home country's real exchange rate.

This phenomenon is known in literature as the Balassa-Samuleson effect to which the trend appreciation of the real exchange rate in the developing countries can be attributed. Following the results of Balassa (1964) and Samuelson (1964), a series of studies tried to extend the framework (adding other supply- and demand-side variables to the initial model which contained just the productivity differential) and empirically verify the presence of Balassa-Samuelson effect in the case of developing countries (Bergstrad, 1991; Fischer, 2002; Lommatzch and Tober, 2002; Égert et al., 2003, 2004, 2005, 2006). These studies also emphasized the fact that structural differences between countries can influence the level of the equilibrium exchange rate. Furthermore, there are economically fundamental variables, others than the productivity differential, which determine the level of the equilibrium exchange rate and the effect of them is permanent or persistent on the long run.

From this category of approach, is worth mentioning the Behavioral Equilibrium Exchange Rate Approach (BEER) proposed for the first time by MacDonald (1997). Moreover, a huge number of studies are based on the former, for example: MacDonald and Clark (1998), MacDonald (1999), MacDonald and Driver (2004). In addition, MacDonald and Clark (2000) propose a new approach, known in the literature as Permanent Equilibrium Exchange Rate (PEER), which is a derivative of the BEER approach using new statistical tool. The only difference between the BEER and PEER approaches is the econometric tools used to estimate the equilibrium exchange rate. Moreover, the PEER approach deals with the decomposition of the real exchange rate into its permanent (considered the equilibrium value of the exchange rate) and transitory components using the univariate and multivariate decompositions of Beveridge-Nelson, SVAR proposed by Clarida and Gali (1994), the decomposition of Granger and Gonzalo (1995). The most important issue, which is common in the case of the above mentioned studies, is that all the countries included in the analysis are developed countries. But also, this approach was successfully applied in the case of developing countries, especially including countries from Central and Eastern Europe (Edwards, 1994; Elbadawi, 1994; Halpern and Wyplosz, 1997; Krajnyak and Zettelmeyer, 1998; Égert and Lommatzsch, 2003). Table 3. serves as a summary of the most important studies done in the case of the CEECs.

It is worth highlighting that this approach has strong statistical characteristics, respectively all econometric tools applied aim to estimate a single equation-type relationship between the real exchange rate and the fundamental factors from the economy which determine its level. Therefore, the basic framework and features of this approach are treated in the next section.

2.2.3. Partial Equilibrium models.

These models are more general and sophisticated than the previous, trying to define the equilibrium exchange rate as an exchange rate which is consistent with both external and internal balance of the economy. Internal balance is characterized by the non-accelerating inflation rate of unemployment (NAIRU). More precisely, the internal balance is reached when the economy functions at full capacity accompanied by low inflation. The definition of the external balance makes the difference between models, but the most frequently used one is that external equilibrium is achieved when the current account is in sustainable position (especially in the case of countries which have a high potential to grow), while the net foreign asset position is constant over time.

In the case of certain papers, the external balance supposes the equality between current account position and the difference between savings and investments on the long run. This serves as a framework to the approach developed by IMF and implemented in the international macroeconomic model, Multimod, known as Desired Equilibrium Exchange Rate (DEER), proposed by Bayoumi, Clark, Symansky and Taylor (1994).

Moreover, this is an equilibrium exchange rate on the medium term, known as DEER due to the fact that the equilibrium exchange rate- which is consistent with a certain economic equilibrium- is based on a series of desired economic objectives. Other studies which may be included in this category are the studies of Isard and Faruquee (1998), Wren-Lewis (1993) and Wren-Lewis (2003). Even though partial equilibrium models have a series of advantages, more precisely they permit the direct notice of the way in which different fundamental factors influence the exchange rate (not only through the current account channel but also through the foreign capital flows), Wren-Lewis (2003) highlights a series of drawbacks of the model which make it difficult to apply in the case of the developing countries, for example: the modeling of the foreign capital flows could be imperfect in the case of the countries facing transition process due to the restricted access of these countries to the international financial markets or because of their financial openness. However, it might be the explanation for the fact that this approach has not been used in the case of the CEECs yet.

1.4. General Equilibrium Models.

The most important advantage of this approach in comparison with the former is that the general equilibrium models suppose the simultaneous achievement of the external and internal equilibrium. Therefore, after solving the model the resulting conditions will be that which ensure the assessment of the general equilibrium correspondingly it is consistent with a sustainable current account and sustainable external debt position.

Williamson (1985), Williamson (1994) proposed the FEER (Fundamental Equilibrium Exchange Rate) approach which is the most representative model for this category. According to Williamson (1994), FEER is a real effective exchange rate which ensures the external and internal balance at the same time for more than two countries. Put differently, the resulting equilibrium exchange rate is expressed in terms of sustainable external position operationally defined as sustainable current account.

The internal equilibrium is characterized not only by an output which is equal to its potential level (the economy produces the maximum level of output), but also by the NAIRU (Non-Accelerating Inflation Rate of Unemployment). This approach permits the researcher to reflect the effect of other factors on the real exchange rate than the productivity differential as it appears in the Balassa-Samuelson framework. Furthermore, the real interest rate differential, fiscal policy, determinants of savings and investments are candidate in order to determine the level of real exchange rate. Taking into account all the characteristics of the above mentioned approach, it is worth mentioning that it seems to be the most realistic one, but at the same time the most complicated to implement in practice because it supposes a great amount of work, high statistical and data availability for a long period of time. Due to this inconveniences, there are a few number of studies implementing FEER approach in the case of CEECs countries. (Coudert and Couharde, 2002; Smidkova et al., 2002; Csajbók and Kovács, 2003; Bulir and Smidkova, 2004; and also see Table 3.)

From this category of approach, also takes part the approach of Stein (1994, 1995, 2002) known as NATREX (NATural Rate of EXchange) in the literature which makes the difference between two levels of the equilibrium exchange rate according to the time horizons, a medium-run and a long-run real equilibrium exchange rate. From Stein's point of view, the medium-run equilibrium exchange rate occurs when the external and internal balance are simultaneously attained. In this way, the medium-run concept makes the NATREX approach function like Williamson's FEER approach. However, there is a small difference concerning the definition of the internal equilibrium which in this case is defined as an economy functioning at its full capacity utilization. While, the long-run equilibrium exchange rate assure the attainment of the steady-state value of the foreign capital and debt stocks.

Other approaches proposed in the literature which fit this category are the approach of Nurkse (1945), Artus (1978), Montiel (1998, 1999) being theoretical models and in the CEEC's the study of Karádi (2003) containing the estimation of the equilibrium real effective exchange rate for Hungary.

2.3.The BEER Methodology and its Econometric Implementation.

The Behavioural Equilibrium Exchange Rate (BEER) was proposed for the first time by MacDonald (1997) and Clark and MacDonald (1998) being rather a statistical approach due to the fact that the main aim of the approach is the estimation of a single equation relationship between the real exchange rate and its fundamentals. Therefore, the basic issue of the approach is the identification of the fundamental factors which influence the real exchange rate. Put differently, if one disposes with a theoretical model which reflects the fundamentals; the only step which should be taken is to estimate a long run relationship between the real exchange rate and the fundamental factors.

The greater part of the papers written about the equilibrium exchange rate in the case of CEECs is based on the BEER approach. Firstly, because, from an econometrical point of view, this methodology is quite simple to implement by using different cointegration techniques. Secondly, this approach does not need complex theoretical framework, for example multi-country models, two-country models or general equilibrium models like FEER or DEER approaches. And finally, the data availability is quite satisfactory in the case of the above mentioned countries in order to implement this approach. Taking into account the above mentioned advantages, in the present paper the equilibrium exchange rate will be estimated using BEER approach.

As much as it may concern the methodological issues in choosing an appropriate econometric strategy in a BEER framework the papers written in the case of the CEECs can be separated into two categories.

The first category contains studies which are focused on ***country-by-country analysis***, making possible the identification of individually specific fundamental factors for each country and the inclusion of the bilateral exchange rate into the empiric analysis. Nevertheless, these are a number of drawbacks from which the followings should be mentioned: researchers have to deal with the problem of the short sample due to the poor data availability in the CEECs countries (data are available from 1995 for many of them); it should be taken into account the quality and the properties of the data, methodological issues regarding the calculation of different macroeconomic indicators which can reduce the sample to 10 years quarterly observations (taking observations from 1998); the majority of estimation techniques are well performing in long-sample analysis. If the entire above mentioned are not fulfilled they could easily conduct to biased estimates and, especially, wrong economic conclusions, which in the next step might frighten the quality and the effect of economic policies.

The second category of studies deals with ***panel data analysis***, including several countries at the same time, in order to overcome the problem of the short time series. The main problem with this category is the selection of the countries; adding countries to the panel which are in different stages of economic development (for example, mixing acceding countries with developed countries) could induce biasness into the estimation. Even though panel data analysis does not take the time series properties of the data properly into account, many studies (Halpern and Wyplosz, 1997; Krajnyak and Zettelmeier, 1998; Kim and Korhonen, 2002; Bulir and Smidkova, 2004; Égert, 2005b) have shown that it could overcome the limitation created by the short samples. Table 2. contains a series of studies conducted in the case of CEECs countries and also the country specification for each study.

In order to implement empirically this approach it is necessary **to take the following steps**:

a. Estimating the long-run relationship between the real exchange rate and fundamental factors which may determine its level on the long run.

In order to estimate an equilibrium relationship between the real exchange rate and the fundamental factors it is necessary to cope with the notion of cointegration. In other words, it should be applied a cointegration test which tests the existence of a linear combination between the above mentioned variable, a linear combination which is stationary. In this paper, the cointegration tests proposed by Johansen (1988, 1995) are considered and the technique is detailed in the following table.

Table II.1. Johansen's Cointegration Methodology.

The estimation and inferential method proposed by Johansen (1988, 1995) starts with the definition of a vector, x_t (nx1), of time series included in the analysis each one being I(1) and supposes the existence of a VAR (Vector Autoregressive) representation:

$$x_t = \eta + \sum_{t=1}^{p} \Pi x_t + \varepsilon_t \qquad \text{(II.1.)}$$

where η (nx1) is a vector of deterministic variables, while ε is a vector of white noise errors, ε ~ iid (0, Ξ).

The above mentioned VAR representation can be transformed into an equivalent VEC (Vector Error Correction) mechanism according to Johansen (1995):

$$\Delta x_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta x_{t-i} + \Pi x_{t-i} + \varepsilon_t \qquad \text{(II.2.)}$$

where Δx_t is the vector of the first differenced endogenous variables, $\Phi_i = -\sum_{j=i+1}^{p} \Pi_j$ is a (nxn) matrix of coefficient, while the rank of $\Pi = \sum_{i=1}^{p} \Pi_i - I$, (nxn), determines the number of cointegration vectors or long run relationships between the elements of x_t.

Therefore, if rank(Π) is equal to 0, it can be concluded that it cannot be estimated any long-run relationship between the variables included in the analysis and it is recommended the estimation of a VAR model. But, if rank(Π) = r < n (the cointegrating rank of the system) there exist two matrices α, the matrix of the speed of adjustment, and β, the matrix of the linearly independent cointegration vectors, in such a way that $\Pi = \alpha\beta'$.

The Johansen's methodology is based on the maximum likelihood estimation technique in order to estimate the eigenvectors (which in this analysis are the cointegration vectors) and eigenvalues of the matrix Π, respectively it allows the researcher to determine the number of the existing cointegration relationships between a given numbers of variables. Using the estimated eigenvalues Johansen (1995) built up two test statistics, TRACE and MAX; the most important difference between them is the null hypothesis.

In the case of the Trace statistics, the null hypothesis supposes that there are at most ***r*** cointegration vectors (i.e. r eigenvalues are different from 0) and the test statistics is calculated according to the following formulae:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log\left(1 - \hat{\lambda}_i\right) \qquad \text{(II.3.)}$$

$$H_0 : \lambda_i = 0, \forall \ i = r+1, \ldots., n; \qquad H_1 : \lambda_i > 0, \forall \ i = r+1, \ldots.., n;$$

where $\hat{\lambda}_i$ are the estimators of eigenvalues (parameters which maximizes the Gaussian likelihood function) of the (nxn) matrix Π.

The Max statistics has the null hypothesis according to which there are ***r*** cointegration vectors, while the alternative hypothesis states that there are ***r +1.*** The value of the test statistics is computed by using:

$$\lambda_{\max} = -T \log\left(1 - \hat{\lambda}_{r+1}\right) \qquad \text{(II.4.)}$$

$$H_0 : \lambda_i = 0 ; \qquad H_1 : \lambda_i > 0$$

b. Determining the long-run or sustainable value of the fundamental factors.

The literature proposes a series of univariate and multivariate techniques which can be used in order to decompose a series into its permanent and transitory component (like Hodrick-Prescott filter, band-pass filter or Beveridge-Nelson decomposition) considering the permanent component of the series as their sustainable value. In this paper Hodrick-Prescott filter is applied to determine the trend component of the fundamental factors which are later associated with their sustainable value.

Table II.2. The Hodrick-Prescott filter.

Let y_t denotes an observed time series. The HP filter decomposes y_t into a smooth trend (long-run component), τ_t and a transitory or cyclical component (residual), c_t:

$$y_t = \tau_t + c_t \qquad \text{(II.5)}$$

The HP filter is a low pass-filter and it was derived as a solution of a problem that balances a trade-off between fit and smoothness in the below presented way. The cyclical component is isolated from the initial time series by solving the following optimization problem subject to (II.5):

$$Min_{\{\tau_t\}_{t=1}^{T}} \left[\sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left(\nabla^2 \tau_{t+1}\right)^2 \right] \qquad \text{(II.6.)}$$

where λ represents a penalizing parameter, known as the HP filter parameter.

The first element of the loss function, $\left[\sum_{t=1}^{T} (y_t - \tau_t)^2 \right]$ penalizes bad fitting, more precisely the variance of the cyclical component; while the second term, $\left[\sum_{t=2}^{T-1}\left(\nabla^2 \tau_{t+1}\right)^2\right]$, penalizes the lack of smoothness, respectively the variance of the trend in order to smooth it in a better way. The parameter λ regulates the trade-off: λ is equal to zero, the trend is equal to the initial time series, but when λ tends to ∞ the trend will be linear. The interpretation of this parameter varies according to the rationalization of the filter.

Regulating the trade-off between fitness and smoothness when the function (II.6.) is minimized, according to Gomez and Maravall (1998) λ is equal to the ratio of the cycle and trend innovations in the approach: $\lambda = \left[4\sin^2\left(\omega_0/2\right)\right]^{-2}$, where ω_0 is the frequency for which 50per cent of the filter gain has been completed. There are predefined values for the parameter λ like 1600 for quarterly data, the interval [100000; 144000] for monthly observations and values between 6 and 14 in the case of yearly observations.

It is clear that the estimator of the trend depends on the length of the series, property which could easily tansform into a drawback in the case of short time series; thus, the filter performs poorly at the end periods of the series. Kaiser and Maravall (1999) proposes applying the filter to the time series extended by ARIMA type forecast and backcast in order to improve the performance of the filter.

c. Computing the real equilibrium exchange rate by substituting the sustainable value of the fundamental factors obtained in the second step into the long-run relationship estimated in the first step.

d. Calculating the real exchange rate misalignmet as the percentage deviation of the actual RER from its fitted value.

There are also some alternative steps of BEER methodology presented in MacDonald (1997) and clearly summarized in Égert and MacDonald (2004) in the case of CEECs, steps which are not considered in this paper.

III. Empirical Analysis.

The empirical analysis focuses on the investigation of any correlation between the real exchange rate misalignment and economic growth in four Central and Eastern European Countries, the Czech Republic, Hungary, Poland and Romania.

In general, literature divides the post-communist countries into four distinct categories according to their size, socialist heritage and macroeconomic performances: the Baltic States, Russia, Southeast Europe and Central Europe or according to others, the Baltic States, Russia, South Europe and Central and Eastern Europe. I used in my empirical analysis the last categorization mainly due to the fact that the Czech Republic, Poland and Hungary are frequently used as comparison base in the case of Romania from macroeconomic, financial, political and social point of view.

This chapter is organized in the following way: the first section deals with the estimation of the real equilibrium exchange rate of the CZK, HUF, PLN and RON against the euro by using the methodology of MacDonald (1997), known as Behavioral Equilibrium Exchange Rate. At the beginning of the section I present the time series applied in the analysis and I also discuss some data availability problem. The second part of the next section contains the estimation results of the long-run relationship between real exchange rate and fundamental factors, the therefore obtained real equilibrium exchange rate and the real exchange rate misalignment indicator.

The second and third section of the present chapter is dedicated to the country-by-country (time series approach) and panel data exploration of the correlation between economic growth and the real exchange rate misalignment. Firstly, the endogenous and exogenous variables included in the estimation are presented, and then the estimation results are explained for several growth regression models estimated by GMM.

The sample for the empirical analysis starts from the first quarter 1998 and ends in the fourth quarter 2007 for all countries, in total forty observations. The main reason for using data just from 1998 is that data is not available for a few countries before this year and the first seven years after the collapse of communist regime are considered the transformational recession period, as a result macroeconomic variable from this period are distortional.

1. Estimating Equilibrium Real Exchange Rate.

1.1. Data overview.

Quarterly data is used for all time series and most of it was obtained from Eurostat, while missing observations were filled from the Data Base of the National Bank of Romania, from national Statistics Institutes and Central Banks. I also included the net foreign asset series for Hungary from the International Financial Statistics, but other time series from this data base presented deviations in comparison with those from Eurostat, most probably due to methodological issues. All time series included in the analysis are seasonally adjusted by applying Tramo-Seats method implemented in Demetra 2.1. a free software developed by Eurostat. The indices (consumer price index- CPI; export unit value; import unit value) and deflators (GDP deflator) have fixed base 2000=100. Since there is a significant difference between the size of the countries, stock and flow variables are normalized to the real GDP in order to get rid of this issue.

1.1.1. The Real Exchange Rate (RER) Measures.

Papers treating the issue of estimating the equilibrium real exchange rate can be divided into two categories concerning the measure of the real exchange rate used. Thus, the majority of the papers using the real effective exchange rate have the main goal to estimate the ERER as an indicator of countries' competitiveness. Moreover, researches conducted in the case of the CEECs are focused on the bilateral exchange rate of the national currencies against the euro. This tendency is economically rational taking into account the effort of these countries to join to the ERM-II and to adopt the euro. (see Table 2.)

Setting the right central parity and an optimal conversion rate will be essential in these countries, while the misalignment of the real exchange rate from the equilibrium value is a fundamental macroeconomic policy variable during the implementation of reforms which could help them to adjust their economies to a market economy. For these reasons, the present paper involves the computation of the CPI based real exchange rate of the Czech

Koruna (CZK), the Hungarian Forint (HUF), the Polish Zloty (PLN) and the Romanian Lei (RON) against the euro (P_t, P_t^* : Consumer Price Index in the home and foreign countries; S_t nominal exchange rate)

$$RER_t = \frac{P_t^* S_t}{P_t} \qquad \text{(III.1.)}$$

and its main challenge is to estimate the equilibrium real exchange rate of the above mentioned currencies against the euro. The estimations are done by taking in logarithm the real exchange rates computed according to the above mentioned definition.

Figure 5. reflects the dynamic of the real exchange rates in the last ten years and it can be noticed a clear real trend appreciation of the four currencies against the euro, particularly in the last four years. All the currencies included in the analysis met a strong, both nominal and real, undervaluation at the beginning of their transition which was followed by recent real appreciation. According to the finding of Égert and Lommatzsch (2003), Égert (2005b), Lommatzsch and Tober (2002b), Halpern-Wyplosz (2001), Smidkova et al. (2002) the major reason for the above mentioned would be the Balassa-Samuelson effect, which, indeed, can explain changes in the CPI based exchange rates due to the productivity gain of the open sector. Halpern and Wyplosz (1997), Krajnyak and Zettelmeyer (1998) argue that the appreciation of the CPI based real exchange rate could be attributed to an adjustment towards equilibrium.

But Égert and Lommatzsch (2003) consider that this behavior of the real exchange rate is closely related to the economic transformation and catching-up process to the Euro Zone. They believe that as a positive effect of economic restructuring, which enables the tradable sector to produce high quality goods with increased productivity, consumers' preferences are shifted from foreign goods to domestic goods during the transformation process, improving also export performances. This leads to the appreciation of the real exchange rate in addition to the increase of the overall price level, which together with the former one will generate a real appreciation of the exchange rate. On the other hand, the real exchange rate appreciation could be related to productive foreign direct investment, capital inflows which may generate future productivity gains and an increase in future export revenues as it is mentioned in Égert (2005).

Analyzing the major structural economic indicators in these countries it could be easily noticed that the industry and the construction sector (these can be considered tradable sectors, see Table 4., Appendix 1.) have increased with a higher speed in the last four years than before probably due, not only, to the foreign investments directed to these sectors, but also to the fulfilled economic reform (privatization, closing huge state factories, fluidizing) and the simplification of the regulation system.

1.1.2. The Fundamental Factors.

There are a huge number of studies discussing the determinants of equilibrium exchange rate in the CEECs and which are summarized in Table 2. These fundamental factors can be classified in four categories according to the nature of the way in which they influence the ERER.

Table 2. Fundamental Factors Included in the Studies Conducted in the Case of CEECs. Literature Summary.

								Fundamental Factors			
Author	Countries		PROD	NFA	OPEN	TOT	GOV	CONS	RIR	INV	FDEBT
Alberola (2003)	CZ,HU,PL	REER	-	+/-	+						
Avallone and Lahrèche (1999)	HU	REER	-		+	-	-	-			
Braumann (1998)	SK	REER	-		+		-			-	
Coudert (1999)	HU	RER	-		+						+
Csajbók and Kovács (2003)	HU	REER	-	-	-	-	-		-		
DeBroeck and Sløk (2001)	CZ,HU,PL SK,SI,EE	REER	-		+				-		
Égert and Lahrèche-Révil (2003)	CZ,HU,PL SK,SI	REER	-	+	+				+/-		
Égert and Lommatzsch (2003)	CZ.HU,PL SK,SI	RER	-		+				+/-	+/-	
Égert (2005b)	BL,RO, RU,UKR	RER	-		+	+	-	-	-		
Filipozzi (2000)	EE	REER	-		+					-	
Fischer (2004)	CZ,HU,PL SK,SI,EE, BL,RO	REER	-			+	-	-	+/-		

Halpern and Wyplosz (1997)	CZ,PL,HU SK,SI	RER	-				-				
Hinnosar (2003)	EE	REER	-	-		-					
Kovacs(2001)	HU	REER	-	+	+				-		

The first category is related to *the Balassa-Samuelson effect*. Viewed as a domestic supply-side factor, the Balassa-Samuelson framework provides the explanation to the trend appreciation of the real exchange rate in transition countries facing a catching-up processwith a more developed economy. Opening up the economy to the international trade, returns in the tradable sector are higher than those in the non-tradable sector, thus wages in the tradable sector will increase faster. According to the basic hypothesis of the BS effect, more precisely the equalization of wages between sectors, wages in the non-tradable sector will be raised generating inflation pressures, correspondingly the appreciation of the real exchange rate.

In order to statistically quantify this effect it becomes necessary to include in the analysis ***the relative productivity differential between each country and the Euro Zone (PROD).*** Considering the measures proposed in the literature, the present analysis considers the productivity differential as the ratio between the labour productivity in the tradable and non-tradable sectors. Hence, the relative productivity differential will be the ratio between the productivity differential in a certain country and that in the Euro Zone. Thinking about the productivity differential the following issues must be taken into account: according to what kind of criteria the economic sectors are divided into tradable and non-tradable; which are the sectors included into the tradable sector. These questions are answered to some extent by DeBroeck and Slok (2001), Hinnosar (2003), Lommatzsch and Égert (2003), Égert (2005). They analyze the structure of each sector (industry, services, construction and agriculture in the case of CEECs and they also give definitions for the tradable and non-tradable sectors which are presented in Table 4. Therefore, most of them consider industry being the tradable sector together with the construction sector in some cases and the other sectors constituting the non-tradable sector.

Conducting the present analysis and following the core target of comparing the results between countries, it has become necessary to apply definitions for the fundamental factors which are the same in the case of each country. Consequently, the tradable sector is associated with the industry, without the construction sector because it has increased artificially lately, while the non-tradable sector is defined as the services. Indeed, agriculture was pulled out from the analysis due to its strong dependence on weather conditions and the specific structural problems inherited from the socialist period. In this way, the definitions used in this paper are in line with those used by Halpern and Wyplosz (2001) in their empirical research which included Slovakia, Slovenia, Latvia, Lithuania, and Bulgaria in addition to the countries considered in this analysis.

Changes in the international economic environment represent the second category of fundamental factors. Many studies quantify this effect by introducing in the analysis the real interest rate differential between the country included in the analysis and the international financial market, the terms of trade indicator, the net foreign asset position or foreign debts. I calculated all the above mentioned indicators for each country applying the following definitions:

- ***Net Foreign Asset Position*** divided by GDP ***(NFA)***: Net foreign assets are normalized by real GDP to adjust for the size of each country. The expected sign of the coefficient of NFA in the long-run equation of the RER is ambiguous. For example, Alberola (2003) found positive correlation in the case of Poland and Czech Republic, but a negative one in the case of Hungary, explaining that countries having net creditor position will expect interest for the foreign assets accumulated which will appreciate de real exchange rate. In contradiction, Countries having net debtor position are obliged to service their foreign debt which will conduct to the depreciation of the national currency, as it was shown by Csajbók and Kovács (2003) in the case of Hungary.
- b. ***Terms of trade (TOT)*** defined as the ratio between the export unit value and the import unit value or by dividing the export deflator by the import deflator. The sign of correlation with the real exchange rate depends on the price elasticity of import and exports. An increase in terms of trade, if exports and imports have low price elasticity, can influence the structure of the domestic manufacture, stimulating the increase of the tradable sector and generating an excess demand in the non-tradable sector, respectively rising export revenues and appreciating the nominal and thus the real exchange rate. Otherwise, when export and imports are price sensitive the impact may be negative.

- ***Foreign Debts Position*** share to the GDP ***(FDEBT):*** Coudert (1999) found **a positive** relationship between real exchange rate and foreign debt position, which is consistent with the economic theory as a result of the servicing process of these debts.
- ***Real interest rate differential (RIRD***): real interest rate is calculated according to the definition of Fisher (1930) by using nominal interbank offered interest rate from each country and the consumer price index. Then, the real interest rate differential is computed as a difference between the domestic real interbank offered rate and the real EURIBOR (European Interbank Offered Rate) interest rate.

The third category contains *commercial policies* regarding the integration into the international market. To incorporate this effect into my analysis, I calculated ***the degree of openness*** of each economy measured by the share of the sum of the volume of exports and imports from the GDP in each country. It reflects the commercial liberalization of a given country being a negative impact on the national currency, correspondingly as the result of an increase in the trade openness the domestic currency will depreciate. (Figure 5.)

Fiscal policy constitutes the last category of fundamental factors which is considered in the present paper. It can be quantified by different fiscal policy indicators such as the ratio between budget deficit and GDP, the final consumption expenditure of general government normalized by real GDP. Generally, the relationship between the real exchange rate and the above mentioned fiscal indicators is positive; respectively an increase of the government's expenditures or a decrease of taxation (expanding budget deficit) will generate inflation pressures, depreciating the national currency. But also, there may be specific structural problems, particularly in the case of transition economies, which change the sign of correlation (Fischer, 2004; Égert, 2005). I consider, in this analysis, the ratio between ***the final consumption expenditure of general government*** and real GDP as fundamental factor.

In addition to the above mentioned fundamental factors I considered a few country-specific fundamental factors:

- The ratio between ***the final consumption expenditure of households*** and real GDP. The sign of correlation of this indicator with the real exchange rate is unclear, being especially related to the nature of good consumed (tradable or non-tradable goods).

- ***Total loans to non-governmental agents normalized*** by real GDP: this fundamental factor was calculated in the case of Romania, where the loans obtained by non-governmental agents have increased considerably in the second part of the considered period and especially those denominated in foreign currency.
- ***The share between wages in the tradable and the non-tradable sector:*** used as a proxy for the relative productivity differential in the case of Poland because of the fact that labour productivity did not seem to be statistically significant in the cointegration equation of the real exchange rate PLN/EUR.

1.2. Estimation Results.

I applied Johansen's cointegration technique which is theoretically presented in the previous chapter, Table II.1. Before estimating the long-run relationships between real exchange rate and the fundamental factors it was essential to verify the order of integration of the time series applied in the analysis. Consequently, I applied three unit root tests, Augmented Dickey-Fuller (1979) – ADF, Phillips-Perron (1988) – PP and (1992) – KPSS. The first two tests (ADF, PP) have the null hypothesis that a given time series is integrated of order one, while KPSS test starts with a null hypothesis which expresses that the time series is integrated at order 0. The results of the tests are included in Appendix 1. , Table 5. and the followings can be noticed: the real interest rate differential in the case of the Czech Republic is I(0), consequently it cannot be included in the cointegration relationship; the same issue seems to emerge in the case of government expenditure in Poland; all the other variable are integrated at the order one, thus the existence of the cointegration relations can be tested.

The test statistics, λ trace and λ max, proposed by Johansen (1995) were performed and Table 6. in Appendix 1. contains the results of the testing procedure. It is obvious that there is only one cointegration relation between the variable mentioned in Table 6. in the case of each country, because the null hypothesis of the existence of at most one long-run relationship cannot be rejected at the 5 per cent significance level. Moreover, the test statistics reflect contradictory results in the case of Poland, put in a different way the Trace test statistics indicates two cointegration relations between the variables included in the analysis, whereas the results of the Maximum Eigenvalue test statistic show only one cointegration vector. Reimers (1992) proposed a solution to this issue reasoning that critical values of Johansen's cointegration tests are well behaving in the case of large sample, suggesting the use of a scaling factor (based on sample size, number of variables in the cointegrating relationship and the lag order in the VAR). Reimers' scaling factor $(T - nk)/T$, where T is sample size, k is the lag order and n the number of variables, adjusts the test statistic which can then be compared to asymptotic critical values from the appropriate source. In addition, Cheung and Lai (1993) suggest an adjustment to the critical values rather than the test statistics using a scaling factor: $T/(T - nk)$, since the Johansen procedure is biased in favour of finding cointegration too often when the lag length of the VAR is too short. They also find that the Trace test is more robust to non-normality than the Maximum Eigenvalue test. Taking into account the above mentioned findings, the scaling factor in the case of Poland would be 0.875 (T = 40, k =1, n = 5), while the value of the Trace test statistics is 50.637545 (H0: at most 1 cointegration vector) which is lower than the critical value (54.0790) at the 5per cent significance level.

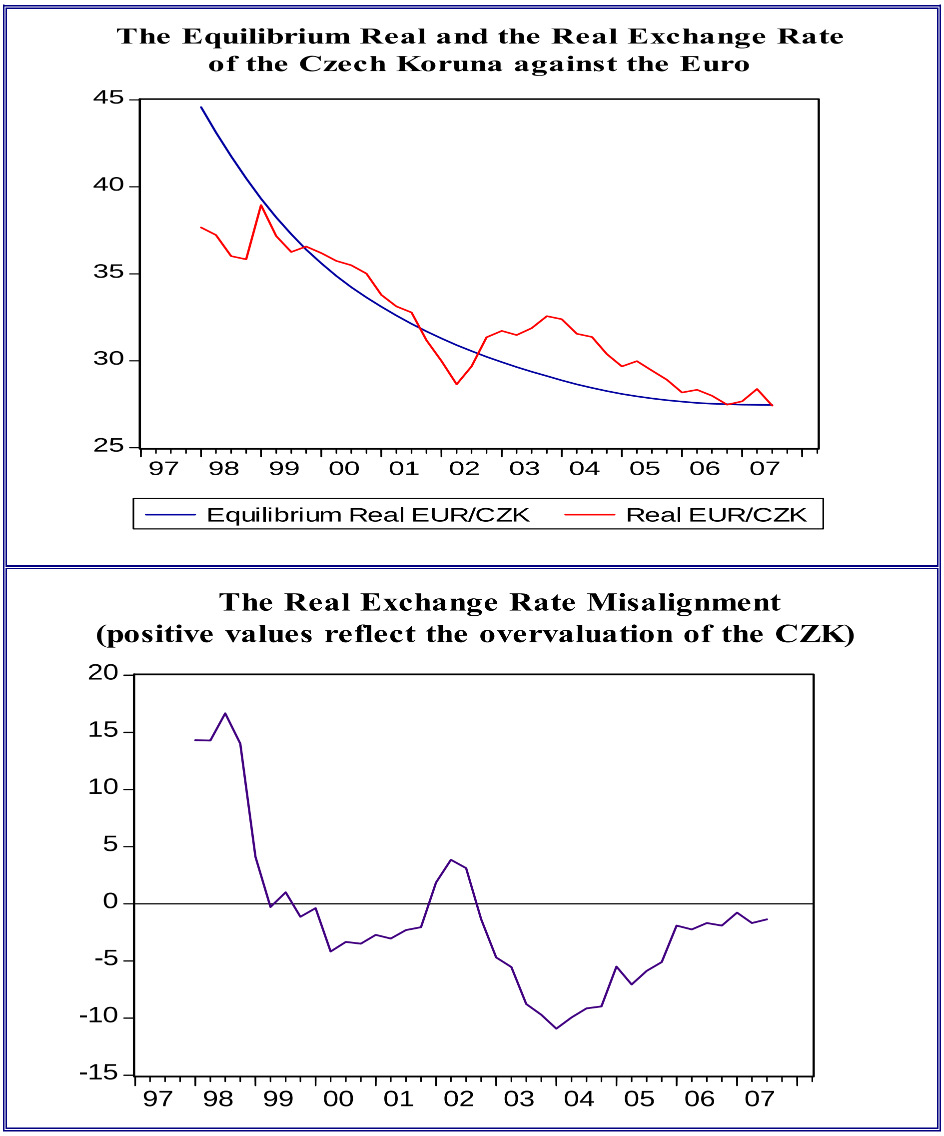
Adjusted cointegration test statistics for the PLN by using Reimers(1992) scaling factor

	Null Hypothesis (nr. of coint. relations)	**Trace test statistic**		**Maximum Eigenvalue test statistic**	
		Computed Value	**5% critical value**	**Computed value**	**5% critical value**
Series:	None *	115.20696	76.97277	64.56945	34.80587
LRER, WAGEDIF,	At most 1	**50.63755**	**54.07904**	**24.53462**	**28.58808**
TOT, NFAEG, RIRD	At most 2	26.10292	35.19275	14.31634	22.29962

The results concerning the long-run relationships between the real exchange rate and the fundamentals are in line with the literature, all the coefficient are statistically significant having the correct sign (see estimation output Table 8-9., Appendix 1.), as a result the country-by-country analysis of them allows us to conclude the followings.

Firstly, it can be concluded, in the case of ***the Czech Republic***, that an increase in the relative productivity differential, the increase of the net foreign asset and an improvement of the terms of trade indicator appreciate the Czech Koruna, lowering the EUR/CZK exchange rate.

Figure 1. The Equilibrium RER, the RER of the Czech Koruna against the Euro and its Degree of Misalignment (%).



$$LRER = 12.6486 - 3.1428\ PROD + 0.3557\ OPEN - 0.2852\ NFA - 6.8978\ TOT \quad \text{(III.2.)}$$

$$[1.7347] \quad [0.5776] \quad [0.1415] \quad [0.1536] \quad [1.0588]$$ [3]

Furthermore, opening up the Czech trade to the international market has conducted to the depreciation of the Czech Koruna. (Estimation output is included in Appendix 1. Tables 8-9.)

[3] Standard errors in brackets [ ].

Following the steps of the BEER methodology presented in the first chapter and using the estimated and above presented cointegration relation for EUR/CZK Figure 1. presents the behavioral equilibrium real exchange rate of the Czech koruna against the euro, correspondingly the rate of misalignment of this national currency.

Obviously, the Check koruna was overvalued at the beginning of the sample period; afterwards it has been undervalued fluctuating slightly above its equilibrium value. Of course, this tendency of the real exchange rate behaviour is a ordinary one taking into account the intentions of the Czech Republic to join to the ERM-II and, later, to adopt Euro as national currency.

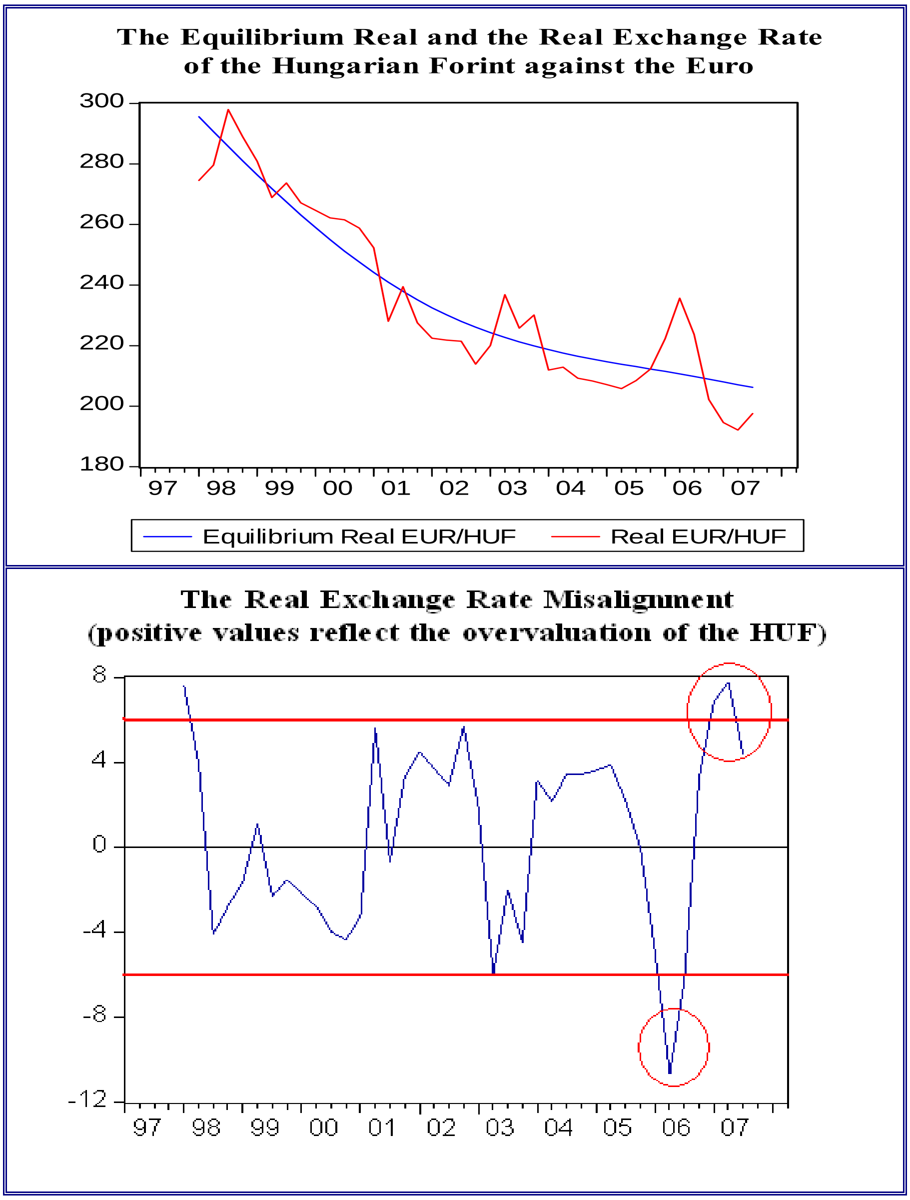
As much as it may concern ***Hungary***, the estimation results are consistent with theoretical predictions. The Balassa-Samuelson effect, quantified by the relative productivity differential appreciates the Hungarian forint, while increases in the degree of trade openness generate a depreciation of the currency. Roughly speaking, a 1per cent increase in the productivity differential is associated with a real appreciation of 0.52 per cent.

$$\underset{}{LRER} = \underset{[1.4347[}{5.4741} - \underset{[0.3046]}{0.5186}\, PROD + \underset{[0.1067]}{0.2615}\, OPEN + \underset{[0.1190]}{0.4733}\, NFA - \underset{[0.1874]}{1.2991}\, RIRD \quad \text{(III.3.)}$$

In addition, an increase of the net foreign assets 1per cent depreciates the Hungarian forint by 0.47 per cent. However, the sign of the real interest differential does not correspond to the expectation, as an increase leads to a depreciation of the real exchange rate.

Following the present findings, the behavioral equilibrium real exchange rate of the Hungarian forint against the Euro, computed by substituting the trend values of the fundamental factors into the above mentioned cointegration relation, is presented in Figure 2.. It is obvious that the real exchange rate of the HUF against the Euro has been fluctuating around its equilibrium value, while the misalignment of the Hungarian forint from its equilibrium value could easily be characterized by a fluctuation band of ± 7 per cent. These results have been expected and they seem to be the right ones, if the exchange rate regime applied by the MNB is taken into account in the analysis. In Hungary, the Hungarian forint was artificially depreciated by regular interventions of the MNB on the foreign exchange market by applying a crawling peg regime which, later, has been replaced by a crawling band since 1998. Nowadays, the official exchange rate regime supposes free fluctuations of the exchange rate within a band of ±15 per cent, whereas the MNB's interventions are allowed when the rate reach one of the borders. Analyzing Figure 2., the effects of the above mentioned technical elements are obvious; correspondingly the real exchange rate misalignment did not exceed a certain level.

Figure 2. The Equilibrium RER, the RER of the Hungarian Forint against the Euro and its Degree of Misalignment (%).

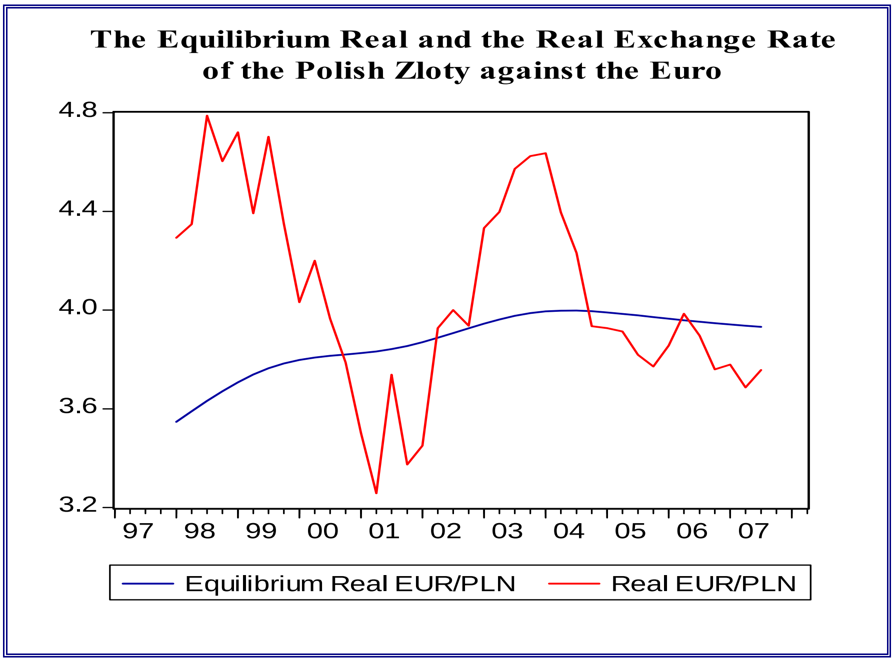


According to the estimation results (Tables 7-8), the long-run relationship of the real exchange rate for Poland contains as fundamentals relative wage-differential as a proxy for the presence of the Balassa-Samuelson effect, terms of trade, the real interest rate differential and net foreign assets.

$$LRER = \underset{[1.0347]}{4.9941} - \underset{[0.2741]}{3.8691}\ WAGEDIF + \underset{[0.1972]}{1.1731}\ TOT - \underset{[0.0989]}{2.1158}\ NFA - \underset{[0.1337]}{2.4987}\ RIRD^{4} \tag{III.4.}$$

The negative sign of the real interest rate differential shows that a rise in this variable results in the appreciation of the real exchange rate. The term of trade indicator is directly correlated with the real exchange rate; therefore an increase in the terms of trade indicator due to the fall of the import prices will depreciate the real exchange rate. This finding is in sharp contrast with the cases of the Czech Republic where the terms of trade indicator negative sign has.

Figure 3. The Equilibrium RER, the RER of the Polish Zloty against the Euro and its Degree of Misalignment (%).



[4] Standard errors in brackets [ ].

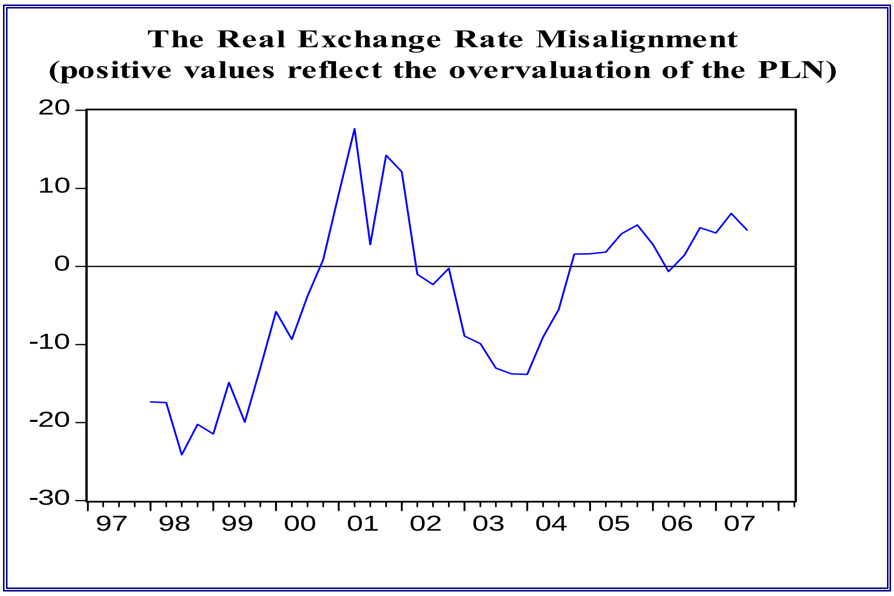


Figure 3. represents the equilibrium real exchange rate of the Polish Zloty against the euro and the rate of misalignment of this currency from its equilibrium value. The Polish Zloty was undervalued with 26 per cent at the beginning of the sample period, then it has started to get closer and closer to its equilibrium value becoming overvalued in the last two years.

Finally, the fundamental which I found that significantly enter in the equilibrium equation of the exchange rate in the case of the Romanian economy is: the relative productivity differential reflecting the Balassa-Samuelson effect works in Romania;

$$LRER = -1.1026 - 1.5221\ PROD + 2.4659\ OPEN - 0.6995\ NFA + 0.8971\ CRED^{5}$$

$$[0.5347] \quad [0.3984] \qquad [0.3358] \qquad [0.2159] \qquad [0.2163]$$

(III.5.)

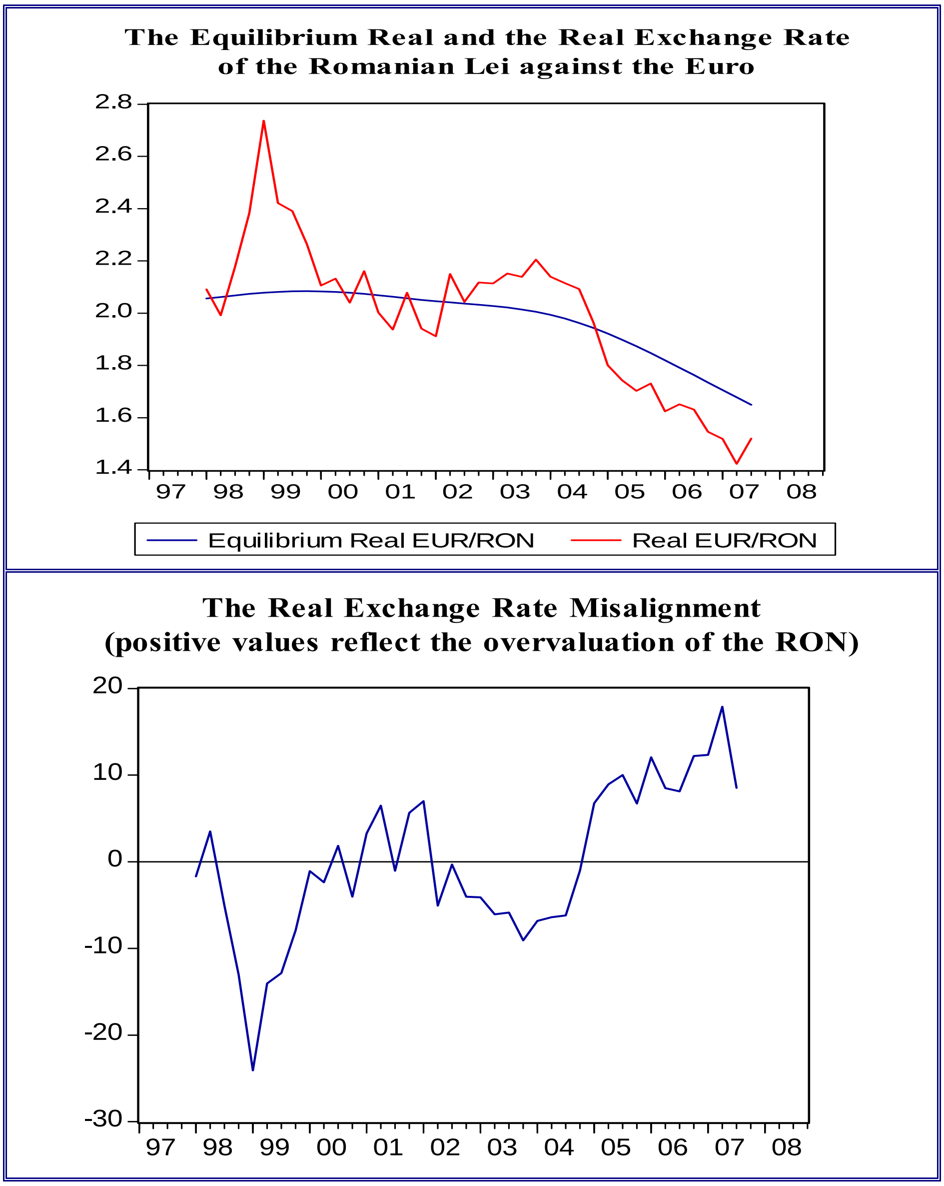
Openness has a negative impact on the exchange rate by depreciating the RON; the net foreign assets ratio influences the real exchange rate in a positive way; the loans to non-governmental agents normalized by real GDP.

Additionally, analyzing the trajectory of the equilibrium real exchange rate (Figure 4.) of the Romanian Lei and the exchange rate misalignment indicator it can be noticed that

[5] Standard errors in brackets [ ].

the Romanian Lei has been overvalued in the last three years against the Euro changing the trend of its development in Q3 2007.

Figure 4. The Equilibrium RER, the RER of the Romanian Lei against the Euro and its Degree Misalignment (%).



Comparing the estimation results obtained for the Check Republic, Hungary, Poland, Romania, moreover the initial set of fundamentals supposed to significantly influence the exchange rates the following conclusions can be drawn. Firstly, private consumption and the final consumption expenditure of government do not enter in the cointegration equation in the case of any country. Therefore, it can be concluded that there is no direct relation between the real exchange rate and the consumption indicator, and they more probably exercise their influence on the exchange rate through a certain channel, like terms of trade, non-governmental loans. Secondly, the productivity differential appears in the cointegration vector of each currency and it is economically compelling, confirming the results of other and the theoretical assumption according to which the Balassa-Samuelson effect works in these countries contributing to the trend appreciation of the real exchange rate. It is worth mentioning that the intensity at which this effect conducts to the appreciation of the national currency is almost equal in the Czech Republic and Poland, having the lowest impact in Hungary. Net foreign asset ratio is the second common fundamental factor, but it acts in a different way concerning each country. Thirdly, the degree of trade openness does not appear in the equilibrium relationship of the real EUR/PLN, but it exercises an average influence of 0.30 per cent on the real exchange rate in the other three countries. Finally, there are three country specific fundamental factors: terms of trade (the Czech Republic, Poland) having different signs; the real interest rate differential (Hungary, Poland) and non-governmental loans (Romania).

The equilibrium exchange rates estimated for the four currencies show a tendency of appreciation (having a decreasing trend), which has become more obvious in the second part of the sample period. Furthermore, it should be noticed that the only currency, which was undervalued at the end of the sample period, is the Czech Koruna, while the Hungarian Forint, the Polish Zloty and the Romanian Lei were all overvalued in comparison with their equilibrium values. The reasons for the above mentioned tendency of the currencies from the region are multiple being related to the double-edged sword character of foreign direct and portfolio investment. As data evidences show foreign direct investment, indifferently of their nature, matters for economic transformation and development acting as a good summary indicator for international competitiveness. In the case of the four CEEC's, inward FDI have increased significantly since 2000, especially due to capital account liberalization. High interest rate differential, soft fiscal stance, policy errors transformed these countries into good speculative investment targets and consequently their overvalued currency can be attributed to the massive capital inflows.

2. Estimating Growth Regressions; The Time Series Approach.

2.1. The model specification.

In respect with those proposed in literature (Razin and Collins, 1999; Aguirre and Calderon, 2006; Prasad, Rajan and Subramanian, 2007; Rodrik, 2007) I estimated the following growth regression in the case of each country:

$$d\lg dp_t = \alpha_0 + \alpha_1 d\lg dp_{t-1} + \alpha_2 og_{t-1} + \alpha_e erm + \beta' X_t + \varepsilon_t \qquad \text{(III.6.)}$$

- $d\lg dp_t$: dependent variable is the log differences in real GDP, reflects *the growth rate of the real gross domestic product*, an economic performance indicator which quantifies economic growth
- $d\lg dp_{t-1}$: first order lag of the growth rate of the real gross domestic product, which , as a proxy, accounts for conditional convergence.
- og_{t-1}: first order lag the *output gap* which measures the cyclical reversion and its impact on economic growth. The output gap was computed as the percentage deviation of the real GDP from its potential level (potential output). The potential output is an unobserved variable and its estimation can have important policy implication. There is a rich literature which deals with the problem of estimating potential output for example Darvas (2005) estimated this unobserved variable in the case of five CEECs. Consequently, I used Hodrick-Prescott filter and Kalman filter. As much as it may concern the former one I set the HP filter parameter, λ, to 1600 as it is suggested by Hodrick and Prescott (1997). The only problem with this parameter is that it was established by the authors as optimal for US output and it is not necessarily suitable for other economies. In these circumstances, I considered important to estimate potential output by using an alternative method to separate the cyclical component from the trend component, correspondingly the Kalman filter implemented in the Stamp 6.2 module of the GiveWin2 software package. The

framework for estimating the potential output by using Kalman filter is an unobserved components or state space model, which, depending on the initial specification used, allows the trend component of output to be either an irregular random walk with drift (filtering) or a smoother series whose growth rate moves over time (smoothing). Kalman filter algorithm is used to decompose the real GDP, taken in logarithm, in two main components, "smooth trend" (potential output) and "irregular trend" (cyclical) components.[6] Moreover, it is important to mention that I did not succeed to apply Kalman filter in the case of Romania due to the short sample (GDP data is available from first quarter 1998).

- erm_t : real exchange rate misalignment obtained by following the procedure presented in the previous section.
- X_t : vector of additional explanatory variables which contains the growth rate of *the degree of trade openness* accounting for national structural policies and the growth rate of *terms of trade* which tries to capture external conditions.

The estimation method applied is the generalized method of moments (GMM) which is a suitable method to control the endogeneity problems in the explanatory variable. Put differently, the presence of the first order lag of the dependent variable as explanatory variable made me consider the possible appearance of endogeneity. In this way, one of the hypotheses of the OLS could be violated generating inconsistent estimators. The instrumental variables applied are lagged values of the explanatory variables and I also included a few country specific instruments, like government expenditure in the case of Hungary, the net foreign asset ratio in the case of the Czech Republic and Poland.

Furthermore, by splitting the real exchange rate misalignment into an under- and overvaluation indicator, I re-estimated (III.6.) model by using the following specifications of the growth regression:

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[6] The results obtained and the specification used for the trend and cyclical components are presented in Appendix 2. Figures 8-11.

$$d\lg dp_t = \gamma_0 + \gamma_1 d\lg dp_{t-1} + \gamma_2 og_{t-1} + \gamma_3 overv_t + \omega' X_t + \varepsilon_t \quad \text{(III.7.)}$$

$$d\lg dp_t = \theta_0 + \theta_1 d\lg dp_{t-1} + \theta_2 og_{t-1} + \theta_3 underv_t + \mu' X_t + \varepsilon_t \quad \text{(III.8.)}$$

- $overv_t$ reflects the degree of overvaluation of a certain currency in respect of its equilibrium value. (Figure 7., Appendix 2.)
- $underv_t$ measures the degree of undervaluation of a certain currency vis-à-vis its equilibrium value. (Figure 7., Appendix 2.)

2.2. Estimation results.

Two categories of models have been estimated. Firstly, output gap estimated by using Hodrick-Prescott filter was considered and three growth regression models were estimated by introducing in the analysis the real exchange rate misalignments, the over- and the undervaluation indicators in the case of each country. Secondly, the output gap was replaced by that obtained by applying Kalman filter to the real GDP and I re-estimated each regression model. The reported J-statistic is the minimized value of the objective function built up as a result of applying GMM estimation method and it is used to compute the value of Sargan's (1958) test[7] which tests the over-identifying restrictions (i.e. the instruments applied in order to estimate the growth regressions by GMM are not correlated with the error terms). The results of this test validate the regressions for inference. The estimation results[8] concerning the real exchange rate misalignment are in line with the literature as much as it may concern the sign, but the coefficient differs from one country to the other.

The Czech Republic

Regarding the sign of correlation between the real exchange rate misalignment and economic growth, it can be noticed that all the models (regardless of their specification)

[7] The null hypothesis of Sargan's (1958) test is that the instruments used are not correlated with the residuals.
[8] The results of the application of GMM are summarized in Appendix 1. Table 11 (for the Czech Republic), Table12 (for Hungary), Table13 (for Poland), Table14 (for Romania).

reflect a negative and significant relationship. It is also worth mentioning that the substitution of the output gap by the KF gap improves the properties of the models, while the size of the real exchange rate coefficient decreases significantly. According to the estimation results the increase of the degree of trade openness has had a negative impact on the economic growth, the cyclical reversion (captured by the output gap) has negatively and significantly influenced the economic growth while favourable terms of trade shocks enhanced growth in the Czech Republic. I used lags of the exogenous variables

Taking as a reference the textbook explanation, it is generally accepted that undervaluation boosts growth, but surprisingly after splitting the real exchange rate misalignment into undervaluation and overvaluation indicator I obtained that both of them had a negative impact on economic growth. As a response to a 1 per cent increase in the overvaluation of the CZK, the economic growth declines by 0.029 per cent and it decreases by 0.02 per cent if the undervaluation increases by 1 per cent.

Hungary

In the case of Hungary (Table 12.), the estimation results show a negative effect of the real exchange rate misalignment on the economic growth. It is worth noticing that estimation results are more robust when the output gap estimated by Hodrick-Prescott filter is used. Even though the R-squares are higher in the case of Model 3 and Model 5, the introduction of the Kalman filter type output gap reduces the statistical significance of the trade openness and the real exchange rate misalignment. Similar to the case of the Czech Republic, both under- and overvaluation of the Hungarian forint generate a slowdown of the economic growth and they have approximately the same coefficient. Moreover, in Model 2 and Model 3, where under- and overvaluation were considered separately the coefficient of the growth rate of trade openness has become negative, which points out the fact that an increase of the trade openness in combination with exchange rate over- (under)valuation hurts economic growth in Hungary. Also, it is obvious that an increase in terms of trade improves growth in this country. The instrumental variables which I applied were lagged values of both dependent and independent variables and the growth rate of the government expenditure.

Poland

In Poland, GMM estimation results suggest that the real exchange rate misalignment hurts growth. More precisely, a 1 per cent increase in the real exchange rate misalignment slows real GDP growth by 0.01 per cent and by 0.016 per cent when we use Kalman filter based estimates for the output gap. Splitting the RER misalignment into under- and overvaluation it can be noticed that both of them negatively influence real GDP growth. It is obvious that the model of undervaluation becomes better after considering the output gap estimated by Kalman filter, while the coefficient of the overvaluation indicator increases significantly in the second specification (a 0.099 per cent decrease in real GDP instead of a 0.0537 per cent decrease obtained in the case of the first specification).

The sign of the other explanatory variables included in the analysis are economically correct and statistically significant. It can be concluded that cyclical movement in the real GDP has a negative impact on economic growth; a higher degree of trade openness improves the economic performances in Poland, at the same time as international economic conditions become better the economic growth increases in Poland.

The set of instrumental variables contains lagged values of the explained and the explanatory variables and the first difference of the log net foreign assets. These instruments are proved to be independent of the errors according to Sargan's (1958) test's results.

Romania

Estimation results are the most confusing in the case of Romania (Table14.). First of all, a negative relationship between the real GDP growth rate and the real exchange rate misalignment can be noticed according to Model 1 and Model 2. After removing the statistically insignificant degree of trade openness from Model 2, a higher and more significant coefficient of the RER misalignment was obtained. Therefore, a 1 per cent increase of RER misalignment would generate a 0.0317 per cent decrease of real GDP.

Secondly, replacing RER misalignment by the overvaluation indicator a surprising result was achieved: a 1 percentage point rise in the overvaluation of the RON in comparison with its equilibrium level increases economic growth by 0.034 percentage points. Moreover, I did not find any significant relationship between the RER undervaluation and real GDP growth in Romania. The above mentioned results are not in line with the textbook explanation; consequently a more detailed research would be necessary in order to investigate the transmission mechanism of the RER misalignment on economic growth. It is obvious that the export channel is not that through which this influence acts especially due to the fact that the ratio between exports and GDP is 40 per cent and the trade balance deficit has reached 37.7 per cent from GDP. It should be taken into account the impact of the fast increasing non-governmental loans which are boosting consumption (household consumption reflects 82 per cent from GDP in Romania) but also the effect of foreign (direct and portfolio; speculative) investment on the real exchange rate movements and particularly on economic growth. Finally, it is worth mentioning that I did not succeed to estimate the output gap by using Kalman filter due to the short real GDP series (39 observations) available in the case of Romania. As a result, alternative models were not considered for this country and model robustness could not be verified.

Summing up the results of the country-by-country analysis concerning the impact of real exchange rate misalignment on economic growth the followings ought to be pointed out: the greatest negative impact of the RER misalignment come into view in the case of Czech Republic, followed by Romania and Hungary.

Change in the Rate of Growth of Real GDP as Response to the Increase in RER Misalignment, Currency Over- and Undervaluation (percentage point)

	1 percentage point RER Misalignment	1 percentage point Currency Overvaluation	1 percentage point Currency Undervaluation
The Czech Republic	-0.0173	-0.0294	-0.0200
Hungary	-0.0256	-0.0678	-0.0503
Poland	-0.0090	-0.0537	-0.0255
Romania	-0.0317	0.0337	Statistically Insignificant

The coefficient of the RER misalignment is the smallest in Poland, consequently it can be perceived as a weak correlation. Furthermore, both under- and overvaluation of the real exchange rate in comparison with its equilibrium value have a negative impact on economic growth in the Czech Republic, Hungary and Poland, while in Romania the RER overvaluation stimulates economic growth. The insignificant coefficient of the RER undervaluation in Romania and the negative sign of this indicator in all the countries included in the analysis raise further questions regarding the transmission channels of these influences. In addition, favourable terms of trade shocks enhance growth, as well as the opening up of the economy to the international trade with the exception of the Czech Republic, where, according to the estimation results, economic growth has been hampered by the widening foreign trade. The control variable in the growth regression which accounts for conditional convergence has positive sign, which indicates that an improvement of economic growth in the previous period is positively transmitted to the next period. Estimating the output gap by applying Kalman filter raises the quality of estimation especially in the case of the Czech Republic and to a certain extent also in the case of Hungary and Poland.

3. Panel Data Approach to Estimating Correlation between RER misalignment and Economic Growth in CEECs.

3.1. The Dynamic Panel Model Specification.

Another way to explore the relationship between RER misalignment and economic growth is panel data analysis. Several reasons are reported in the literature which strengthen the utility of this form of analysis. On the one hand, as a matter of robustness, it is useful to bear out whether the correlations obtained from country-by-country analysis also hold within countries. On the other hand, the issue of omitted variables, the unobserved country specific effects and the problem of endogeneity could be solved more easily by applying panel data analysis which permits the inclusion of country specific effect and time specific effect in the estimated model by controlling for unobserved heterogeneity between countries.

I used the generalized method of moments (GMM) estimation technique to estimate the following dynamic panel model proposed by Arellano and Bond (1991):

$$y_{i,t} = \alpha' X^{1}_{i,t-1} + \beta' X^{2}_{i,t} + \mu_{i} + \lambda_{t} + \varepsilon_{i,t} \qquad \text{(III.9.)}$$

- y is the first difference of the log real GDP *($dlgdp_t$)* , the dependent variable, and reflects *the growth rate of real gross domestic product*, an economic performance indicator which quantify economic growth.
- X^1 contains a set of lagged explanatory variables: *first order lag of the growth rate of the real gross domestic product ($dlgdp_{t-1}$)*, which, as a proxy, accounts for conditional convergence and the first order lag of the *output gap* which measures the cyclical reversion *(og_{t-1})*.
- X^2 represents a set of contemporaneous explanatory variables the growth rate of *the degree of trade openness ($dlopen_t$),* accounting for national structural policies, and the growth rate of *terms of trade ($dltot_t$)* which tries to capture external economic conditions and, in addition, my variable of interest the real exchange rate misalignment (erm_t) obtained by following the procedure presented in the previous section.
- μ is an unobserved country-specific effect, while λ is a time specific effect.
- the index terms i and t symbolize country, correspondingly time period (39 quarters).

3.2. Estimation results.

First of all, the correlation between economic growth and the real exchange rate misalignment was empirically studied by estimating model (III.9.). The sample starts from the first quarter 1998 and it ends in the third quarter 2007, in total 140 observations; there are four cross sections[9] included in the analysis represented by the Czech Republic, Hungary, Poland and Romania. After applying the GMM estimation method by introducing a set of instrumental variables (lagged values of both, dependent and independent variables) and an identity instrument weighting matrix, the following model has been obtained[10]:

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[9] More technically speaking, there are a total of 140 observations representing a balanced panel (every group has an identical set of cell ID value and every cross section follows the same regular frequency) of four cross sections with data from 1998:Q1 to 2007:Q3.

[10] Standard errors are presented in [ ] and the entire estimation output is presented in Appendix 1. Tables. (Table 15., 16, 17)

$$d\lg dp_{i,t} = \underset{[0.0599]}{0.2731} + \underset{[0.0460]}{0.8736}\, d\lg dp_{i,t-1} - \underset{[0.0471]}{0.1202}\, og_{i,t-1} - \underset{[0.0057]}{0.0169}\, erm_{i,t} + \underset{[0.0068]}{0.0356}\, dltot_{i,t} - \underset{[0.0248]}{0.1243}\, dlopen_{i,t}$$

$$+\mu_i + \lambda_t + \varepsilon_{i,t} \qquad \text{(III.10)}$$

My main interest is related to the sign of real exchange rate misalignment which is negative and statistically significant at the 1 per cent significance level; as well R-square is very high 0.90 suggesting that the independent variables explain a great part of the variance of the dependent variable (the regression fits well). Therefore, it can be concluded that a 1 percentage-point increase in the degree of RER misalignment decreases economic growth by about 0.02 percentage-points. The other variables are all statistically significant at the 1 per cent significance level and have economically correct signs excepting the degree of trade openness which has negative impact on economic growth. On the one hand, an increase in terms of trade (which may be generated by an increase in export prices or a decrease in import prices) improves economic growth, while a 1 per cent increase of the real GDP in the previous period raises growth by 0.8736 per cent in the present quarter. On the other hand, cyclical movements in real GDP slow economic growth down and they have an approximately similar impact on economic performances as the increase of the degree of trade openness.

Comparing the estimation results with those obtained in the case of the country-by-country analysis it can be concluded that the size of coefficients are similar and the sign of them are identical. Besides, the quality of the model has improved significantly by including the dummy variables (country and time specific effect) proposed by Arellano and Bond (1991). The most robust model, according to the estimation results, seemed to be that which fits the unobserved country-specific effect (μ) and the time specific effect (λ) as fixed effects. The fixed character of these elements was also obvious by the fact that Eviews 5 software automatically adds the constant to the instrument list if there is fixed effect. Arellano and Bond (1991) recommend performing the Sargan's test of the over-identifying restrictions in order to insure that the instrumental variables are not correlated with the residuals. Performing the test, by using as output the J-statistics, the resulted p-value was equal to 0.97. This proves that the applied instrumental variables are not correlated with the residuals while the resulting estimators are consistent.

Razin and Collins (1997), Aguirre and Calderon (2006), Rodrik (2007) point out that even though overvaluation hurts growth and undervaluation encourages it, disproportionate or large undervaluation could also have a negative impact on growth. The most efficient way to check this statement is to divide real exchange rate misalignment series into over- and undervaluation variables and to re-estimate the model III.9. by using these measures. Thus, X^2 vector in model III.9. will also contains the degree of the overvaluation of a certain currency in respect of its equilibrium value (*overv*) and the degree of the undervaluation of a certain currency vis-à-vis its equilibrium value (*underv*) instead of RER misalignment.

I found a negative and statistically significant relationship at the 5 per cent significance level between economic growth indicator and the real exchange rate overvaluation, correspondingly a 1 percentage-point increase in the degree of overvaluation decreases quarterly economic growth by 0.03 per cent. This negative impact on growth is higher than in the case of RER misalignment.

$$d\lg dp_{i,t} = \underset{[0.1964]}{0.5991} + \underset{[0.1502]}{0.6827}\, d\lg dp_{i,t-1} - \underset{[0.1941]}{0.3865}\, og_{i,t-1} - \underset{[0.0129]}{0.0306}\, overv_{i,t} + \underset{[0.0127]}{0.0287}\, dltot_{i,t} - \underset{[0.0423]}{0.1249}\, dlopen_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad \text{(III.11.)}$$

Moreover, the sign of the output gap and the degree of trade openness have remained negative and their size is similar to those in Model III.10. . The country specific effect and the time specific effects are also significantly present in the growth regression.

Finally, I considered the correlation between economic growth and the exchange rate undervaluation. (III.12.)

$$d\lg dp_{i,t} = \underset{[0.1032]}{0.3856} + \underset{[0.0848]}{0.7742}\, d\lg dp_{i,t-1} - \underset{[0.0711]}{0.1368}\, og_{i,t-1} - \underset{\mathbf{[0.0112]}}{\mathbf{0.0041}}\, underv_{i,t} + \underset{[0.0070]}{0.0193}\, dltot_{i,t} - \underset{[0.0256]}{0.1299}\, dlopen_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

Unfortunately, I did not find any statistically significant coefficient (see equation III.12.) in the case of the real exchange rate undervaluation by estimating the growth regression model even though the R-squared is high and all the other coefficients are statistically significant, as it is revealed by the above presented model.

The main results of the panel data analysis reflect that there is an overall negative impact of the real exchange rate misalignment on economic performances and also that the real exchange rate overvaluation slows economic growth down in the four Central and Eastern European countries included in the empirical study. As well, the negative effect of overvaluation is stronger than the effect of the whole RER misalignment, respectively real GDP decreases by 0.017 per cent as a response to the 1 per cent increase of the degree of RER misalignment and it decreases by 0.031 per cent when overvaluation increases by 1 per cent. The impact of the cyclical reversion on economic growth decreased as I controlled for the effect of overvaluation

Naturally, the increase of the degree of openness should enhance growth, because the sustainability of economic growth is relying on constantly growing exports. However, as it can be noticed my empirical analysis reveals that the overall effect of the opening up of the national economies to the external trade on economic growth is negative. Indeed, in case of Central and Eastern Europe it is hard to overlook that a serious external disequilibrium has emerged since 1997 and it has been sustaining. Put differently, after the transformational recession period (in average, 1991-1997) in Central and Eastern Europe the growth of import demand has been faster than the growth of export revenues, phenomenon which has had an unhealthy influence on economic performances in the region.

IV. Concluding Remarks.

The main goal of this paper was to investigate the impact of real exchange rate misalignment on economic growth in four Central and Eastern European countries: the Czech Republic, Hungary, Poland and Romania. Consequently, I estimated the real equilibrium exchange rate of the Czech koruna, the Hungarian forint, the Polish zloty and the Romanian lei against the euro in order to compute their misalignment. After calculating the percentage real exchange rate misalignment I studied its impact on economic growth (measured by the first difference of the log GDP) by performing both country-by-country (time series) and panel data analysis through different growth regression models. Moreover, I introduced additional explanatory variables in the above mentioned models like: the output gap, which controls for cyclical reversion in the real GDP; the first lag of the first difference of the log GDP in order to quantify the transitional convergence of GDP; the degree of trade openness as a proxy to structural policies; the terms of trade which tries to capture the effect of external shocks on economic growth.

Summing up the findings of the empirical analysis the following conclusions can be drawn:

Firstly, after carrying out Johansen's (1995) cointegration tests I obtained that the fundamental factors which determine the level of the ERER are different from one country to the others. In this way, performing panel cointegration tests makes no sense, taking into account that only two fundamental factors (the relative productivity differential and the net foreign assets ratio) are common in the case of these four countries. Furthermore, an equilibrium real appreciation of the Hungarian forint takes place when the relative productivity differential to the euro zone increases, whereas HUF depreciates as a response to the increase in the net foreign assets ratio, raising real interest rate differential and the widening of the degree of trade openness. The equilibrium CZK/EUR is negatively influenced by the relative productivity differential to the euro zone, by the net foreign assets ratio and by the improvements in terms of trade indicator, while the increase of the trade openness positively influences it. As much as it may concern the equilibrium PLN/EUR exchange rate, the expansion of the relative productivity differential, the real interest rate differential with respect to the euro zone and an increase in the net foreign assets ratio appreciate the Polish Zloty; but an improvement in terms of trade depreciate Poland's national currency. In addition, the Romanian lei is inversely correlated with the relative productivity differential and the net foreign assets ratio, respectively directly correlated with the degree of trade openness and the non-governmental credit ratio to GDP.

The VEC models estimated in the case of each currency show that the speed of adjustment (quantified by the coefficient of the lagged equilibrium error term) of the Hungarian forint, the Polish zloty and the Romanian lei to their equilibrium levels is quite strong, correspondingly any disequilibrium inherited from the previous period is eliminated in maximum four quarters.

Secondly, concerning the real exchange rate misalignment of the above mentioned currencies, I found that the Hungarian forint, the Polish zloty and the Romanian lei were overvalued in respect with their equilibrium value in the third quarter 2007, at the same time as the Czech koruna was undervalued. The RER misalignment series, the overvaluation and the undervaluation indicators (these were calculated by splitting the RER misalignment into two series) were used in order to study the impact of exchange rate gap on economic growth.

Thirdly, after conducting the panel data analysis, which supposed the estimation of three panel growth regression in line with the three RER movement indicators by using GMM estimation technique, I found that a one per cent increase of the RER misalignment decreases economic growth by 0.017 per cent in the region. By controlling individually for the effect of currency over- and undervaluation, the results are consistent with the idea according to which persistent currency overvaluation hurts economic growth by decreasing the real GDP with 0.031 percent. Unfortunately, the coefficient of the currency undervaluation did not seem to be statistically significant consequently I could not draw any conclusion concerning its overall effect in the region. These results are in line with the existing evidence presented by Razin and Collins (1997), Rodrik (2007).

Fourthly, deepening the analysis I considered important to look after evidences at country level and, in that order, to conduct a country-by-country analysis which allowed me to identify the individually country specific effects. Even though none of the papers presented in the literature review deals with this kind of analysis, I found out a series of interesting evidences which prove the utility of time series analysis. Therefore, the estimation results confirm that the real exchange rate misalignment of the four currencies negatively influences economic growth indifferently whether I use the output gap estimated by HP or Kalman filter. Contrarily, when I control for the individual effect of the national currencies over- and undervaluation on economic growth I get quite surprising results which are not perfectly in line with the general evidence obtained in the case of the panel data analysis.

On the one hand, both national currency under- and overvaluation negatively influence growth in the Czech Republic, in Hungary and in Poland. These results are not perfectly corresponding to the textbook theory which states that currency undervaluation is beneficial to economic growth by encouraging the export oriented production sector to produce and sell more abroad, allowing them to be more profitable. The reason for these contradictory results could be the fact that I included in the analysis only indicators which characterize external trade. Nevertheless, if one looks at the statistics it is obvious that in the above mentioned countries external trade has not been an engine of economic growth: since the speed of growth of imports was higher than that of exports, the phenomenon which has generated external trade deficit and, to a certain extent, created disequilibrium in these economies.

On the other hand, in accordance with the estimation results, Romania represents an exception in comparison with the rest of the countries because of the fact that I did not find any significant relationship between economic growth and the undervaluation rate of the Romanian lei. Furthermore, the RER misalignment had a negative and statistically significant influence on economic growth, even though the overvaluation of the Romanian lei enhanced growth in the sample period. These confusing results could be attributed to the fact that the external trade has had a significantly negative contribution to GDP particularly in the second part of the sample period. Besides, household consumption has approximately represented 78% in total GDP at quarterly level while this consumption has been financed predominantly from credits, contracted in foreign currencies, and from remittances of Romanian employees working abroad. Taking into account the data evidence, the above mentioned explanation is quite binding since the overvaluation of the Romanian lei which took place in the period October 2004- June 2007 was followed by high economic growth.

***Fifthly*,** if seen in global perspective the estimation results, it makes sense to conclude that it would be useful if the National Banks from the four countries were conducting their monetary policy in such a way that the real exchange rate of their national currencies stay as close as possible to their equilibrium level. This tendency would be helpful in the process of fulfillment of the (nominal and real) convergence criteria concerning the integration to the European EMU.

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Appendix

Appendix 1. Tables.

Table 3. Types of the Approaches Used for estimating Equilibrium Real Exchange Rate in the CEECs. Literature Summary.

Author	**Countries**	**Methodologies**	**Estimation Technique**
Alberola (2003)	**CZ,HU,PL**	BEER/PEER	ST
Avallone and Lahrèche (1999)	**HU**	BEER	ST
Braumann (1998)	**SK**	BEER	ST
Bulir and Smidkova (2004)	**CZ,HU,PL**,SI	FEER	ST/PL
Coudert (1999)	**HU**	BEER	PL
Coudert and Couharde (2002)	**CZ,HU,PL**,SK,SI	FEER	PL
Csajbók and Kovács (2003)	**HU**	FEER	ST
DeBroeck and Sløk (2001)	**CZ,HU,PL**,SK,SI,EE	BEER	PL
Égert, Lahrèche-Révil (2003)	**CZ,HU,PL**,SK,SI	BEER	ST/PL
Égert and Lommatzsch (2003)	**CZ.HU,PL**,SK,SI	BEER	ST/PL
Égert (2005b)	BL,**RO**,RU,UKR	BEER	ST/PL
Filipozzi (2000)	EE	BEER	ST
Halpern-Wyplosz (1997)	**CZ,PL,HU**,SK,SI	BEER	ST
Halpern-Wyplosz (2001)	**CZ,PL,HU**,SK,SI,BL,RO	BEER	PL
Hinnosar et al (2003)	EE	BEER	ST
Karádi (2003)	**HU**	BEER/NATREX	ST
Kovacs(2001)	**HU**	BEER	ST
Kim and Korhonen (2005)	**CZ,PL,HU**,SK,SI	BEER	PL
Lommatzsch and Tober (2004)	**CZ,PL,HU**	BEER	ST
Smidkova et al. (2002)	**CZ,HU,PL**,SI,EE	FEER	PL
Vonnák and Kiss (2003)	**HU**	BEER	ST/PL

Table 4. Classifying Economic Sectors into Tradable and Non-tradable Sectors. Literature Summary.

Authors	Countries	Tradable sector	Non-tradable Sector
DeBroeck and Slok (2001)	CZ HU PL SK SI	Industry, construction	The other sectors, agriculture excluded
Egert (2002)	CZ HU PL SK SI	Industry	The other sectors
Egert (2003)	CZ HU PL SK SI LT	Industry, agriculture	The other sectors
Egert (2005)	RO BL RU UKR	Industry	Services, construction
Filipozzi (2000)	EE	Industry	The other sectors, agriculture excluded
Fischer (2002)	CZ HU PL SK SI BL RO	Industry, agriculture	The other sectors
Halpern and Wyplosz (2001)	CZ HU PL SK SI LT BL RO HU LI	Industry	Services; agriculture excluded
Hinnosar (2003)	EE	Industry, agriculture	The other sectors
Kovacs and Simon (1998)	HU	Industry	Servicer; agriculture excluded
Lommatzsch and Egert (2003)	CZ HU PL SK SI	Industry	Services, the other sectors

Table 5. Unit Root Tests. (ADF – Augmented Dickey-Fuller test; PP – Phillips-Perron test; KPSS - Kwiatkowski-Phillips-Schmidt-Shin test).

		Czech Republic			**Hungary**			**Poland**			**Romania**	
	ADF[1)]	**PP[2)]**	**KPSS[3)]**	**ADF[1)]**	**PP[2)]**	**KPSS[3)]**	**ADF[1)]**	**PP[2)]**	**KPSS[3)]**	**ADF[1)]**	**PP[2)]**	**KPSS[3)]**
LRER	-2.54235	-0.90821	0.23195	-1.91779	-2.03936	0.27686	-1.81458	-1.92636	0.67315	-2.43940	-2.40936	0.17851
	(0.30734)	(0.77478)		(0.62342)	(0.56171)		(0.36803)	(0.31710)		(0.35470)	(0.36915)	
WAGEDIF							-0.07278	0.27333	0.44599			
							(0.65250)	(0.76061)				
PROD	-2.98536	-3.08835	0.88114	-1.85217	-2.23112	0.47816	-2.09497	-1.98943	0.93296	-0.78404	-0.77893	0.22257
	(0.14825)	(0.12220)		(0.66114)	(0.46100)		(0.24764)	(0.29020)		(0.95830)	(0.95880)	
OPEN	-2.92093	-3.09754	0.20314	-1.73398	-1.86959	0.90175	-1.98784	-2.39087	0.23341	-2.55965	**-2.71771**	0.92213
	(0.16632)	(0.11980)		(0.40743)	(0.34307)		(0.59123)	(0.37890)		(0.11035)	**(0.08039)**	
TOT	-2.47741	0.67028	0.53795	-1.84747	-1.60017	0.63947	-0.27180	0.53761	0.20445	-2.69395	0.83379	1.28774
	(0.12840)	(0.85696)		(0.35328)	(0.47386)		(0.58183)	(0.82820)		(0.24452)	(0.99341)	
NFA	-0.81435	-0.52448	0.35114	-2.05252	-1.99994	0.28927	-1.78577	-1.97169	0.57784	-1.58288	-1.07292	1.13722
	(0.95590)	(0.97840)		(0.55669)	(0.58481)		(0.38226)	(0.29774)		(0.48110)	(0.71648)	
FDEBT	-1.21367	-1.24311	2.60643				0.74807	0.34872	0.95825			
	(0.20254)	(0.19312)					(0.99185)	(0.97818)				
CONS	-2.41009	-2.56947	0.22144	-0.89953	-1.12460	0.79799	-0.41172	-0.39572	0.57666			
	(0.36945)	(0.29546)		(0.77893)	(0.69752)		(0.89797)	(0.90079)				
GOV	-1.33416	-1.40453	0.93296	-3.28591	-3.22445	0.28995	**-4.79007**	**-4.88540**	**0.27127**			
	(0.60509)	(0.57130)		(0.08224)	(0.09326)		**(0.00033)**	**(0.00025)**				
RIRD	***-7.15682***	***-6.66257***	***0.37324***	-3.01173	-2.74331	0.23926	-2.63980	**-4.12174**	0.41620			
	(0.00000)	***(0.00000)***		(0.14388)	(0.22613)		(0.26610)	**(0.01274)**				
CRED										-1.98019	-1.70203	0.52679
										(0.29388)	(0.42218)	

[1)] critical values of the test are -3.2003 (at 10% level), -3.5366 (at 5%), -4.2268 (at 1%)

[2)] critical values of the test are -3.1983 (at 10% level), -3.5333 (at 5%), -4.2191 (at 1%)

[3)] critical values of the test are 0.1190 (at 10% level), 0.1460 (at 5%), 0.2160 (at 1%) if linear trend is included in the test's regression and they are 0.3470 (at 10% level), 0.4630 (at 5%), 0.3470 (at 1%) if the test specification contains just constant

[()] MacKinnon (1996) one-sided p-value in brakets ( ).

Table 6. Johansen's Cointegration Tests.

Country	Null Hypothesis (nr of coint. relations)	Eigenvalue	Trace test statistic			Maximum Eigenvalue test statistic		
			Computed value	5% critical value	p-value**	Computed value	5% critical value	p-value**
Czech Republic	None *	0.61936	80.65831	76.97277	0.02550	36.70394	34.80587	0.02930
(Series:	At most 1	0.44151	**43.95437**	**54.07904**	**0.28970**	**22.13577**	**28.58808**	**0.26700**
LRER PROD OPEN NFA TOT)	At most 2	0.25679	21.81860	35.19275	0.60770	11.27753	22.29962	0.72430
Hungary	None *	0.61277	86.18609	76.97277	0.00840	35.10300	34.80587	0.04610
(Series:	At most 1	0.47641	**51.08309**	**54.07904**	**0.09020**	**23.94051**	**28.58808**	**0.17550**
LRER PROD NFA TOT RIRD)	At most 2	0.32582	27.14258	35.19275	0.28170	14.58744	22.29962	0.40970
Poland	None *	0.87124	131.66510	76.97277	0.00000	73.79366	34.80587	0.00000
(Series:	At most 1 *	0.54108	57.87148	54.07904	0.02210	**28.03957**	**28.58808**	**0.05860**
LRER WAGEDIF TOT NFAEG RIRD)	At most 2	0.36523	**29.83191**	**35.19275**	**0.16880**	16.36153	22.29962	0.27340
Romania	None *	0.69341	80.04013	69.81889	0.00610	44.92465	33.87687	0.00160
(Series:	At most 1	0.38615	**35.11548**	**47.85613**	**0.44190**	**18.54414**	**27.58434**	**0.45050**
LRER PROD NFA OPEN CRED)	At most 2	0.27876	16.57134	29.79707	0.67150	12.41750	21.13162	0.50700

* denotes rejection of the hypothesis at the 5% significance level

**MacKinnon-Haug-Michelis (1999) p-values

Table 7. Vector Autoregressive Lag Order Selection Criteria

The Czech Republic

VAR Lag Order Selection Criteria

Endogenous variables: LRER PROD OPEN NFA TOT

Lag	LR	AIC	SBC	HQ
0	NA	-12.47696	-12.25703	-12.40020
1	**216.8334***	**-18.31586**	**-16.99626***	**-17.85528***
2	26.94893	-18.00492	-15.58566	-17.16054
3	37.61021	-18.49655*	-14.97761	-17.26834

Hungary

VAR Lag Order Selection Criteria

Endogenous variables: LRER PRODDIF OPEN NFA RIRD

Lag	LR	AIC	SC	HQ
0	NA	-13.33358	-13.11365	-13.25682
1	253.0755	-20.38054	-19.06094*	-19.18703
2	**40.84927***	**-20.68500***	**-17.61216**	**-19.91997***
3	25.99423	-20.03142-	-17.16607	-19.45680

Poland

VAR Lag Order Selection Criteria

Endogenous variables: LRER WAGEDIF TOT NFAEG NIRD

Lag	LR	AIC	SC	HQ
0	NA	-16.35979	-16.13986	-16.28303
1	195.1975	-21.47749	-19.76612	-21.01691
2	**52.41973**	**-22.74633***	**-20.15789***	**-21.51813***
3	38.99656*	-22.18539	-19.22740	-21.34100

Romania

VAR Lag Order Selection Criteria

Endogenous variables: LRER RELPRODDIF NFA OPEN CRED

Lag	LR	AIC	SC	HQ
0	NA	-13.57158	-13.35164	-13.49481
1	**268.5923**	**-21.28636***	**-19.81617***	**-20.67519***
2	38.48701*	-21.13577	-18.86709	-20.44197
3	23.93910	-21.09442	-17.57549	-19.86622

* indicates lag order selected by the criterion; LR; sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SBC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Table 8. Vector Error Correction Estimates in the Case of the Hungarian Forint.

Vector Error Correction Estimates
Sample (adjusted): 1998Q3 2007Q3
Included observations: 37 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1				
LRER(-1)	1.000000				
PROD(-1)	0.518586				
	(0.30463)				
	[1.70233]				
OPEN(-1)	-0.261495				
	(0.10668)				
	[-2.45112]				
NFA(-1)	-0.473313				
	(0.11895)				
	[-3.97914]				
RIRD(-1)	1.299004				
	(0.18744)				
	[6.93010]				
C	-5.474090				
Error Correction:	**D(LRER)**	**D(PROD)**	**D(OPEN)**	**D(NFA)**	**D(RIRD)**
CointEq1	-0.372008	-0.079957	0.109123	1.079651	-0.109960
	(0.14860)	(0.08627)	(0.18922)	(0.27420)	(0.06894)
	[-2.50350]	[-0.92681]	[0.57671]	[3.93752]	[-1.59497]
R-squared	0.352587	0.093889	0.259499	0.372818	0.314602
Akaike AIC	-3.631556	-4.719032	-3.148211	-2.406322	-5.167485
Schwarz SC	-3.326788	-4.414263	-2.843442	-2.101553	-4.862717
Mean dependent	-0.009387	0.004174	0.009625	0.015032	-0.013641
S.D. dependent	0.041056	0.020148	0.048883	0.076971	0.018513
Determinant resid covariance (dof adj.)		7.73E-16			
Determinant resid covariance		2.71E-16			
Akaike information criterion		-19.49307			
Schwarz criterion		-17.75154			

Table 9. Vector Error Correction Estimates in the Case of the Czech Koruna, the Polish Zloty and the Romanian Lei.

Sample (adjusted): 1998Q2 2007Q3

Included observations: 38 after adjustments

The Czech Republic [Lag Intervals for D(Endogenous) : 0 0]

	Error Correction (α)	Cointegrating Vector (β) LRER(-1)	PROD(-1)	OPEN(-1)	NFA(-1)	TOT(-1)	C	AIC	SBC	Det. Resid cov. (dof adj.)
Coefficient	***-0.1293***	***1.0000***	***3.1428***	***-0.3558***	***0.2852***	***6.897791***	***-12.6486***	-18.3058	-17.6594	4.59E-15
Std. errors	[0.1032]		[0.5776]	[0.1415]	[0.1536]	[1.0588]	[1.7347]			
t-statistics	(-1.2537)		(5.4416)	(-2.5147)	(0.1536)	(6.5149)	(-7.2917)			

Poland [Lag Intervals for D(Endogenous) : 1 1]

	Error Correction (α)	Cointegrating Vector (β) LRER(-1)	WAGEDIF(-1)	RIRD(-1)	NFA(-1)	TOT(-1)	C	AIC	SBC	Det. resid cov. (dof adj.)
Coefficient	***-0.4051***	***1.0000***	***3.8691***	***2.498737***	***2.1159***	***-1.1731***	***-4.9941***	-22.0028	-19.1437	3.93E-17
Std. errors	[0.1703]		[0.2741]	[0.1337]	[0.0989]	[0.1972]	[1.0347]			
t-statistics	(-2.3783)		(14.1149)	(18.6879)	(21.3894)	(-5.9480)	(-4.8267)			

Romania [Lag Intervals for D(Endogenous) : 0 0]

	Error Correction (α)	Cointegrating Vector (β) LRER(-1)	PROD(-1)	OPEN(-1)	NFA(-1)	CRED(-1)	C	AIC	SBC	Det. resid cov. (dof adj.)
Coefficient	***-0.2522***	***1.0000***	***1.5221***	***-2.4660***	***0.6995***	***-0.8971***	***1.1025***	-20.9855	-20.3391	3.15E-16
Std. errors	[0.0835]		[0.3984]	[0.3358]	[0.2159]	[0.2163]	[0.5347]			
t-statistics	(3.0209)		(3.8209)	(-7.3440)	(3.2404)	(-4.1483)	(2.0621)			

Table 10. Panel Unit Root tests.

	Levin, Lin & Chu t-statistics[1]	Im, Pesaran and Shin W-statistics[2]
dlgdp*	-2.3479 (0.0094)	-3.9291 (0.0000)
og*	-4.5288 (0.0000)	-2.3917 (0.0084)
erm*	-4.3220 (0.0000)	-4.1806 (0.0000)
overv*	-3.2424 (0.0006)	-4.1312 (0.0000)
underv*	-2.4594 (0.0070)	-2.8822 (0.0020)
dlopen*	-9.0798 (0.0000)	-8.3085 (0.0000)
dltot*	-7.1547 (0.0000)	-11.5822 (0.0000)

p-values in brackets (); * rejecting null hypothesis at the 1% significance level
[1] null hypothesis: unit root (common unit root process);
[2] null hypothesis: unit root (individual unit root process)

Table 11. Growth Regression Models for the Czech Republic. GMM Estimation Results.

Dependent variable: the growth rate of real GDP											
	cst.	**DLGDP(-1)**	**OG(-1)**	**ERM**	**OVERV**	**UNDERV**	**DLOPEN**	**DLTOT**	**R2**	**J-statistic**	**Sargan's (1958) test***
Output gap estimated by HP filter											
Model 1	**0.0213**	-0.5853	1.8474	**-0.4436**			-0.7900	0.0262	0.2881	0.0516	1.8060
[Std. error]	[0.0092]	[0.2512]	[0.3537]	[0.1725]			[0.2214]	[0.3514]			
Model 2	**0.0203**	-0.5789	1.7250	**-0.4645**			-0.8141		0.2815	0.0556	1.9460
[Std. error]	[0.0077]	[0.2356]	[0.6855]	[0.1860]			[0.2793]				
Model 3	2.8831	-0.5546	-0.6848		**-1.7724**		-0.4346	0.6193	0.3505	0.06996	2.4486
[Std. error]	[0.6327]	[0.0292]	[0.4007]		[0.3344]		[0.2804]	[0.0906]			
Model 4	0.0212	-0.5541	1.2618			**-0.2170**	-0.4393	0.3109	0.3563	0.17092	5.9822
[Std. error]	[0.0016]	[0.0612]	[0.4601]			[0.0803]	[0.1135]	[0.0755]			
Output gap estimated by Kalman filter											
Model 5	0.0829	0.9421	-0.3953	**-0.0173**			-0.0220	0.0188	0.8236	0.17309	6.0581
[Std. error]	[0.1000]	[0.0454]	[0.1163]	[0.0060]			[0.0086]	[0.0064]			
Model 6	0.5730	0.6801	-0.3531		**-0.0294**		-0.0250	0.0165	0.7167	0.12832	4.4912
[Std. error]	[0.0471]	[0.0237]	[0.1729]		[0.0043]		[0.0032]	[0.0045]			
Model 7	0.0690	0.9658	-0.8227			**-0.0200**	-0.0279	0.0169	0.7395	0.1978	6.9232
[Std. error]	[0.0821]	[0.0361]	[0.1142]			[0.0071]	[0.0057]	[0.0046]			

* the critical value at the 5% significance level is 12.84 ($X^2_{(3)}$)

Table 12. Growth Regression Models for Hungary. GMM Estimation Results.

Dependent variable: the growth rate of real GDP											
	cst.	DLGDP(-1)	OG(-1)	ERM	OVERV	UNDERV	DLOPEN	DLTOT	R2	J-statistic	Sargan's (1958) test
Output gap estimated by HP filter											
Model1	0.3195	0.6642	-0.4010	**-0.0289**			0.0483	0.0986	0.1728	0.0188	0.6587
[Std. error]	[0.1675]	[0.1526]	[0.0864]	[0.0131]			[0.0203]	[0.0361]			
Model 2	0.5046	0.6948	-0.1335		**-0.0678**		-0.0265	0.1184	0.2812	0.0862	3.0181
[Std. error]	[0.1008]	[0.0771]	[0.0624]		[0.0216]		[0.0093]	[0.0481]			
Model 3	0.1637	0.7737	-0.3306			**-0.0503**	**-0.0072**	0.1596	0.2288	0.1668	5.8376
[Std. error]	[0.0540]	[0.0736]	[0.0685]			[0.0156]	[0.0107]	[0.0339]			
Output gap estimated by Kalman filter											
Model 4	0.0375	0.9171	-0.7910	**-0.0256**			**0.0148**	0.0952	0.2947	0.2426	8.4941
[Std. error]	[0.0041]	[0.1990]	[0.2143]	[0.0154]			[0.0149]	[0.0425]			
Model 5	0.5537	0.6081	-0.8074		**-0.1357**		-0.0101	0.0695	0.1207	0.0830	2.9062
[Std. error]	[0.0082]	[0.3323]	[0.3401]		[0.0368]		[0.0031]	[0.0238]			

* the critical value at the 5% significance level is 12.84 ($X^2_{(3)}$)

Table 13. Growth Regression Models for Poland. GMM Estimation Results.

Dependent variable: the growth rate of real GDP	cst.	DLGDP(-1)	OG(-1)	ERM	OVERV	UNDERV	DLOPEN	DLTOT	R2	J-statistic	Sargan's (1958) test*
Output gap	**estimated by HP filter**										
Model 1	**-0.0668**	0.4306	-0.0833	**-0.0090**			0.0540	0.0706	0.2462	0.0436	1.5249
[Std. error]	[0.0060]	[0.0510]	[0.0158]	[0.0026]			[0.0168]	[0.0061]			
Model 2	**-0.0438**	0.3581	-0.1137		**-0.0537**		-0.0350	0.0528	0.1719	0.1286	4.5014
[Std. error]	[0.0202]	[0.1635]	[0.0648]		[0.0213]		[0.0028]	[0.0202]			
Model 3	-0.0436	0.3873	-0.0379			**-0.0296**	0.0993	0.0471	0.2247	0.0848	2.9692
[Std. error]	[0.0144]	[0.0500]	[0.0064]			[0.0087]	[0.0223]	[0.0149]			
Output gap	**estimated by Kalman filter**										
Model 4	0.6542	0.2333	-0.3136	**-0.0163**			0.1318	0.0156	0.1654	0.1510	5.2871
[Std. error]	[0.0595]	[0.0462]	[0.0375]	[0.0053]			[0.0088]	[0.0049]			
Model 5	1.0571	0.2492	-0.2528		**-0.0994**		0.0433	0.0240	0.1914	0.1711	5.9901
[Std. error]	[0.1692]	[0.0720]	[0.0213]		[0.0268]		[0.0170]	[0.0066]			
Model 6	-5.2848	0.3058	-0.0614			**-0.0255**	0.0364	0.0573	0.272775	0.109911	3.8469
[Std. error]	[1.8059]	[0.1145]	[0.0247]			[0.0046]	[0.0118]	[0.0182]			

* the critical value at the 5% significance level is 12.84 ($X^2_{(3)}$)

Table 14. Growth Regression Models for Romania. GMM Estimation Results.

Dependent variable: the growth rate of real GDP												
	cst.	DLGDP(-1)	OG(-1)	ERM	OVERV	UNDERV	DLOPEN	DLTOT	R2	J-statistic	Sargan's (1958) test*
Output gap estimated	**by HP filter**										
Model 1	0.0075	0.2758	-0.2820	**-0.0248**			**0.0164**	0.0497	0.1835	0.0808	2.8283
[Std. error]	[0.0015]	[0.1018]	[0.0663]	[0.0105]			[0.0391]	[0.0192]			
Model 2	0.0075	0.3089	-0.2492	**-0.0317**				0.0541	0.1504	0.0737	2.5804
[Std. error]	[0.0017]	[0.1418]	[0.1136]	[0.0153]				[0.0224]			
Model 3	0.0042	0.3856	-0.3328		**0.0337**			0.0880	0.1624	0.1053	3.6860
[Std. error]	[0.0018]	[0.0888]	[0.0467]		[0.0135]			[0.0089]			
Model 4	0.0058	0.3984	-0.3173			**-0.0002**	**-0.0040**	0.0681	0.0939	0.0969	3.3901
[Std. error]	[0.0026]	[0.1211]	[0.1131]			[0.0506]	[0.0930]	[0.0182]			
Model 5	0.0060	0.3860	-0.3184			**0.0034**		0.0668	0.0935	0.0983	3.4396
[Std. error]	[0.0019]	[0.1186]	[0.0417]			[0.0228]		[0.0101]			

* the critical value at the 5% significance level is 12.84 ($X^2_{(3)}$)

Table 15. The Impact of RER Misalignment on Economic Growth. Panel Growth Regression Model.

Dependent Variable: PDY
Method: Panel GMM EGLS (Period weights)
Sample (adjusted): 1999Q1 2007Q3
Cross-sections included: 4
Total panel (balanced) observations: 144
Identity instrument weighting matrix
Linear estimation after one-step weighting matrix
Instrument list: C PDY(-2) PDY(-4) POG_HP(-3) POG_HP(-4) PERM(-3) PERM(-4) PERM(-1) PDLTOT(-4) PDLOPEN(-4) PDLTOT(-3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.273041	0.059986	4.551725	0.0000
PDY(-1)	0.873588	0.046009	18.98730	0.0000
POG_HP(-1)	-0.120248	0.047144	-2.550654	0.0123
PERM	-0.016987	0.005744	-2.957292	0.0039
PDLTOT	0.035641	0.006847	5.205660	0.0000
PDLOPEN	-0.124347	0.024843	-5.005396	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.907622	Mean dependent var	1.851509
Adjusted R-squared	0.867900	S.D. dependent var	2.082253
S.E. of regression	0.756808	Sum squared resid	57.27578
Durbin-Watson stat	2.696484	J-statistic	4.328003
Instrument rank	49.00000		

Table 16. The Impact of Currency Overvaluation on Economic Growth. Panel Growth Regression Model.

Dependent Variable: PDY
Method: Panel GMM EGLS (Period weights)
Sample (adjusted): 1999Q1 2007Q3
Cross-sections included: 4
Total panel (balanced) observations: 144
Identity instrument weighting matrix
Linear estimation after one-step weighting matrix
Instrument list: C PDY(-2) PDY(-4) POG_HP(-3) POG_HP(-4) POVERV(-3) POVERV(-4) POVERV(-1) PDLTOT(-4) PDLOPEN(-4) PDLTOT(-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	0.599106	0.196450	3.049668	0.0029
PDY(-1)	0.682798	0.150236	4.544828	0.0000
POG_HP(-1)	-0.386567	0.194155	-1.991026	0.0492
POVERV	-0.030653	0.012910	-2.374379	0.0195
PDLTOT	0.028791	0.012721	2.263223	0.0258
PDLOPEN	-0.124910	0.042335	-2.950500	0.0040

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.826423	Mean dependent var	1.511931
Adjusted R-squared	0.751785	S.D. dependent var	1.362144
S.E. of regression	0.678636	Sum squared resid	46.05466
Durbin-Watson stat	2.190802	J-statistic	2.576644
Instrument rank	49.00000		

Table 17. The Impact of Currency Undervaluation on Economic Growth. Panel Growth Regression Model.

Dependent Variable: PDY
Method: Panel GMM EGLS (Period weights)
Date: 06/25/08 Time: 14:48
Sample (adjusted): 1999Q1 2007Q3
Cross-sections included: 4
Total panel (balanced) observations: 144
Identity instrument weighting matrix
Linear estimation after one-step weighting matrix
Instrument list: C PDY(-4) PDY(-3) POG_HP(-3) POG_HP(-4)
PUNDERV(-2) PUNDERV(-4) PUNDERV(-3) PDLTOT(-4)
PDLOPEN(-4) PDLTOT(-3) PDLOPEN(-3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.385600	0.103224	3.735549	0.0003
PDY(-1)	0.774291	0.084829	9.127679	0.0000
POG_HP(-1)	-0.136853	0.071123	-1.924177	0.0572
PUNDERV	-0.004116	0.011239	-0.366193	0.7150
PDLTOT	0.019331	0.007039	2.746229	0.0072
PDLOPEN	-0.129988	0.025600	-5.077625	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.875403	Mean dependent var	1.789867
Adjusted R-squared	0.821826	S.D. dependent var	1.786779

S.E. of regression	0.754210	Sum squared resid	56.88329
Durbin-Watson stat	2.476004	J-statistic	9.088479
Instrument rank	50.00000		

Appendix 2. Figures.

Figure 5. The Real Exchange Rate of the Czech Koruna, the Hungarian Forint, the Polish Zloty and the Romanian Lei.

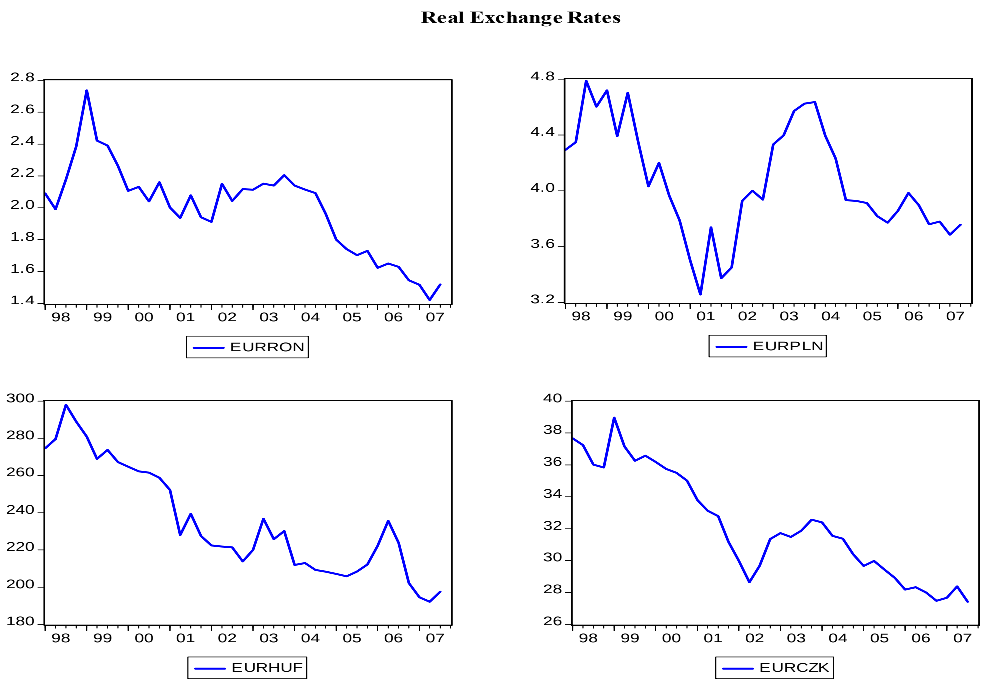
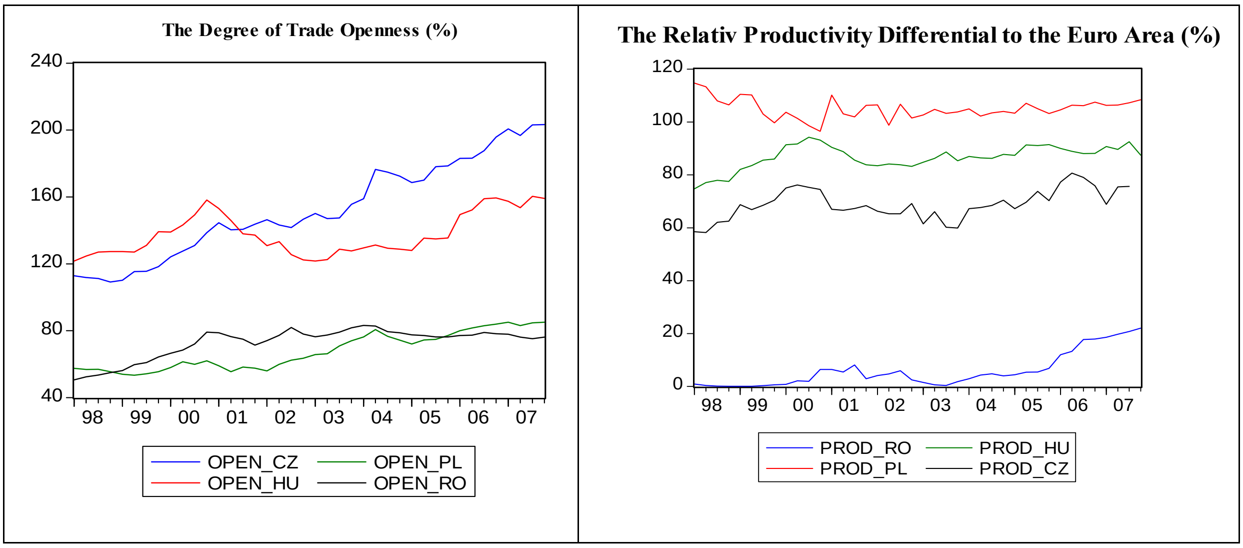
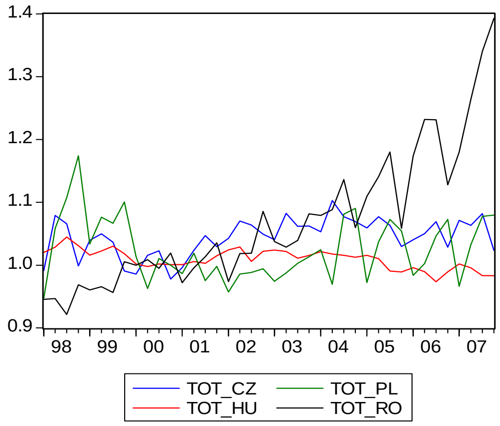


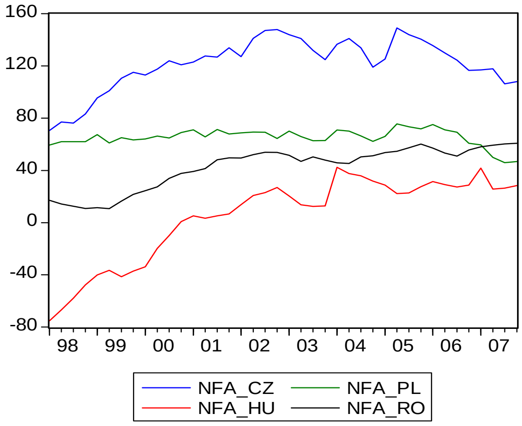
Figure 6. Fundamental Factors Included into the Empirical Analysis.



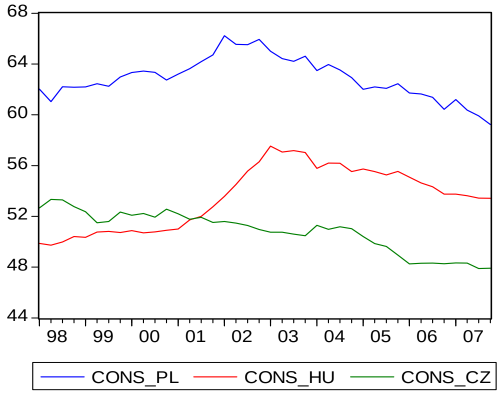
Terms of Trade



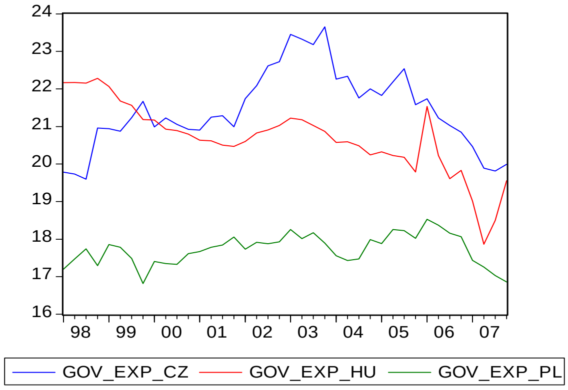
The Report between Net Foreign Assets and GDP (%)



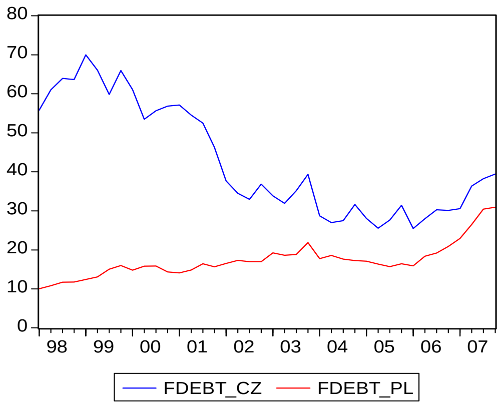
The report between consumption and GDP (%)



The report between government expenditure and GDP (%)



The report between foreign debt and GDP (%)



The real interest rate differential to the Euro Area (%)

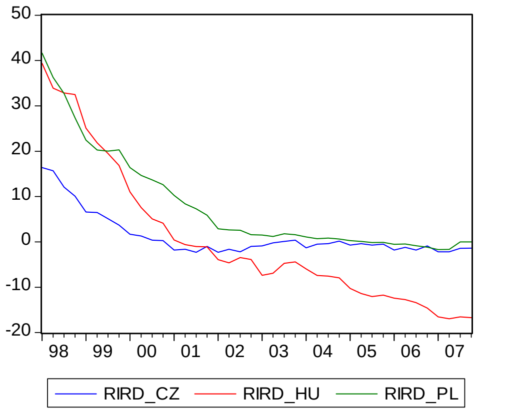


Figure 7. Currency Over- and Undervaluation Indicators (%).

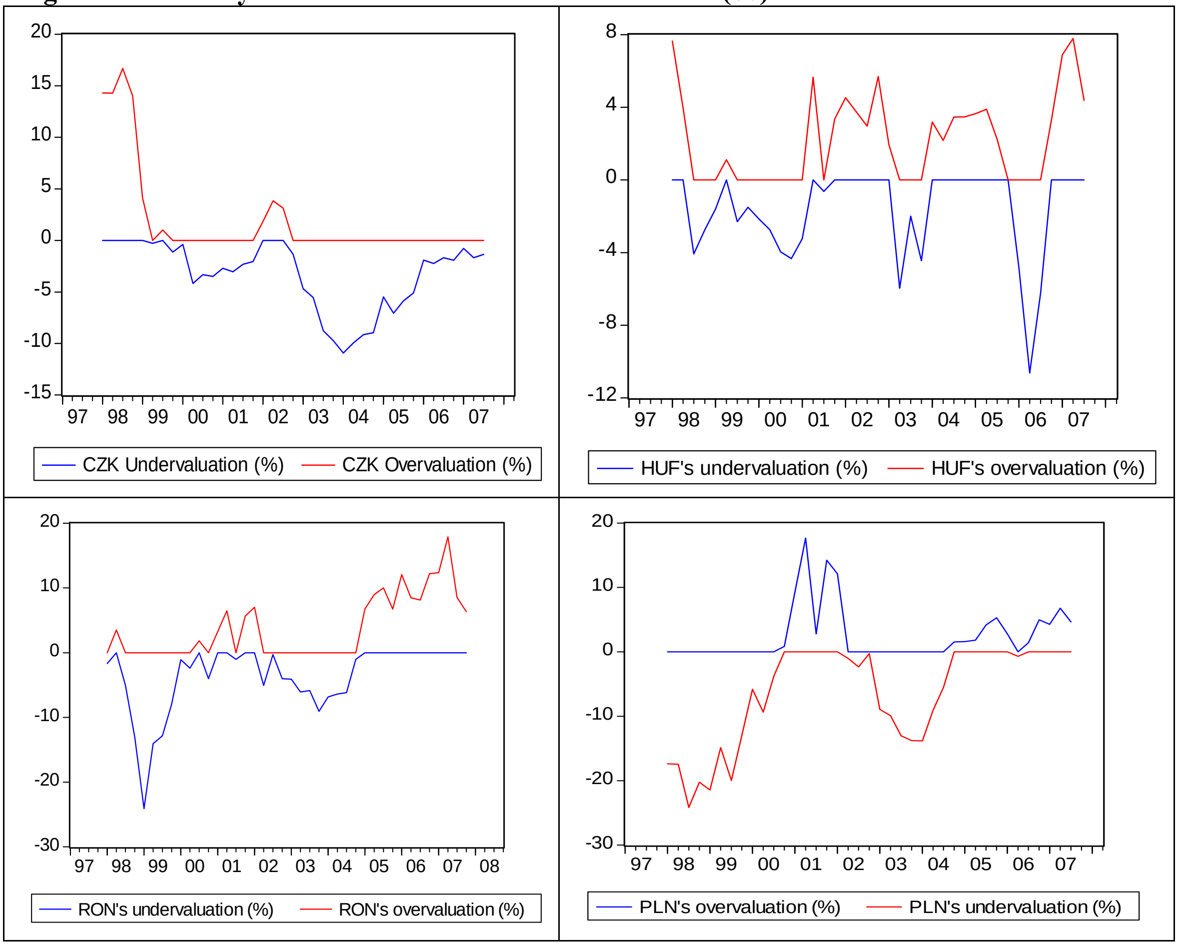
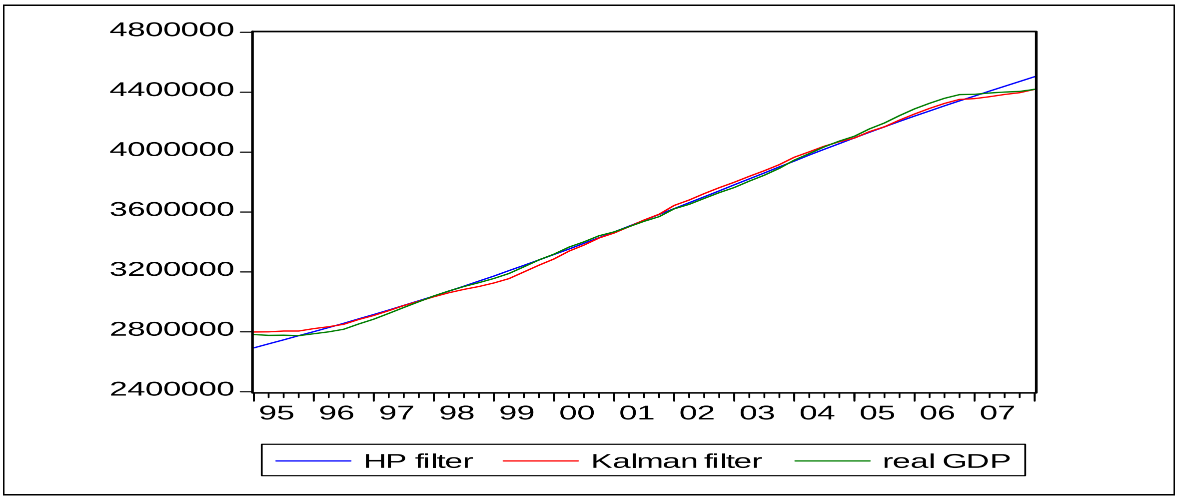
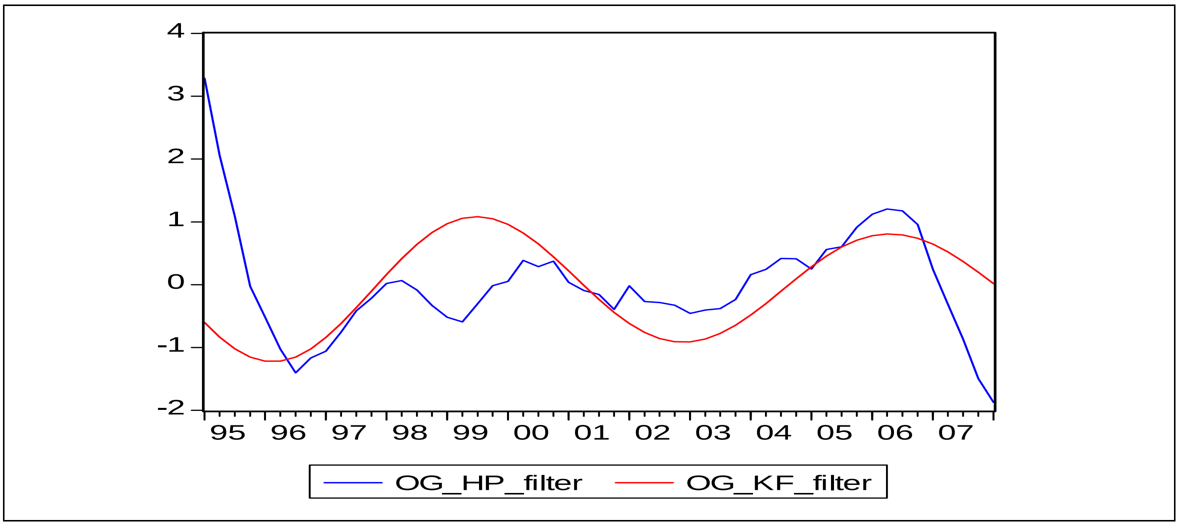


Figure 8. Potential GDP and Output Gap (%) Estimated in the Case of Hungary by Using Kalman Filter and Hodrick-Prescott Filter





Component specification in Stamp 6.3 : stochastic level + stochastic slope + no seasonal component.

Eq 11 : Estimated parameters of Cy1.

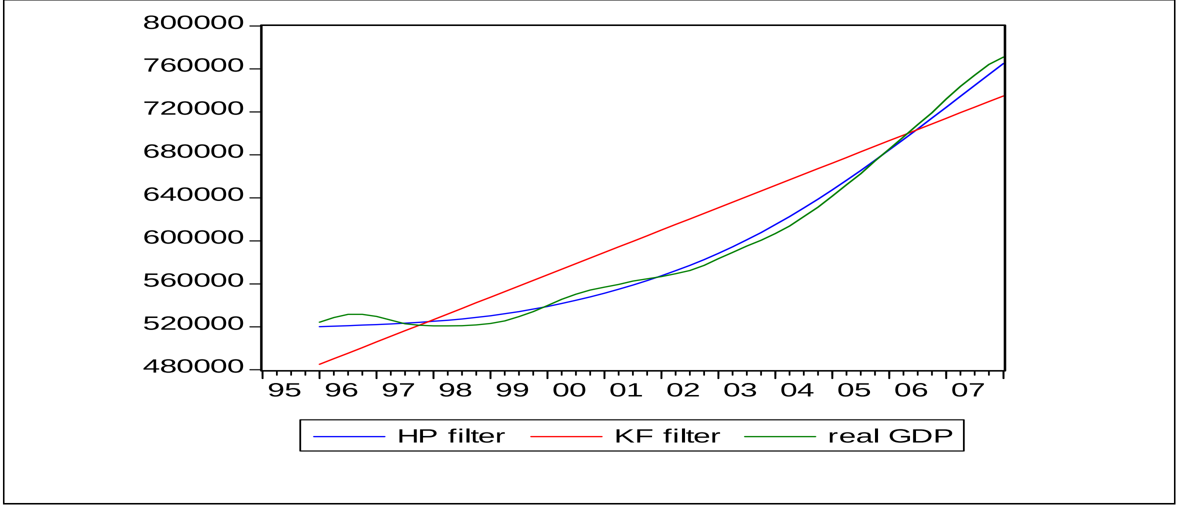
The cycle period is **27.1416 (6.78541 'years').**

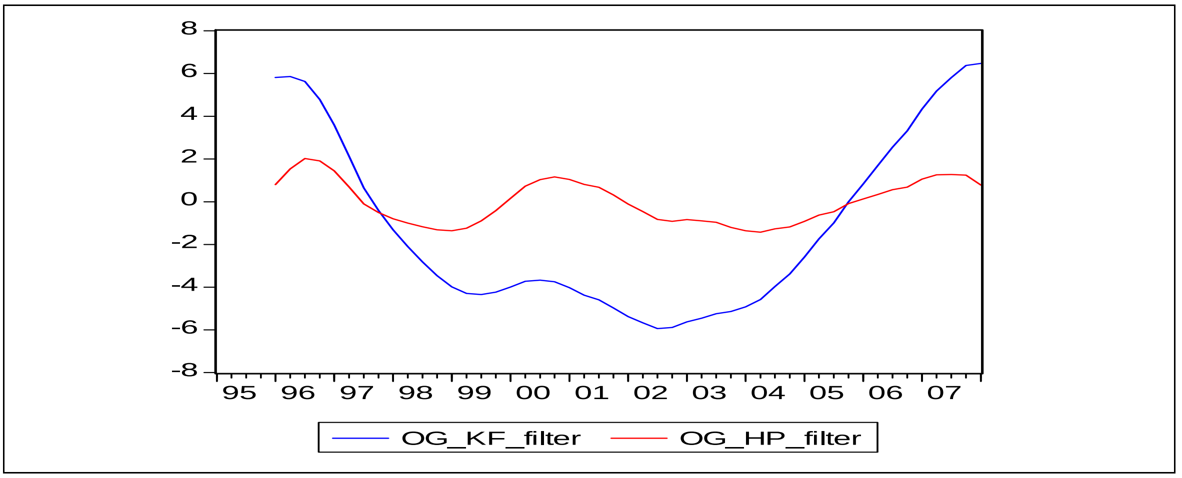
Eq 11 : Diagnostic summary report.

Estimation sample is 1995. 1 - 2008. 1. (T = 53, n = 51).

Summary statistics	lgdphu
DW	2.1493
Q(10, 6)	20.998
Rd^2	0.67176

Figure 9. Potential GDP and Output Gap (%) Estimated in the Case of Czech Republic by Using Kalman Filter and Hodrick-Prescott Filter





Component specification in Stamp 6.3: fixed level + fixed slope + irregular component +no seasonal component

Eq 35 : Estimated parameters of Cy3.

The cycle period is **53.502 (13.3755 'years').**

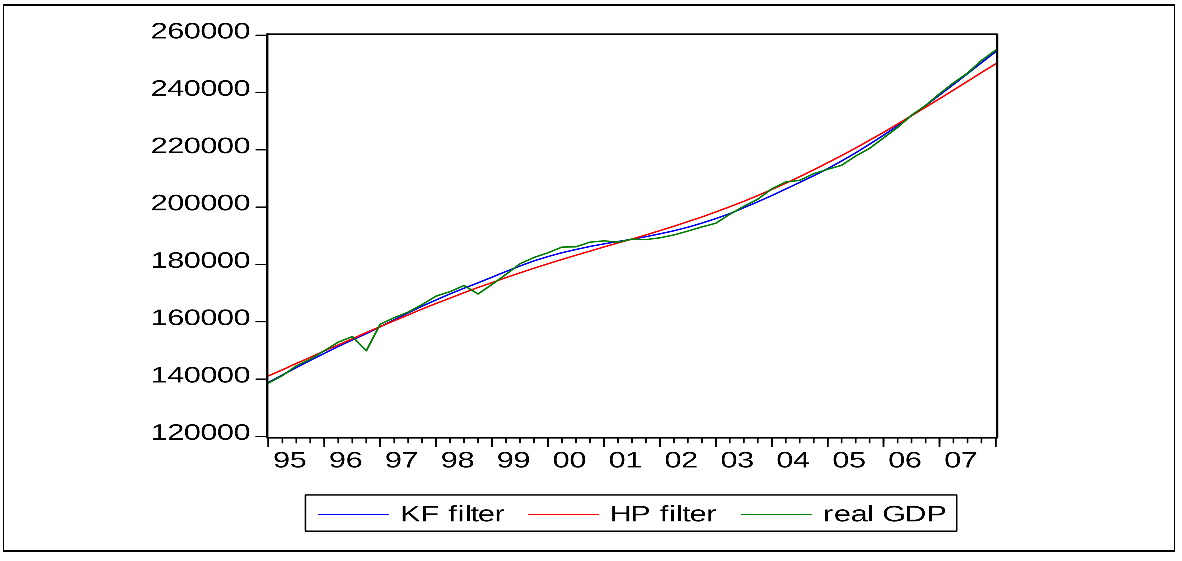
Eq 35 : Diagnostic summary report.

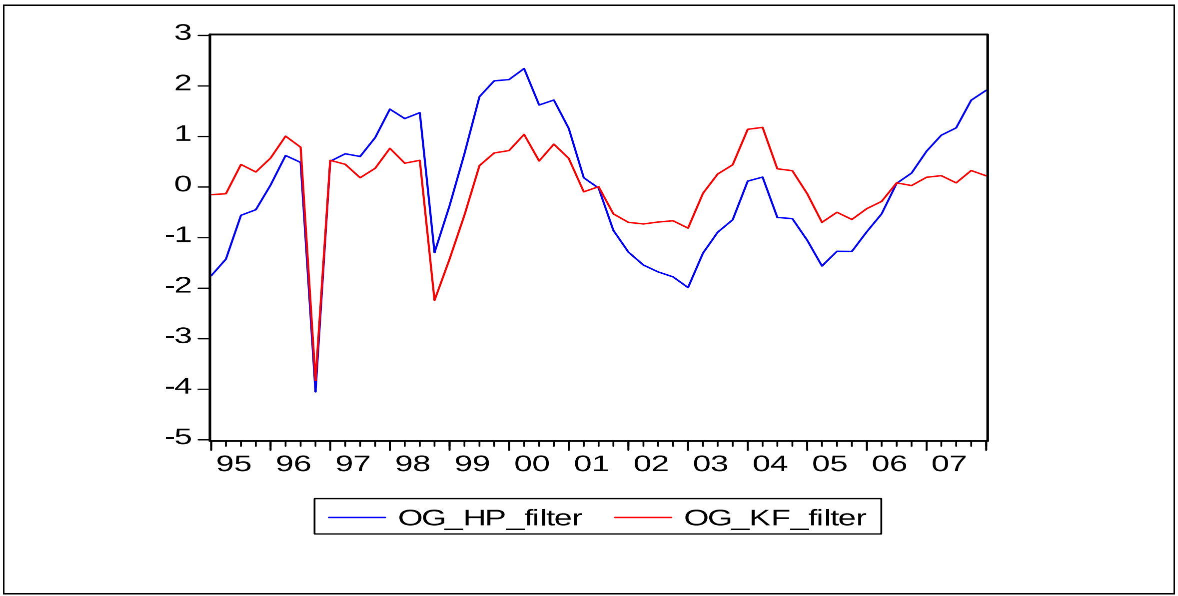
Estimation sample is 1996. 1 - 2008. 1. (T = 49, n = 47).

Summary statistics lgdpcz

DW	0.25559
Q(8, 6)	70.488
Rd^2	0.71139

Figure 10. Potential GDP and Output Gap (%) Estimated in the Case of Poland by Using Kalman Filter and Hodrick-Prescott Filter





Component specification in Stamp 6.3: fixed level + stochastic slope + no seasonal component

Eq 16 : Estimated parameters of Cy1.

The cycle period is **36.3788 (9.0947 'years').**

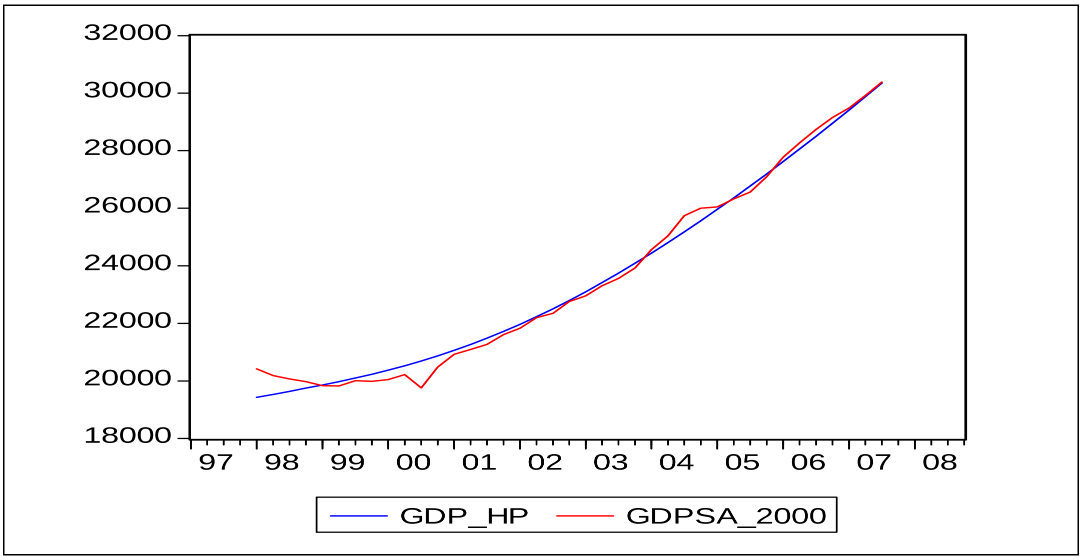
Eq 16 : Diagnostic summary report.

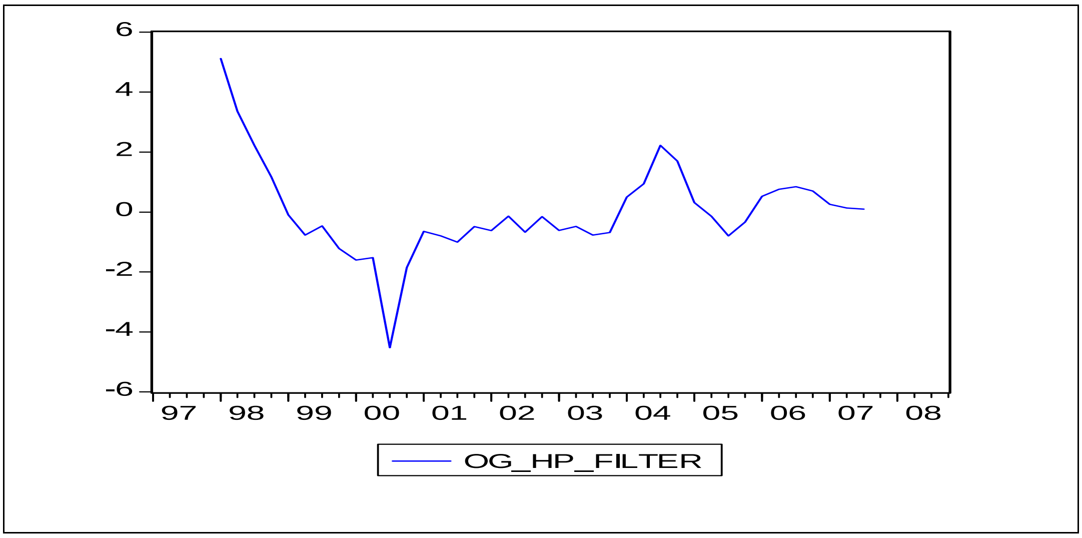
Estimation sample is 1995. 1 - 2008. 1. (T = 53, n = 52).

Summary statistics gdppl

DW	0.88547
Q(9, 6)	7.5687
R^2	0.79042

Figure 11. Potential GDP and Output Gap (%) Estimated in the Case of Romania by Hodrick-Prescott Filter.




6
4
2
0
-2
-4
-6
97 98 99 00 01 02 03 04 05 06 07 08
OG_HP_FILTER