"Estimating the Equilibrium Effective Exchange Rate for Potential EMU members"

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Abstract: In this study, we attempt to examine the possibility of emergence of significant fluctuations of the exchange rates in the future for the candidate EMU countries. In doing so, we estimate the equilibrium rate of the nominal effective exchange rate for Poland, Hungary, Slovak Republic and Malta through the BEER and PEER approaches. While the PEER-based estimation implies a large misalignment rate for the Hungarian forint, the BEER-based analysis shows that the present exchange rates of the countries considered do not deviate significantly from their equilibrium rates. As a consequence, based on BEER analysis, we do not expect large fluctuations in the effective exchange rates among the currencies considered. Hence, the relevant effective exchange rates are expected to be relatively stable. As a matter of fact, the entry of those countries into EMU is not expected to weaken the stability of Euro.

Key words: Exchange rate - cointegration - BEER - PEER
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1. Introduction

In May 2004, ten additional countries have joined the European Union. The new members are Cyprus, Malta, Czech Republic, Poland, Hungary, Slovenia, Slovakia, Latvia, Lithuania and Estonia. The second step of economic integration for these countries is the membership to EMU and the adoption of the single currency.[1] These developments have created a long debate about the way EU will be affected by this enlargement. Among others, the stability of the single European currency is an important policy question.

In this study, we attempt to examine the likelihood of emergence of significant exchange rate fluctuations in the future for the candidate EMU countries. In doing so, we estimate the equilibrium rate of the nominal effective exchange rate for Poland, Hungary, Slovakia and Malta. If significant misalignments persist, the behavior of nominal exchange rate is expected to be unstable in its attempt to find its equilibrium rate. If the actual rate is undervalued, the domestic economy is expected to face inflationary pressures. On the other hand, if the actual rate is overvalued, the domestic economy is expected to loose competitiveness. Each of the above scenarios will cause significant problems to the process of joining EMU. In contrast, an observed exchange rate close to its equilibrium implies that we do not expect large fluctuations in the future, excluding unanticipated shocks.

This paper's contribution to the EMU enlargement empirical literature is the way of examining exchange rate stability. In other words, our approach accepts the exchange rate convergence criterion as a necessary but not sufficient condition for successful entry into EMU.[2] The intuition is that if the exchange rate is currently stable but, significantly away from its equilibrium rate, the exchange rate is likely to be unstable in the future. Moreover, a high misalignment rate can cause macroeconomic instability as well, because the unstable exchange rate will affect negatively the macroeconomic indicators. Therefore, the stability of Euro will not be weakened if the examined exchange rates are not significantly misaligned. The estimation of the equilibrium effective exchange rate is undertaken by the Behavioral Equilibrium Exchange Rate (BEER) and the Permanent

[1] On January 1, 2007, Slovenia adopted the euro.

[2] In this study we examine nominal effective exchange rates. However, the Maastricht exchange rate criterion does not deal with effective exchange rates. A successful entry into EMU requires stability in the bilateral rate against euro. We argue that an unstable effective exchange rate may entail instability in bilateral exchange rates, such as this against euro.

Equilibrium Exchange Rate (PEER) approaches, presented by Clark & MacDonald (1998) and MacDonald (2000). The BEER approach involves the direct econometric analysis of the behavior of the exchange rate. It estimates exchange rate misalignments in accordance with the deviations of the actual exchange rate from the estimated value, derived from the relationship between the exchange rate and the macroeconomic fundamentals. The PEER approach is similar to the BEER one. The PEER differs from BEER in the way that the exchange rate is a function of variables, which have only persistent effect on it.

There is a plenty of empirical work in the literature regarding the estimation of equilibrium exchange rates. A starting point is convergence to Purchasing Power Parity in the long run as a baseline of equilibrium exchange rate. Recently, there is an increasing interest in PPP hypothesis for developing countries. Some studies apply univariate unit root tests on real exchange rates (i.e. Bahmani-Oskooee, 2000), while others apply more powerful panel unit root tests (for example Alba & Park, 2003). Some researchers apply univariate, multivariate and panel cointegration techniques on the relationship between nominal exchange rates and relative prices. Mahdavi & Zhou (1994) find evidence of weak-form PPP in 8 out of the 13 examined developing countries and state that stronger evidence exists in relatively high inflation countries. Others show that convergence to PPP equilibrium may be a non-linear instead of a linear mean reverting process (i.e. Sarno, 2000; Liew, 2003).

Besides to PPP equilibrium, numerous empirical studies estimate equilibrium exchange rates by employing alternative - to the traditional - approaches. Coudert & Couharde (2002) estimate the equilibrium of seven CEEC exchange rates. The applied methodology is the FEER[3] while the estimation is undertaken by the NIGEM macroeconometric model. They find, among others, that during 2000-2001 the effective exchange rates of the Hungarian forint, the Polish zloty and the Slovak crown or their bilateral rates against Euro do not deviate significantly from their equilibrium. Similarly, Egert (2002) combining the BEER and PEER approaches estimates the equilibrium exchange rate of five Central European Countries. The estimated period is from 1992 to

[3] The Fundamental Equilibrium Exchange Rate (FEER) was originally presented by Williamson (1985). This approach indicates that the exchange rate is at its equilibrium value when satisfies the condition of simultaneous internal and external balance. In other words, the Fundamental Equilibrium Exchange Rate is the equilibrium rate that would be consistent with ideal macroeconomic performance.

2001 for the cases of Hungary and Poland, while for Slovakia the estimated period begins from 1993. He finds that the Polish zloty and the Slovak crown were overvalued, but the Hungarian forint was undervalued before its convergence.

Egert & Lommatzsch (2003) find that the bilateral exchange rates of the Hungarian forint and the Polish zloty against Euro were overvalued in the fourth quarter of 2002 by 7%-12% and 12%-15%, respectively. Bulir & Smidkova (2005) examine the real effective exchange rates of the Polish zloty and the Hungarian forint, from 1995:q1 to 2003:q1, applying the NIGEM macroeconometric model. Their findings imply that the forint was close to equilibrium until 2000, but overvalued from 2001 and now. Similarly, the zloty was not away from its equilibrium rate before 2000. Thereafter, the zloty was overvalued and in 2003 the misalignment rate decreased to less than 20%.

Egert & Lahreche-Revil (2003) combined the FEER and BEER approaches estimate a VAR-based three equation cointegration system. The estimation sample is from 1992:q1 to 2001:q2 for Hungary and Poland, and from 1993:q1 to 2001:q2 for Slovakia. The under examination exchange rates are real effective exchange rates, computed as a weighted average of US dollar and Euro[4]. They find that the Hungarian forint was undervalued until 1998 and close to equilibrium thereafter. The polish zloty was overvalued during the estimated period while the highest deviation is observed after 1995. The Slovak crown was very close to equilibrium until 1997. From then, it is overvalued. The highest misalignment rate was about 10% and at the end of the estimated period was observed at 8%. Other relevant studies, which focus on developing as well as developed countries, are: MacDonald (2002); Fernandez et. al. (2001); Melecky & Komarek (2005) and Frait & Komarek (2001)[5].

This paper is organized as follows. The next section presents the model that is going to be estimated, while section 3 outlines the applied econometric methodology. Section 4 describes the data and section 5 provides the empirical findings. A concluding section summarizes and evaluates the derived output.

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[4] The Deutsche mark is used as a proxy of Euro until 1999.

[5] This study examines the Czech crown/Deutsche mark rate by the NATREX approach, presented by Stein (1994). This rate is consistent with simultaneous internal and external balance and equates the sustainable current account with saving and investment.

2. Theoretical Framework

The equilibrium exchange rate is estimated through the Behavioural Equilibrium Exchange Rate and the Permanent Equilibrium Exchange Rate approaches, presented by Clark & MacDonald (1998) and MacDonald (2000). The BEER approach involves the direct econometric analysis of the behavior of the exchange rate. It estimates exchange rate misalignments in accordance with the deviations of the actual exchange rate from the estimated value, derived from the relationship between the exchange rate and the macroeconomic fundamentals. The BEER is estimated when the actual values of the fundamentals are replaced by their sustainable (or smoothed) values.

The Permanent Equilibrium Exchange Rate (PEER) can be seen as a special approach of the BEER. According to BEER approach, the exchange rate is a function of transitory and permanent factors. The PEER approach differs in the way that the equilibrium exchange rate is a function of variables that have only persistent effect on it. So, we decompose the fundamentals into permanent and transitory components. These permanent series are allowed to determine the equilibrium exchange rate.

2.1. The Model

These approaches do not actually rely on any theoretical model and the equilibrium rate is designated by the long run behavior of the macroeconomic variables. It is based on the estimation of a reduced-form equation that explains the behavior of the effective exchange rate. However, this does not mean that any theoretical concept is not required. Following Clark & MacDonald (1998) and MacDonald (2000), the theoretical framework is based on the UIP condition[6]:

$$i = i^* + \Delta E[neer_{t+1}] \tag{1}$$

where i and i* are domestic and world nominal interest rates, respectively

neer is nominal effective exchange rate

E is conditional expectations

Solving for neer, equation (1) becomes:

$$neer_t = E_t[neer_{t+1}] - (i_t - i_t^*) \tag{2}$$

[6] Clark & MacDonald (1998) and MacDonald (2000) assume that in the UIP condition a risk premium is included. This has a time-varying component, which reflects the relative supply of domestic to foreign debt. Here, due to lack of data availability we assume that the risk premium is equal to zero.

Now, focusing on the forward-looking dynamics of the exchange rate we get:

$$neer_t = E_t[neer_{t+1}] + E_t E_{t+1}[neer_{t+2}] - (i_t - i_t*) \quad (3)$$

Using the Law of Iterated Expectations ($E_t[.] = E_t E_{t+1}[.]$), we have:

$$neer_t = E_t[neer_{t+1}] + E_t[neer_{t+2}] - (i_t - i_t*) \quad (4)$$

$$neer_t = E_t[neer_{t+1}] + E_t[neer_{t+2}] + ... + E_t[neer_{t+n}] - (i_t - i_t*) \quad (5)$$

$$neer_t = \sum_{i=0}^{\infty} E_t[neer_{t+i}] - (i_t - i_t^*) \quad (6)$$

Equation (6) shows that the current value of the nominal effective exchange rate depends on the nominal interest rate differential plus the expectations on future values of the exchange rate. The expected exchange rate, which can be shown as the long run component of the nominal exchange rate, depends on the expected values of the macroeconomic fundamentals. Thus, besides to the interest rate differential, the long run effective exchange rate depends on the macroeconomic fundamentals. The vector of the macroeconomic fundamentals includes the domestic terms of trade, the domestic foreign asset holding, and the world oil price. So, the vector is of the form: {tot, fa, op). Hence, Long run Effective Exchange Rate is given by the following expression:

$$LEER = f(i - i*, tot, fa, op) \quad (7)$$

2.2. Expected Signs of the Variables

Interest Rate Differential: Based on the Monetary model of exchange rate determination a positive interest rate differential is going to depreciate the domestic currency (i.e. the effective exchange rate decreases). This can be seen by the UIP condition (equation 1) and the nominal effective exchange rate equation (6). On the other hand, accepting the Portfolio Balance model of exchange rate determination, (Branson, 1977), a higher domestic interest rate relative to the world level is going to appreciate the effective exchange rate. This is because the increased interest rate will cause capital inflows and the capital account will be improved. Therefore, the expected sign of the interest rate differential is ambiguous.

Terms of Trade: A higher increase in the value of exports relative to the value of imports (i.e. an increase in the terms of trade) is expected to affect the effective exchange rate in two different ways. The first effect, called as substitution effect, improves the current account and as a consequence the exchange rate appreciates. On the other hand, the income effect means that the improved current account will increase domestic income. So, domestic consumption of imported goods increases and as a result the domestic currency has to depreciate to restore equilibrium. The final effect depends on the relative price elasticity of demand for imports and exports. However the first effect comes before the latter. Therefore, we expect that the direct effect of a positive terms of trade shock on the exchange rate is the appreciation of the effective exchange rate.

Domestic Holding of Foreign Assets: This variable reflects the external position of the domestic country. It is actually the amount of assets that domestic agents hold abroad and affects the domestic monetary base. Following the portfolio balance model of exchange rate determination (Branson, 1977), an increase in foreign assets can decrease the effective exchange rate. In other words, if domestic agents prefer foreign than domestic assets, there is a capital outflow responsible for the capital account deficit. This is going to depreciate the domestic currency. Therefore, the expected sign of foreign asset holding is negative.

Oil Price: This variable is included to the model to capture a kind of external shock. Usually an increasing trend in the world level of oil price produces negative consequences in any economy. However, the magnitude of the effect depends on the type of the economy. More oil dependent economies face serious problems and the terms of trade deteriorate. As a result, the exchange rate depreciates. On the other hand, less oil dependent economies are able to handle this shock and to avoid the depreciation trend. For example, an increase in oil price will affect less the US. In contrast, this shock will affect heavily developing countries. To sum up, the sign of this variable for the domestic country is expected negative (i.e. effective exchange rate depreciation).

2.3. Equilibrium Exchange Rates

The Behavioural Equilibrium Exchange Rate is estimated by getting the smoothed values of the fundamentals. If the long run exchange rate is estimated by the following reduced form equation:

$$LEER = a_1(i - i^*) + a_2 tot + a_3 fa + a_4 op \qquad (8)$$

Then, the BEER estimate is shown below (a hat denotes a smoothed series):

$$BEER = a_1(\hat{i} - \hat{i}^*) + a_2 \hat{tot} + a_3 \hat{fa} + a_4 \hat{op} \quad (9)$$

The Permanent Equilibrium Exchange Rate is estimated by using in the regression equation only the permanent series of the fundamentals. This is shown below (p denotes to a permanent series):

$$PEER = a_1(i - i^*)^p + a_2 tot^p + a_3 fa^p + a_4 op^p \quad (10)$$

Comparing these rates with the actual exchange rate we find how the latter deviates from the former. In other words, this yields to the total misalignment rate, which shows whether the exchange rate is overvalued or undervalued. If s > beer or peer, the domestic currency is said to be overvalued and if s < beer or peer, the domestic currency is undervalued.

3. Econometric Methodology

Estimation is undertaken by the well-known Johansen's (1988, 1991) cointegration technique. Under this framework, the acceptance of at least one cointegrating vector means that the effective exchange rate and the vector of fundamentals form a valid long run relationship. If this is the case, the fundamentals can explain the exchange rate fluctuation. Then, by normalising the cointegrating vector, we can derive the reduced form equation which explains the relationship between the exchange rate and the fundamentals. This equation will be valid if the weak exogeneity assumption is accepted. This means that all the variables included in the exchange rate equation are weakly exogenous to the exchange rate. In other words, any misalignment from the equilibrium rate must be absorbed only by exchange rate movements. The derived reduced-form equation computes the Long run Effective Exchange Rate. This rate is the anchor for estimating the Behavioural Equilibrium Exchange Rate (BEER) and the Permanent Equilibrium Exchange Rate (PEER).

According to the BEER methodology, the reduced-form equation, implied by the cointegrating vector, is called as current equilibrium exchange rate. The total equilibrium is derived by estimating the long run (sustainable) values of the fundamentals. These values are estimated by the Hodrick-Prescott (1997) filter.[7] This is a univariate smoothing method, which estimates the long run components of the variables.

The alternative methodology (PEER) implies that the equilibrium exchange rate is a function of only permanent elements of the fundamentals. The decomposition into permanent and transitory elements is undertaken by Gonzalo-Granger (1995) methodology[8], which based on information derived form the multivariate cointegration analysis, decomposes the vector of fundamentals into permanent and transitory components. The smoothed values of the fundamentals (derived from H-P filtering) as well as the permanent series (derived from Gonzalo-Granger decomposition) substitute their actual values, in the reduced from equation, to derive the Behavioural Equilibrium Exchange Rate (BEER) and the Permanent Equilibrium Exchange Rate (PEER), respectively.

Finally, we check robustness of our estimation through testing for structural breaks, at an unknown date, in the estimated equilibrium exchange rates. In line with our estimation procedure, in which only permanent (low-frequency) series are allowed to determine the equilibrium rate, we should expect that no significant structural breaks are included in the equilibrium rates. Nonetheless, even if a significant break is reported, we examine whether the corresponding actual exchange rate contains a structural break as well. Here, we apply Perron's (1997) test to detect for a single structural break in both the intercept and the slope at an unknown date. This test is performed by the Colletaz & Serranito (1998) procedure for RATS.

[7] A lot of criticism has been applied to the statistical properties of the H-P filter. One of the discussed issues is its poor performance near the end of the sample. Mise et. al. (2005), Kaiser & Maravall (1999) and Baxter and King (1999) provide evidence of suboptimal H-P filtering at the endpoints. To avoid this inconsistency, following Kaiser and Maravall (1999), we estimate optimal ARIMA forecasts and we apply the H-P filter to the extended series.[7] As noted by Mise et. al. (2005), this approach minimizes revision standard deviation.

[8] Other studies use the Univariate and Multivariate Beveridge-Nelson (1995) Decomposition. This methodology entails the direct decomposition of the exchange rate into permanent and transitory components. Some of these studies are Huizinga (1987) and Cumby & Huizinga (1990). A different way of measuring PEERs is that proposed by Clarida & Gali (1994). They decompose the real exchange rate into supply, demand and nominal components and test the importance of these variables to the exchange rate. In other words, they create three shocks (supply, demand and nominal) and examine the effects of each shock to the variability of the exchange rate. Moreover, two of the studies, which applied the Gonlzalo-Granger approach to estimate PEERs are Clark & MacDonald (2000) and Hoffmann & MacDonald (2000).

4. Data

The data set includes quarterly observations for four new EU-members. These countries are Poland (1993:1-2004:1), Hungary (1990:1-2004:1), Slovak Republic (1993:1-2003:4) and Malta (1990:1-2003:3), which stand for the domestic country. All variables, including the nominal effective exchange rate of the domestic country, the world and the domestic nominal interest rates, the domestic terms of trade, the domestic holding of foreign assets and the world price level of petroleum (hereafter called oil price), are taken from IFS CD-ROM statistical database. The nominal effective exchange rate ***(neer)*** is an indicator of the domestic economy's international competitiveness in terms of its foreign exchange rate. It is a measure of the value of the domestic currency against a basket of other currencies. It is calculated as a weighted average of exchange rates and it is expressed as an index (base year 2000 = 100). An increase in this index is equivalent to the appreciation of the domestic currency. Obviously, a reduction corresponds to the depreciation of the nominal effective exchange rate.

The nominal interest rates correspond to lending rates. For the world interest rate the US prime loan rate is applied, while for the rest of the panel standard lending rates are applied. Subtracting the US lending rate from the domestic one we get the nominal interest rate differential ***(i-i*)***. An increase in this variable implies a relatively higher increase in the domestic interest rate. Next, domestic holding of foreign assets ***(fa)*** shows all foreign assets held by domestic agents abroad, expressed in millions (domestic currency). The terms of trade ***(tot)*** variable is calculated as a ratio of the value of exports to the value of imports, both expressed in millions (domestic currency). A higher increase in the price of exports relative to the price of imports is linked to the rise of the terms of trade. This means that the terms of trade are improved and the trade position of the domestic economy is enforced. Finally, oil price ***(op)*** is the world price level of petroleum per barrel, expressed in US dollars. All variables, except interest rates, are expressed in natural logarithms.

5. Estimation

5.1. Preliminary Analysis

The estimation procedure starts with estimating appropriate VAR models.[9] Next, we move on to the cointegration analysis by selecting the appropriate sub-model. In doing so, we follow Koukouritakis & Michelis (2005) who select their model through a test proposed by Johansen (1995, chapter 11, Corollary 11.2 & Theorem 11.3, p. 161-162).[10] Cointegration test is applied when no constant and trend are included either to data or to the model for Poland; Hungary and Slovak Republic, while for Malta a constant term is included in the model.

At first glance, in all models the fundamentals and the effective exchange rate are cointegrated. However, only in Poland and Malta models weak exogeneity is not rejected.[11] This means that, in the other two models, some of the fundamentals may be endogenous to the exchange rate. By excluding the foreign asset variable and the terms of trade variable from the Hungary and Slovak Republic models, respectively, we re-estimate those models applying again cointegration and weak exogeneity tests. Table 1 shows that the revised estimation satisfies both cointegration and weak exogeneity hypotheses.

Table 1: Cointegration – Weak Exogeneity Test

Model	Cointegrating Vectors	Cointegration Sub-model	LR Statistic	Probability
Poland	1	1st	6.40	0.17
Hungary	2	1st	5.006	0.28
Slovak Republic	1	1st	8.94	0.03
Malta	1	2nd	8.46	0.075

MacKinnon-Haug-Michelis (1999) p-values

Having established the validity of the implied long run relationships, we estimate the non-restricted component of the alpha matrix, known as adjustment coefficient. The adjustment coefficient is statistically significant in all models. This value denotes the

[9] Since a VAR model is valid only when stationary variables are included, we regress VAR models in an error correction form by using the first differences of the variables. Robustness of the corresponding VEC models is confirmed since the residuals are non-autocorrelated, homoskedastic and normally distributed in each of the estimated models. Diagnostics' tests are available on request.

[10] We test the restricted against the less restricted model using their computed trace statistics. These tests follow the X^2 distribution and the degrees of freedom are as shown below:

1~2 (**r** d.f.), 2~3 (**p-r** d.f.), 3~4 (**r** d.f.) , 4~5 (**p-r** d.f.)

where r is the number of cointegrated vectors and p is the number of parameters.

[11] This test's output is available on request.

speed of adjustment of the exchange rate toward to equilibrium. Specifically, it is estimated that deviations are expected to decrease in a quarter (3-months) by about 30%, 43% and 4% for the Poland, Malta and Hungary models, respectively. The positive value of the adjustment coefficient in the Slovak Republic model implies that the actual exchange rate is expected to move away from its long run rate, in a quarter, by about 3%.

All estimated coefficients are statistically significant apart from the interest rate differential in the Slovak Republic model and the Malta's terms of trade. When it comes to the sign of the estimated coefficients, the interest rate differential and the terms of trade are positively signed, as expected, in each estimated model. Based on the Portfolio Balance model (Branson 1977), a higher domestic interest rate is going to appreciate the nominal effective exchange rate because of the increased capital inflows. The terms of trade sign shows that the substitution effect will overshoot the income effect. In other words, the improvement in the current account will be higher than the increase in domestic income. Thus, the nominal effective exchange rate rises.

The domestic holding of foreign assets sign is as expected only in the Malta's model. For the rest it is estimated that an increase in the domestic holding of foreign assets is going to appreciate the exchange rate, which is not consistent with our theoretical model. A possible explanation can be given by examining the monetary base of domestic country. As the foreign asset position of the domestic country affects its monetary base, a rise in foreign bonds decreases the monetary base. Then, domestic money supply decreases.[12] Now, following the monetary model of exchange rate determination we can easily explain the appreciation of the effective exchange rate. We just need to assume that this action decreases domestic money supply, which in turn appreciates the domestic currency. An alternative explanation states that the increased foreign asset holding creates positive expectations of high capital inflow in the future. This is due to the expected capital gains caused by this investment.

Finally, the effect of the oil price shock is surprisingly unusual for all cases except this of Slovak Republic. The estimated coefficients imply that an increase in the world

[12] Based on the money multiplier theory, the amount of money (coins & notes) held by domestic residents, decreases. Since the monetary base (H) is equal to the sum of bank reserves (R) plus coins & notes held by domestic residents (P) [H = R+P], monetary base declines. Thus, domestic money supply declines as well because money supply is equal to monetary base multiplied by the money multiplier. However, this holds only if the purchase of foreign bonds is financed by coins and notes. In case of an exchange between domestic and foreign bonds, monetary base remains unaffected.

price level of oil is going to appreciate the nominal effective exchange rates of Poland, Hungary and Malta. This movement may be sensible for less oil dependent countries. This interesting finding is an inspiration for further research. However, a possible reason for this is that while the nominal effective exchange rate is a weighted average of a basket of currencies, these countries may have been relatively less affected from oil shock.

5.2. Equilibrium Exchange Rates

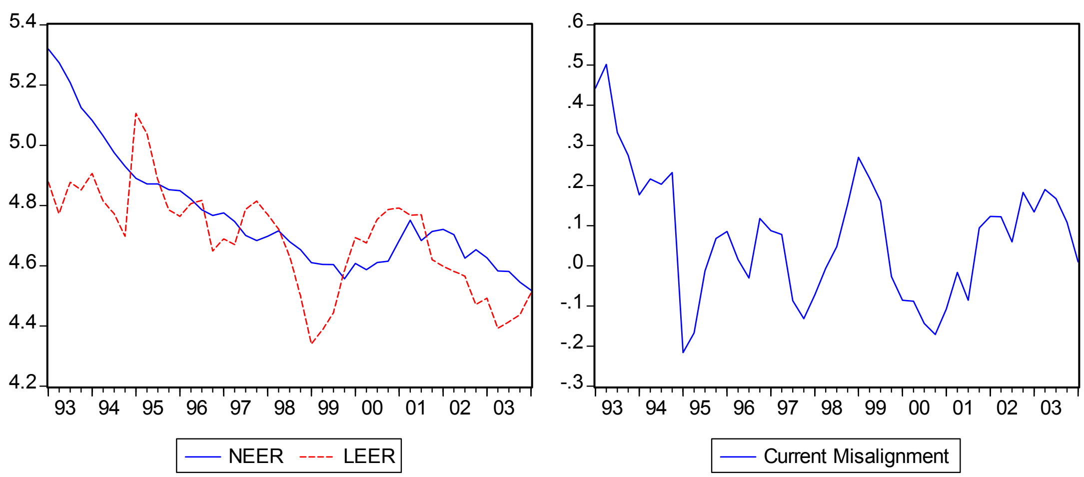
5.2.1 Polish zloty

Having tested the significance of the estimated coefficients, we can now derive the Long run Effective Exchange Rate (LEER) for the Polish zloty, implied by the estimated cointegrating vector. This is estimated from equation (1).

$$leer_t = \underset{(0.002)}{0.05} \cdot (i - i^*)_t + \underset{(0.17)}{0.3} \cdot tot_t + \underset{(0.02)}{0.27} \cdot fa_t + \underset{(0.08)}{0.35} \cdot op_t \qquad (1)$$

Below, this rate is plotted against the observed Nominal Effective Exchange Rate (NEER), while the right hand-side of the graph illustrates the current misalignment.

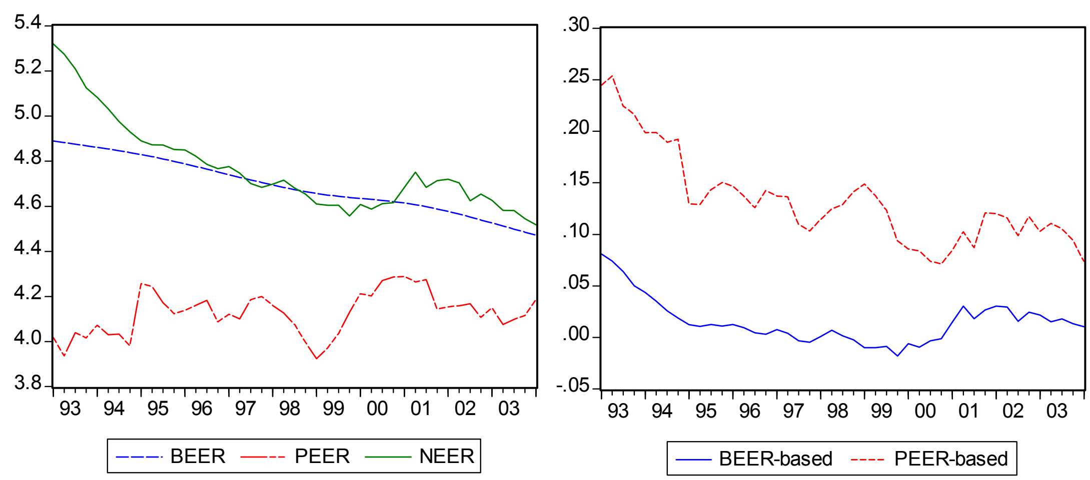
Figure 1: Long Run Effective Exchange Rate; Current Misalignment



Positive values indicate that the observed effective exchange rate is above the estimated (i.e. overvalued) and negative values show that the observed exchange rate is undervalued. This graph implies that there are both overvaluation and undervaluation periods, with the former to be a more usual case. However, this that actually matters is total misalignment, which is the deviation of the actual effective exchange rate from the BEER and PEER estimates. So, we evaluate the long run values of the fundamentals, by the Hodrick-Prescott (H-P) filter (λ=1600), which replace their actual series in the estimated exchange rate equation (1).

Gonzalo-Granger decomposition implies that about the 60% of the interest rate differential is permanent and the 88.6% of the oil price movements have a permanent effect. Moreover, about the 97% of the terms of trade and the domestic holding of foreign assets is permanent.[13]. By multiplying the permanent rates with the actual series of the fundamentals we get their permanent components. Both Equilibrium Exchange Rates are plotted against the actual exchange rate in the following figure:

Figure 2: BEER; PEER; Total Misalignment



It is obvious that the actual effective exchange rate was mainly overvalued. The BEER line implies that the long run values of the macroeconomic fundamentals indicate a lower effective exchange rate than the observed. A single undervaluation period is from 1998 to 2001. Comparing this graph with the current misalignment figure (1), we can see that there is a significant difference between current and total misalignments. This is due to the inclusion of the filtered values of the fundamentals in the BEER estimation. From 2002, the actual nominal effective zloty declines following the BEER's trend. This is an indicator of a movement approaching the equilibrium rate.

It is clear-cut that the PEER implies a lower effective exchange rate. Moreover, the difference between thee BEER and the PEER estimates is obvious. Although, both rates show that the Polish Zloty was mainly overvalued, the PEER shows that the overvaluation rate is much higher. Recall that the BEER estimate allows for a single undervaluation period, which does not hold in the PEER implication. This is clearly

[13] The robustness of this decomposition is confirmed because the summation of the permanent and the transitory components yields to unity. The estimation procedure is not presented here to save space. However, the analytical decomposition is available on request.

shown in the misalignment’s figure. Taking as ground that both rates provide evidence of an overvalued Polish zloty, we now analyze the difference in the magnitude of misalignments. The BEER estimate is very close to the actual effective exchange rate, implying highest overvaluation at a rate of 8%, while on average the exchange rate deviates by 2%. In contrast, the PEER estimate deviates significantly from the actual exchange rate. The corresponding misalignment rate is about 25%, while on average deviates by 13%. These high rates are observed at the beginning of the estimated period. It is worth notable that both misalignment rates follow a downward path, implying that the actual exchange rate moves towards to equilibrium. In the first quarter of 2004, the BEER-based misalignment rate was 1%, while the PEER-based deviation has declined to 7%. The divergence between the BEER and the PEER implies that the BEER estimate incorporates some transitory elements. Finally, testing for structural breaks we found no significant break in either BEER or PEER. In contrast, a significant structural change is observed in the actual effective exchange rate (1998:Q1). This implies that the observed break is not consistent with the macroeconomic developments in the domestic country. The actual effective exchange rate may contains a break because of the applied exchange rate policy by the Polish monetary authorities.

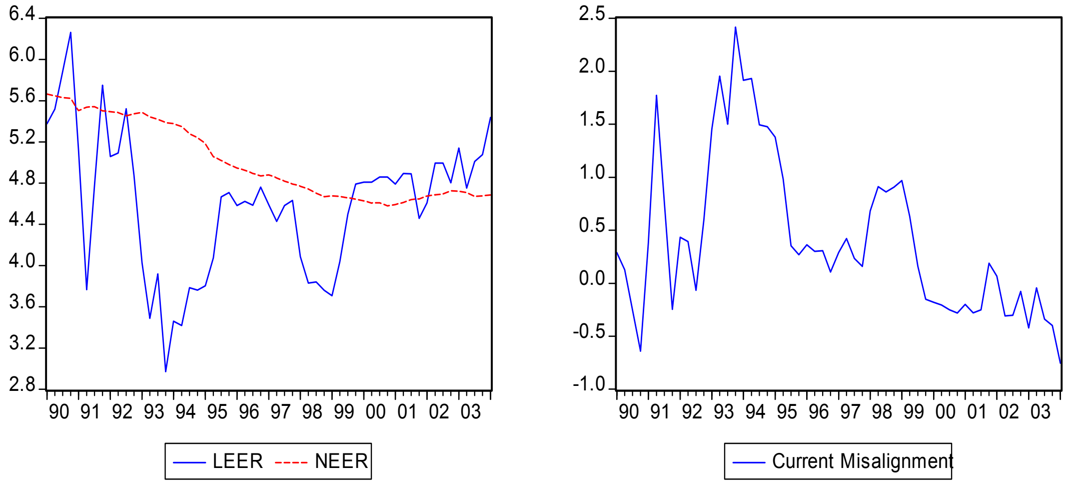
5.2.2 Hungarian forint

The long run effective exchange rate for the Hungarian forint (LEER) is estimated by equation (2):

$$leer_t = \underset{(0.01)}{0.024} \cdot (i - i^*)_t + \underset{(1.13)}{3.99} \cdot tot_t + \underset{(0.06)}{1.58} \cdot op_t \qquad (2)$$

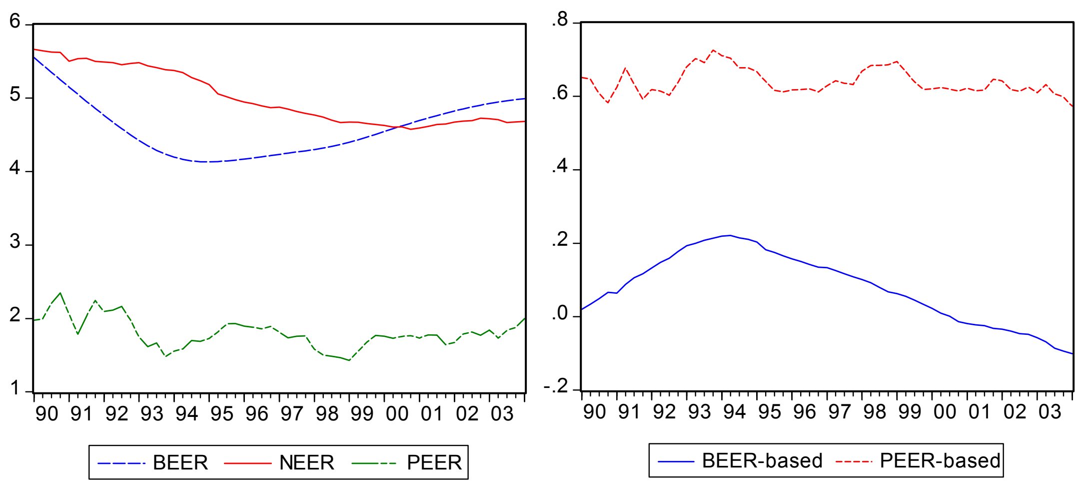
This rate is plotted against the actual effective exchange rate, while the second part of the following figure shows the deviation of the former from the latter. The figure shows that the Hungarian Forint is mainly overvalued, while there are two undervaluation periods. This is clearly shown in the second part of the following figure.

Figure 3: Long Run Effective Exchange Rate; Current Misalignment



The Behavioural Equilibrium Exchange Rate is estimated by the sustainable values of the fundamentals, while the alternative methodology implies that the rate of permanent elements is high for the interest rate differential but, most of the fluctuation of the terms of trade and the oil price variables are transitory. About the 84% of the interest rate differential movements are permanent, while only the 21% and 34% of the terms of trade and the oil price fluctuation, respectively, are permanent.[14]

Figure 4: BEER; PEER; Total Misalignment



In this case the two alternative procedures provide considerably different equilibrium exchange rates. The BEER-based approach shows that the actual forint does not deviate

[14] See footnote 11.

significantly from its equilibrium rate. The highest overvaluation rate is about 20%, while on average the Hungarian forint deviates by 10%. The interesting point here is that from 1994 the BEER follows an upward path, implying that the domestic currency should appreciate. In contrast, the actual exchange rate continues the depreciation until 2001. Hereafter the actual exchange rate is very close to its equilibrium rate. At the end of the estimated period, the Hungarian forint is overvalued by less than 10%.

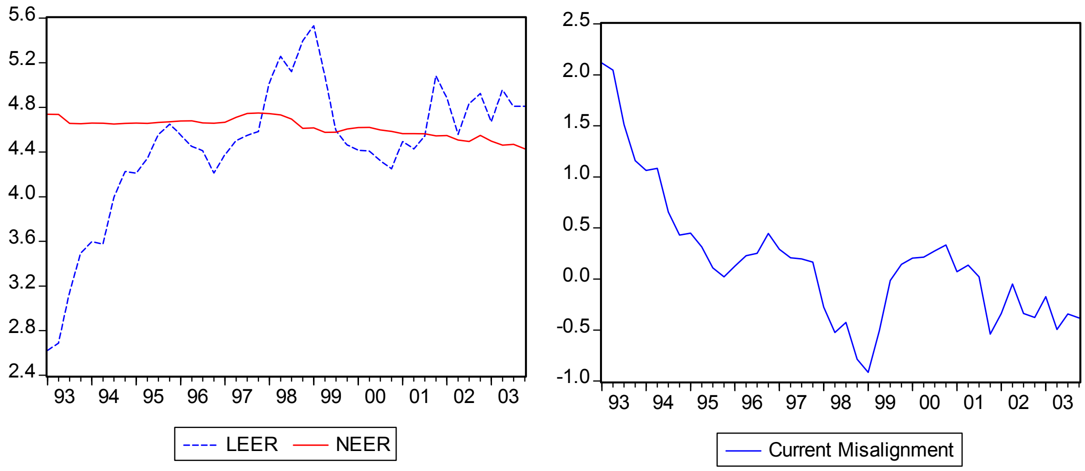
The PEER estimate is clearly lower than the actual exchange rate and the estimated BEER. This seems sensible since a significant percentage of the terms of trade and the oil price variables can be characterised as transitory. As a consequence, the deviation of the PEER from the BEER is due to the transitory components of the BEER estimate. This deviation becomes more impressive if we calculate the misalignment rates and compare the BEER-based misalignment with the PEER one. The BEER-based misalignment rate does not exceed the 30%. In contrast, the PEER-based misalignment rate shows that the overvaluation rate is high and sustainable. On average, the Hungarian forint is undervalued by about 60%. Finally, a structural break occurs in both the BEER and PEER. Moreover, a break is found in the actual effective exchange rate. But, the break dates do not coincide. A change in BEER series is observed at the end of 2001, while the corresponding break for the PEER is found during the second quarter of 1992. The actual exchange rate includes a break in 1999:Q2.

5.2.3. Slovak crown

The analysis is analogous to the other two models' estimation. The long run effective exchange rate is given by equation (3).

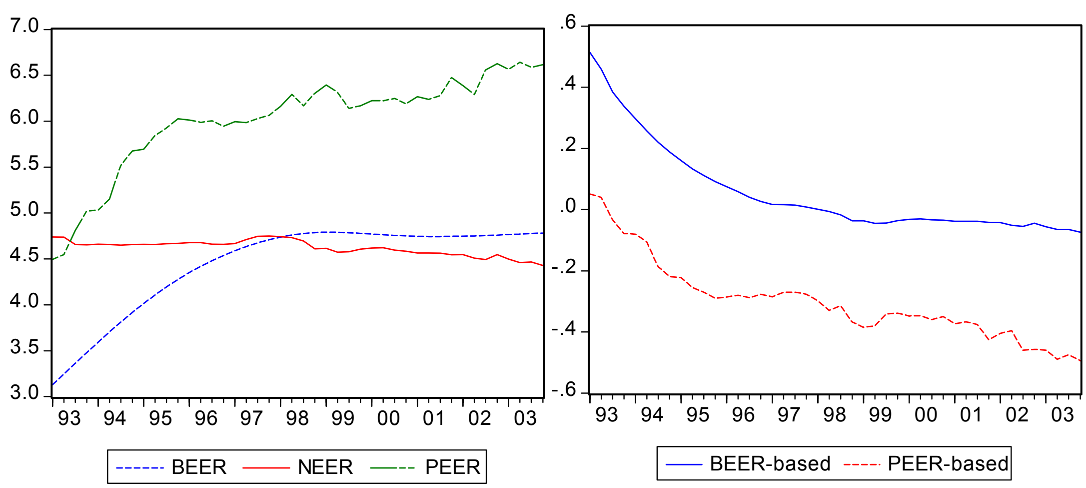
$$leer_t = \underset{(0.21)}{0.8} \cdot fa_t - \underset{(0.77)}{1.63} \cdot op_t \qquad (3)$$

Figure 5: Long Run Effective Exchange Rate; Current Misalignment



The exchange rate was initially overvalued and at the end of the estimated period was undervalued but, relatively close to its long run value. As in the previous models, this rate cannot be considered as the equilibrium exchange rate and the above misalignment rate stands for the current misalignment rate. The BEER and PEER[15] estimates as well as the implied misalignment rates are shown below:

Figure 6: BEER; NEER; Total Misalignment



The BEER estimate follows the same path as the long run effective exchange rate does. The difference is that the former is smoother than the latter. So, the Slovak Crown was initially overvalued but, during the estimated period became undervalued. The

[15] About the 78% of the foreign asset movements are permanent and only the 26% of the oil price fluctuation is permanent. To find more, see footnote 11.

overvaluation rate has a decreasing trend. While the actual effective exchange rate (NEER) is stable the BEER implies an appreciation trend. This contradiction is under consideration. Is the stability of the exchange rate natural or a consequence of a specific exchange rate policy?[16] In the beginning of the estimated period the exchange rate was overvalued by about 50%. In the first quarter of 1998 the BEER becomes equal to the actual rate. Thereafter, the BEER implies a stable exchange rate, while the actual exchange rate follows a slightly depreciation path. Instead of the former overvaluation period, these movements show that the exchange rate is undervalued. However, this deviation is not a significant one. During 2003 the Slovak Crown was undervalued by about 5%, while at the end of the estimated period the misalignment rate was 7%. The declining trend of the actual exchange rate may be due to the effects of the former stabilisation exchange rate policy. The exchange rate can meet its equilibrium rate when these effects are totally absorbed.

The PEER estimate implies that the value of the Slovak currency should be higher than its observed value and the BEER estimate. As a matter of fact, the Slovak Crown is undervalued during all the estimated period. While the BEER decomposes the estimated period into overvaluation and undervaluation periods, the PEER estimate shows that the exchange rate is clearly undervalued. An implicit difference in the misalignment rates is that according to the BEER-based estimation, the exchange rate was initially overvalued and at the end of the estimated period was very close to equilibrium. On the contrary, according to the PEER-based estimation, the exchange rate was initially very close to equilibrium and during the time becomes more and more undervalued.

In overall, the BEER seems to be more close to the actual exchange rate. Although, the BEER-based misalignment was about 50%, this rate has been reduced to 7% at the end of the estimated period. The PEER-based misalignment rate shows that the exchange rate moves away from its equilibrium. While the misalignment rate was only 5% at the beginning of the estimated period, this rate has been jumped to 50% at the end of this period. On average the Slovak crown deviates by 10% according to the BEER analysis and by 30% based on PEER analysis. Finally, a structural break is found only in BEER

[16] National Bank of Slovakia was fixing exchange rates of selected currencies during the period 1993-1998. Slovak crown was pegged on a basket of two currencies (60% of Deutsche mark and 40% of US dollar), and it was allowed to fluctuate by no more than 7%. Since October 1998, Slovak crown is freely determined in the foreign exchange market.

(2002:Q1) and the actual effective exchange rate (1996:12), while there is no evidence of a significant break in the PEER series.

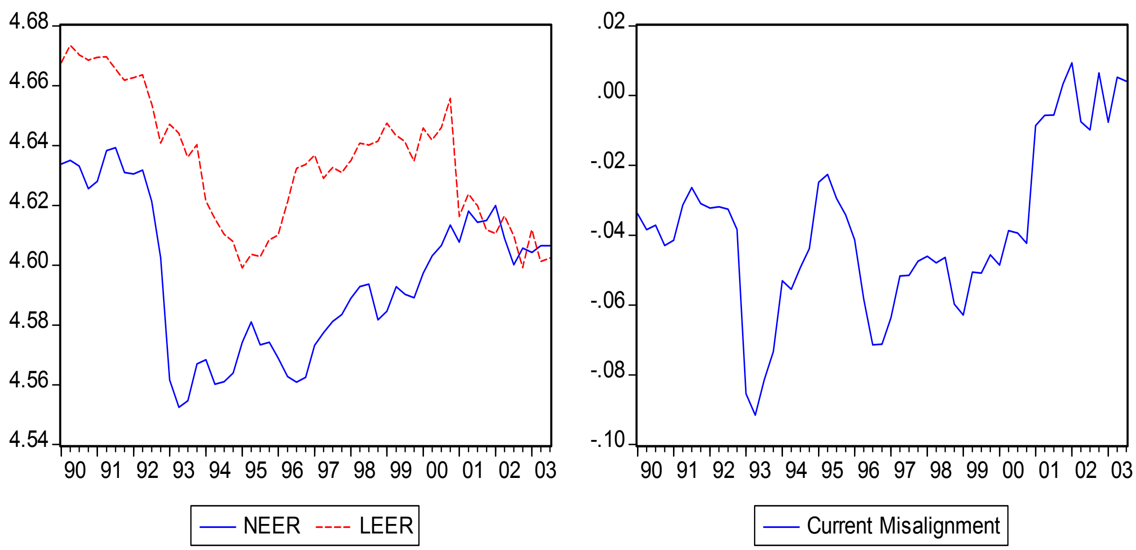
5.2.4. <u>Maltese pound</u>

Given that the corresponding cointegration model implies the inclusion of a constant term in the model, the Long run Effective Exchange Rate is estimated by:

$$leer_t = \underset{(0.13)}{5.24} + \underset{(0.001)}{0.008} \cdot (i - i^*)_t - \underset{(0.017)}{0.117} \cdot fa_t + \underset{(0.01)}{0.03} \cdot op_t \qquad (4)$$

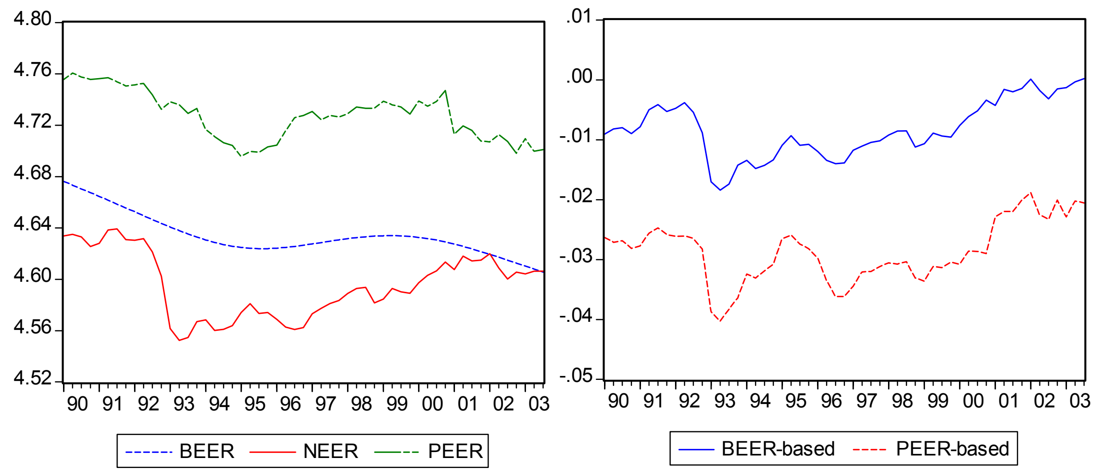
This estimate is presented in the following graph against the actual exchange rate, while the second part of the figure presents the current misalignment rate. Once again the estimated period is divided in two sub-periods. The first period is from 1990 to 2001, in which the estimated rate is stably above the actual exchange rate. From 2001 a new period arises, in which the estimated long run exchange rate is very close, and in some cases equal, to the actual rate. At the end of the estimated period the misalignment rate lies around zero.

<u>Figure 7: Long run Effective Exchange Rate; Current Misalignment</u>



Although the BEER (shown in figure 8) is higher than the actual exchange rate, the degree of misalignment is not too high. The highest rate of misalignment is observed in the second quarter of 1993 (1.8%), while the average misalignment rate is less than 1%. More satisfactory is the evidence at the end of the estimated period. The actual exchange rate deviates from the BEER by 0.01%. This implies that the Malta pound completely meets its equilibrium rate.

Figure 8: BEER; PEER; Total Misalignment



On the other hand, the PEER implies a higher undervaluation rate. The PEER-based misalignment rate implies that during the estimated period the pound was undervalued, an implication which coincides with the BEER analysis. What is different is that the exchange rate never meets its equilibrium rate. It is always away from the PEER estimate. However, the magnitude of the misalignment is low. The highest undervaluation rate does not exceed the 4%, the lowest deviation is about 2%, while on average the Maltese pound deviates by less than 3%.

All of these enforce us to believe that the actual exchange rate does not deviate significantly form its equilibrium rate. In accordance, BEER and PEER estimates seem quite similar. This implies that the BEER estimate entails only a small percentage of transitory components.[17] However, while a structural change is found in both the constant and the trend of the BEER (1999:Q4), the PEER series involves a change only in the trend (1995:Q4). On the contrary, the actual effective exchange rate incorporates a structural change only in the intercept term (1992:Q3).

6. Concluding Remarks

As we have already mentioned, the motivation of the present study was to examine the likelihood of emergence of significant exchange rate fluctuations in the future for the

[17] About the 89% of the interest rate differential, the 81% of the foreign asset holding and the 99% of the oil price movements are permanent. To find more, see footnote 11.

candidate EMU countries. In doing so, we estimated the equilibrium rate of the nominal effective exchange rates for selected EMU potential members: 3 Central Eastern European Countries (Poland, Hungary, Slovak Republic) and Malta. If significant misalignments persist, the behavior of nominal exchange rate is expected to be unstable in its attempt to find its equilibrium rate. In contrast, an observed exchange rate close to its equilibrium implies that we do not expect large fluctuations in the future, excluding unanticipated shocks. Thus, the foregoing participation into EMU does not lead Euro, regarding its stability, to any hazardous pathway.

In general, the PEER estimates imply a higher misalignment rate than the BEER estimates do.[18] The Polish zloty was very close to equilibrium at the end of the estimated period. Following BEER, it has been overvalued by less than 1% and by 7% according to PEER. The Hungarian forint was slightly overvalued (less than 10%) at the end of the estimated period, based on BEER estimation. In contrast, the PEER estimation shows that the overvaluation rate was high and sustainable. Similarly, the Slovak crown was both overvalued and undervalued. Although, the PEER misalignment rate implies a high misalignment rate (about 50%), the BEER estimate shows that the exchange rate does not deviate significantly. Specifically, at the end of the estimated period, the Slovak crown was undervalued by 7%. Finally, the BEER-based analysis shows that in the last quarter of 2003 the actual Maltese pound has been totally matched with its equilibrium rate. Following the PEER analysis, at the same time, the effective exchange rate was undervalued by only 2%.

Our results are by and large consistent with previous empirical studies. Although, we have taken as granted that exchange rate dynamics are characterised by a linear process, this is not always the case. Heckscher (1916) first introduced the idea that adjustments may be nonlinear because of transaction costs. Taylor et. al. (2001) ; Sarno et. al. (2004a); Obstfeld & Taylor (1997); Michael et. al. (1997), applying Threshold Autoregressive (TAR) models, find that the adjustment toward to equilibrium is an increasing function of the exchange rate misalignment. Furthermore, Kanas (2005) finds that the relation between the US/UK real exchange rate and the real interest rate differential is subject to regime-switching. Sarno et al (2004b), estimating Markov

[18] This finding should worry us about robustness of the trend-cycle decomposition. This is not a panacea, since alternative procedures can lead to different, and in some cases contradictory, estimates.

Switching VEC models for six industrialized countries, find that the causality between exchange rates and macroeconomic fundamentals changes over time. For five CEEC, Arghyrou et al (2005) find significant non-linear short run dynamics in the relation between exchange rates and fundamentals, in which the speed of adjustment toward to equilibrium depends on the size of exchange rate misalignments.

To conclude, our analysis indicates that the actual effective exchange rates do not deviate significantly from their equilibrium rates. As a consequence, based on BEER analysis, we do not expect any anticipated large fluctuations in the examined effective exchange rates. Hence, the relevant effective exchange rates are expected to be relatively stable. This evidence persuades us to assert that those countries can successfully meet the exchange rate criterion. As a matter of fact, the introduction of those countries to EMU is not expected to weaken the stability of Euro. Finally, this study can be extended by estimating the equilibrium exchange rate under a nonlinear framework. The nonlinear behavior is not surprising for the case of CEEC. Actually, we expect a regime-switching process because of (i) changes in exchange rate regimes, (ii) monetary policy reforms, i.e. change to inflation targeting policy, and (iii) other economic and political developments during the transition period. So, the estimation of the equilibrium exchange rate by a Markov Switching VEC model (MS-VECM), highlighting directions for future research, seems to be appropriate.

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