Studia i Analizy
Studies & Analyses

Centrum Analiz
Społeczno-Ekonomicznych

Center for Social
and Economic Research

247

Łukasz W. Rawdanowicz

Poland's Accession to EMU – Choosing the Exchange Rate Parity

Warsaw, 2002

The publication was financed by AIG Pension Society.

Key words: **real exchange rates, equilibrium exchange rates, EMU enlargement.**

Acknowledgements:
I am greatly indebted to Przemek Kowalski and Mateusz Szczurek for their valuable and inspiring comments, and their help with collecting data.

Graphic Design: Agnieszka Natalia Bury

DTP: CeDeWu Sp. z o.o.

ISSN 1506-1701, ISBN 83-7178-298-5

Publisher:
CASE – Center for Social and Economic Research
ul. Sienkiewicza 12, 00-944 Warsaw, Poland
tel.: (4822) 622 66 27, 828 61 33, fax (4822) 828 60 69
e-mail: case@case.com.pl

Contents

Ł ukasz W. Rawdanowicz

Łukasz Rawdanowicz graduated from Sussex University in 1998 (MA in International Economics) and Warsaw University - Department of Economics in 1999 (MA in quantitative methods). His main area of interest is macroeconomics and econometrics. He is a member of the editorial board and co-author of the quarterly bulletin „Polish Economic Outlook - Trends, Analyses, Forecasts and Global Economy".

Abstract

This paper deals with the choice of the exchange rate parity upon Poland's entry to EMU. Given that the euro parity should reflect some equilibrium exchange rate, two theoretical concepts are discussed: fundamental and behavioural equilibrium exchange rates. These approaches are then estimated. According to these calculations, the zloty-euro exchange rate in 2002 is not far from the level consistent with the current state of fundamentals (as indicted by BEER) and requires some depreciation to be in line with the equilibrium level of fundamentals (as indicated by FEER). The possible FEERs range between 3.88 and 4.08 zlotys per euro depending on the variant and REER definition. The results should be treated with great caution as they are demonstrated to be sensitive to the adopted assumptions and model specifications. It is argued that the range of "optimal" exchange rates is quiet wide. This stems from the fact that consequences of exchange rate misalignment depend primarily on its degree as well as due to the intrinsic uncertainty about empirical estimates of equilibrium exchange rate. Moreover, the scope for depreciation of the nominal zloty-euro exchange rate is limited by the ensuing costs to the economy, needs to meet Maastricht criteria, and political bargain.

1. Introduction

Prior to entering to EMU, Poland will have to stay in ERM2 for at least two years. The core principle of the ERM2 is the maintenance of the exchange rate within the +/-15% fluctuation band without devaluation of the central parity (some narrower bands are also possible). Thus, upon entry to ERM2 and then to EMU a nominal zloty-euro parity must be chosen. The ERM2 parity may be the irrevocable exchange rate in EMU, though revaluation is possible.

In 1999, countries that took part in the stage 3 of the EMU establishment fixed their currencies to the euro at their ERM parities. They were initially set prior to 1979 and then devalued on several occasions. In the case of the UK, which joined the ERM in 1990, the parity was chosen based on the purchasing parity criterion (MacDonald, 2000). In all cases, the exchange rates were set so as to reflect some "equilibrium" conditions. This principle should also apply to the case of Poland and other prospective EMU members. However, to speak about equilibrium exchange rate, the corresponding conditions must be clearly defined. The existing literature offers various approaches to defining equilibrium exchange rates. They differ in economic interpretation and empirical estimations.

The paper deals with the choice of the exchange rate parity upon Poland's entry to ERM2 and EMU. In the quest of equilibrium exchange rate for Poland estimations in the notion of fundamental and behavioural equilibrium exchange rates are undertaken. The results are discussed in terms of their sensitivity to adopted assumptions and models' specifications. Also their economic interpretation is explained. Finally, the discussion of the parity choice is extended by considerations other than model-based analyses. In principle, issues on the consequences of choosing the particular nominal exchange rate, political bargains and reactions of financial markets are addressed.

The paper is organised as follows. Section 2 surveys theoretical concepts of equilibrium exchange rates. Section 3 deals with empirical estimations of fundamental and behavioural equilibrium exchange rates for Poland and discusses problems of their application. Section 4 summarises the theoretical and empirical considerations and draws practical guidelines for setting the zloty-euro parity. Finally, Section 5 concludes.

2. Concepts of Equilibrium Exchange Rate

TThe issue of equilibrium exchange rate and assessment of its over/under-valuations has attracted considerable theoretical and empirical attention – for instance Williamson (1994), Montiel (1997), Clark and MacDonald (1998), MacDonald (2000), and Isard *et al.* (2001). Generally, three most popular approaches to assessing the equilibrium exchange rate are identified in the economic literature. These are purchasing power parity (PPP), fundamental equilibrium exchange rate (FEER), and behavioural equilibrium exchange rate (BEER). All of these concepts will be briefly discussed in what follows.

2.1. PPP

According to PPP, a nominal exchange rate of any two currencies should reflect closely the relative purchasing powers of the two monetary units represented by national price levels (Isard *et al.*, 2001). As an implication, changes in a nominal exchange rate should mirror changes in relative price levels between the two countries. This condition implies constant real exchange rate.

The PPP hypothesis has been rejected to hold in the short run, though some econometric evidence of its long-run properties has been found (see Isard *et al*. (2001)). One refinement introduced to the PPP approach was due to incorporation of the Harrod-Balassa-Samuelson effect. Because of differences in relative productivity (tradable sector vs. nontradable sector) between two countries and the ensuing differences in relative prices, the real exchange rate tends to deviate from the PPP path. A country with high productivity growth in the tradable sector has higher inflation in nontradable goods (a sector with low productivity). Consequently, this country's currency appreciates in the real terms versus the currency of a country with lower relative productivity (i.e. with lower relative inflation).

PPP is the most straightforward approach, but it raises many reservations. First, PPP as a measure of an equilibrium exchange rate is incomplete. The relative PPP is based on changes in the price levels. Thus, the assessment of exchange rate would require choosing some base period as equilibrium (Bayoumi *et al.*, 1994). Second, it fails to take into account explicitly major changes in economic policies or in the economic structure. It also does not allow real variables to affect the equilibrium exchange rate (MacDonald, 2000). Finally, this approach is sensitive to the chosen price indicator – different price indices may render

quite different results (Isard *et al.*, 2001) – see Figure 2. Consequently, Williamson (1994b) and MacDonald (2000) claim that PPP is not a good metric to measure currency misalignment. The former researcher stated strongly that the PPP criterion should be rejected not just as a conceptually incorrect basis on which to estimate the equilibrium exchange rate, but also as not even providing a useful empirical first approximation.

2.2. FEER

The notion of fundamental equilibrium exchange rate (FEER), popularised by Williamson (1985), is based on the idea of internal and external macroeconomic balance. The former is defined in terms of output at the full-employment level coupled with low and sustainable inflation, whereas the latter in terms of a sustainable and desired net flow of capital between countries that are internally balanced (Clark and MacDonald, 1998). The FEER shows the exchange rate that would prevail under "ideal economic conditions". Thus, this approach should be viewed as normative. It simply boils down to calibrating the exchange rate at a set of well-defined economic conditions (Clark and MacDonald, 1998). In this context, the FEER is a comparative static, partial equilibrium approach.

The solution for FEER is obtained in the balance of payments framework, where the current account balance is squared with the capital account balance[1]:

$$CA \equiv - KA \qquad (1)$$

Assuming that the "sustainable" current account balance is determined by domestic and foreign demand at full employment and the real effective exchange rate, the solution for FEER can be found by solving the model:

$$CA(FEER^*, Y_d^*, Y_f^*) = -KA^* \qquad (2)$$

where Y is domestic (d) and foreign (f) demand, asterisks denote the potential/desired level. Thus, in order to calculate the FEER one would have to know the current account model, estimates of potential output in the home country and abroad as well as the estimate of equilibrium capital flows.

[1] Formally according to the Balance of Payments Manual by IMF, it is the financial account that comprises capital flows and not the capital account.

The FEER approach does not refer explicitly to the theory of the exchange rate determination, but rather states the equilibrium position. As pointed by MacDonlad (2000), this equilibrium position should be viewed as "statistical" one. Given its stock-flow inconsistency, it cannot represent a true steady-state equilibrium. Wren-Lewis (1992) noted that the FEER approach assumes implicitly a convergence of the actual real effective exchange rate to its FEER value. In this context, a medium-run current account theory of exchange rate determination is embedded in this approach. It is simply assumed that any divergence in real exchanges will be eliminated. However, the adjustment process is not explained and the concept explains explicitly only the equilibrium position (MacDonald, 2000).

The FEER method facilitates simple and transparent calculations with a sensitivity analysis of adopted assumptions. However, this approach disregards changes in policies that affect potential output as well as considerations on asset market equilibrium. The latter omission, as Bayoumi *et al*. (1994) stressed, leads to an implicit assumption that over the medium term interest rates will settle at their equilibrium. This assumption seems to be very restrictive one and constraining on monetary policy.

The calculated FEER can be used for an assessment of the total exchange rate misalignment – i.e. the misalignment resulting from the departure of macroeconomic variables from their fundamental-equilibrium levels (defined in terms of internal and external balance). Thus, this approach makes it impossible to decompose exchange rate misalignment between random/transitory factors and those stemming form misaligned fundamentals. In a sense, the FEER points to the ideal situation with implicit equilibrium in all markets.

Bayoumi *et al.* (1994) and IMF (1998) clearly stress that plausible estimates of FEER may vary quite substantially. In addition, as Bayoumi *et al.* (1994) point out, the underlying economic conditions that affect a country's FEER are subject to changes and thus the computed FEER will not be constant over time.

2.3. BEER

The behavioural equilibrium exchange rate (BEER) seeks relations between macroeconomic fundamentals and the exchange rate. Therefore, it can be treated as a theory of exchange rate determination. The estimation of BEER is usually done in a single-equation model where explanatory variables (fundamentals) are chosen based on believes on the exchange rate determinants (example the balance of payments theory, Harrod-Balassa-Samuelson effect, uncovered interest parity, purchasing power parity,

etc.). For instance, Baffes *et al.* (1997) employed: terms of trade, indicator of economy openness (measured as imports plus exports over nominal GDP), resource balance to GDP (trade balance over GDP – in constant prices), investment share, whereas Clark and MacDonald (1998) – difference in real interest rates, relative government debt, relative ratios of tradables and nontradables prices, and net foreign assets.

The estimated BEER provides information about the current misalignment. The latter term means a misalignment stemming from transitory and random effects, i.e. factors not treated as "fundamental" determinants of the exchange rate (MacDonald, 2000). The BEER method also makes it possible to calculate a "fundamental" equilibrium exchange rate and in turn total misalignment (as in the notion of FEER). This requires choosing the equilibrium levels of the fundamental variables. Having done such calculations, it can be learned to what extent the exchange rate misalignment results form the transitory factors and to what extent from misaligned fundamentals.

On the practical side, highly demanding data requirement – both with regard to data coverage and length of time series (usually annual or quarterly) – is the main drawback of the BEER approach. It is very often the case (especially for transition and developing countries) that the data shortcomings make BEER estimations questionable. However, the data shortcoming can be circumvented by application of panel techniques.

3. Empirical Estimations

Before turning to empirical estimations, definitions of real exchange rate will be briefly discussed. Empirical models of equilibrium exchange rates usually employ real effective exchange rate (REER) – i.e., the weighted nominal exchange rate against currencies of main trading partners deflated by selected price indices. The common practice is to use the geographic structure of a country's trade as a proxy for weights in the REER. However, the geographic structure does not have to correspond closely to the currency structure of trade transactions as indicated by invoices. This is certainly the case for Poland (see Table 1 and Table 2). The share of trade transactions invoiced in US dollars is significantly higher than the actual share of exports/imports to/from the US. Thus, using the trade structure for weighting REER may render some bias.

Table 1. Geographic and currency structure of Polish exports, 1995-2001 (% of total)

	1995	1996	1997	1998	1999	2000	2001
EU15	70.0	66.2	64.0	68.3	70.5	69.9	69.2
UK	4.0	3.9	3.8	3.9	4.0	4.5	2.4
USA	2.7	2.3	2.6	2.7	2.8	3.1	2.4
EUR*	45.3	44.6	45.1	52.3	54.8	55.8	58.2
USD	49.1	49.4	48.5	40.0	36.2	36.2	33.8
PLN	0.0	0.0	0.0	2.7	4.2	3.5	4.1
GBP	2.8	2.3	2.3	2.1	2.2	2.1	2.1

Source: Central Statistical Office (CSO) and National Bank of Poland (NBP).
Note: * – sum of all EU12 currencies.

The selection of particular price index may also impact the final value of REER. Given that REERs are usually used as an indicator of country's competitiveness, prices, which cover mainly tradables, are more appropriate in this respect. It seems that producer price index (PPI) or unit labour costs (ULC) suit better for this purpose than the consumer price index (CPI) which is most commonly used to compute REER. As shown in Figure 1 inferences with regard to the zloty appreciation differ quite substantially among different measures of REER. The appreciation of the zloty in 1995, 1998 and 2001 was not that severed when measured by the REER based on the PPI as compared to the one based on the CPI.

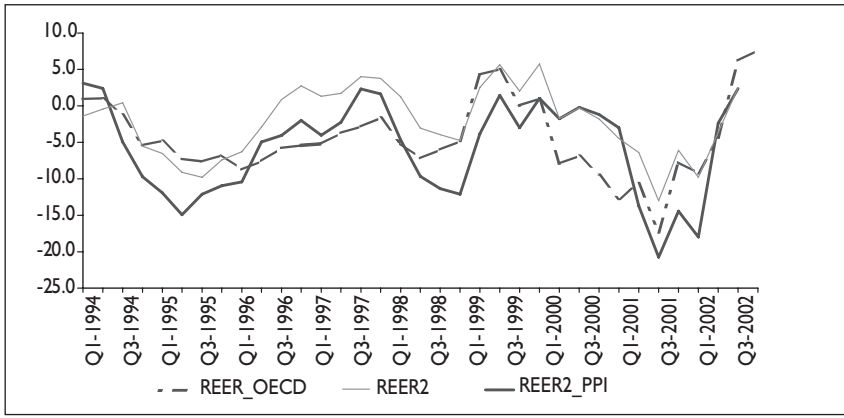
Table 2. Geographic and currency structure of Polish imports, 1995-2001 (% of total)

	1995	1996	1997	1998	1999	2000	2001
EU15	64.6	63.9	63.8	65.6	64.9	61.2	61.4
UK	5.2	5.9	5.5	4.9	4.6	4.4	4.2
USA	3.9	4.4	4.5	3.8	3.6	4.4	3.4
EUR*	50.8	52.7	54.6	59.7	58.5	55.8	58.4
USD	41.0	39.5	38.0	32.3	32.2	34.8	32.1
PLN	0.0	0.0	0.0	1.5	3.5	3.9	4.6
GBP	3.2	3.4	3.3	2.8	2.3	2.0	2.0

Source: CSO and NBP.
Note: * – sum of all EU12 currencies.

For the purpose of all estimations in this paper, the REER is constructed as an euro-dollar basket deflated by the corresponding consumer prices. The nominal exchange rate is defined as a unit of domestic currency (the zloty) per one unit of foreign currency (the euro and dollar). Thus, the increase in the REER means the depreciation of the zloty.

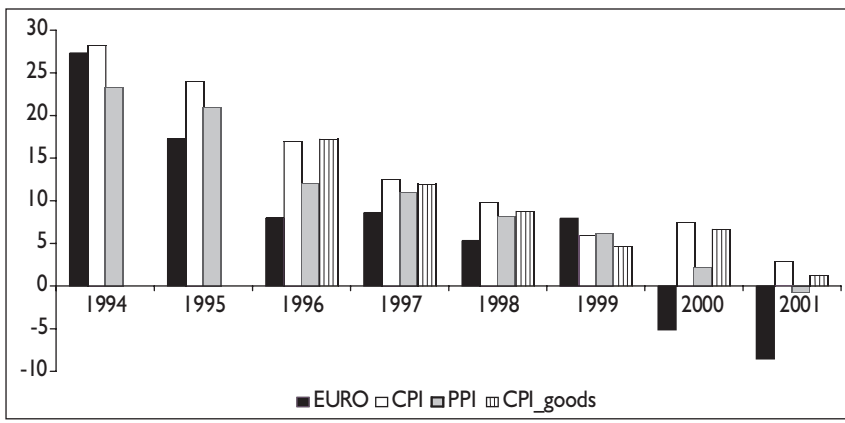
Figure 1. Measures of real effective exchange rates for Poland, 1994-2002 (% change, yoy)



Source: OECD, author's calculations based on NBP and ECB data.

Notes: 1. OECD REER – based on 40-currency basket deflated with consumer prices.
2. REER2 – based on the euro and US dollar deflated with consumer prices.
3. REER2_PPI – based on the euro and US dollar deflated with the PPI.

Figure 2. Nominal zloty-euro exchange rate vs. relative PPP exchange rate, 1994-2001 (% change, yoy)



Source: NBP and ECB.

Notes: 1. Changes refer to annual averages.
2. Euro – % change in nominal zloty-euro exchange rate (euro – synthetic).
3. CPI – % change in relative consumer prices between Poland and the EU15.
4. PPI – % change in relative producer prices between Poland and the EU12.
5. CPI_goods – % change in relative prices of consumer goods between Poland and the EU12.

No formal inferences on equilibrium exchange rate based on the PPP model will be pursed in this paper. Only an illustration of different dynamics of prices and nominal zloty-euro exchange rate in terms of relative PPP will be presented. Figure 2 shows that changes in the nominal zloty-euro exchange rate do not correspond closely to changes in prices. Larger discrepancies are in the case of consumer prices than in the case of producer prices. This could be indicative of the Harrod-Balassa-Samuelson effect.

3.1. FEER Calculations

In order to conduct the FEER calculation for Poland one would have to know the balance of payments model, assumptions on potential output growth in Poland and its main trading partners, and the sum of equilibrium capital flows. These three steps will be dealt with in turn.

The Balance of Payments Model

The simplest trade equations define relations between real exports/imports on the one side and real foreign/domestic demand and REER on the other. Foreign demand is usually proxied by GDP in main trading partners, and domestic demand with GDP of the country under investigation. Unfortunately, in the case of Poland it is difficult to arrive at reliable trade elasticities. They are very sensitive to model specification and the variables employed. The estimated trade equations relate volume of exports with REER and real GDP in the EU15[2] (main Polish trade partner, see Table 1), and volume of imports with REER and Polish real GDP. Various definitions of REERs were tested. In the case of exports (and also of imports depending on the model specification) price elasticity was at odds with theoretical expectations. The positive relation of REER and export volume was found (i.e., that the depreciation – higher value of REER – would lead to the export contraction). In our opinion, the distortion due the Russian crisis is the main factor behind. In the aftermath of the Russian crisis, trade volumes contracted significantly and the zloty depreciated. In the course of 1999 and 2000 the zloty started to appreciate and trade volumes to increase. The distortion was so big that the simple application of dummy variables did not alter the findings – disregarding employment of various econometric techniques (VAR, ECM, and single equation models). All equations were estimated using quarterly data.

[2] Where long enough time series for the euro zone (EU12) are not available, then they are approximated by the corresponding variables for the EU15.

Apparently, more complex trade equations (for instance using trade weighted foreign demand based on GDP growth not only in the EU or relating import volume to domestic demand and exports rather then simply GDP) could improve their statistical and theoretical properties of these estimations, but would make them more difficult to apply to FEER calculations. Also the short lag structure could be the problem, however data availability made it impossible to test for higher lags. In addition, there are reasons to expect that trade elasticities were not constant in the transition period in Poland. This could be attributable, among other things, to changes in the commodity and geographic structure of Polish trade.

Potential Output

Potential output is usually defined as maximal output that does not produce inflationary pressures given the supply-side constraints of the economy. Although the theoretical aspect of this notion seems to be clear, its operational side is far from easy. As in the case of equilibrium exchange rate, potential output is an unobservable variable and its final estimate depend to a large extent on judgmental assumptions or estimations. For instance, the IMF does not pursue a standardised approach for all countries, but it rather bases its estimates on knowledge of country specific features. One of the methods of estimating the output gap focuses on estimation of a production function (De Masi, 1997). The production function approach aims at identifying specific factors contributing to output growth. Linking supply of production factors (labour, capital, and total factor productivity) with output facilitates calculations of the output in the situation when the ratio of utilisation is at a potential level. As pointed by De Masi (1997) this approach is the middle ground between fully structural models and mechanical measures such as the Hodrick-Prescott (HP) filter. The fully structural models, where the variables under investigation are endogenised, have most desired conceptual properties, but are difficult to apply due to problems with their estimations. Given practical difficulties with estimation of either production function or structural models, purely technical methods of time series smoothing are most commonly used. This approach (for instance HP filter), however, is atheoretical and sensitive to the selected parameter and time window. Structural or semi-structural estimation of potential output in Poland would deserve a research on its own and no formal calculations are pursued in this paper.

Equilibrium Capital Flows

The estimation of equilibrium capital flows is based on the national account identity that relates the capital account balance (which must be equal to the current account

balance) with the difference between domestic investment and savings. The most straightforward approach is to set the investment and savings levels consistent with the potential output. However, it is difficult to find criteria needed to select such levels. Williamson (1994b) attempted to approximate these variables with investment needs in the debt cycle and demographic effects on saving behaviour as well as with judgmental criteria of sustainability and consistency.

The most common approach, however, focuses on estimating the saving-investment norm (Isard and Faruqee, 1998). Using historic data for panel of countries, the current account (equal by the accounting identity to the capital account) is regressed on saving-investment determinants. The determinants could include the stage of development (proxied by income *per capita*), demographic structure (dependency ratio), fiscal position, output gap and world interest rates (Isard and Faruqee, 1998). Having estimated the coefficients of the saving-investment norm, the equilibrium capital flows (or the equilibrium current account) can be calibrated at the 'equilibrium' levels of the determinants. The problem is, however, that although saving-investment norm have been estimated for various countries (for instance, Chinn and Prasad (2000) covered developing countries – excluding emerging markets, and Doisy and Herve (2001) focused on CEECs), there are no attempts to calibrate the determinants at equilibrium levels. Therefore, no formal analysis of the equilibrium current/capital account was undertaken for the purpose of this paper.

Results

In the face of the aforementioned problems with collecting all information needed to calculate the FEER, back-of-the-envelope calculations will be undertaken. Their aim is to demonstrate sensitivity of results to the adopted assumptions, rather than to provide precise estimates of FEER based on formal analyses of its determinants. Given this reservation, we try to calculate what is the FEER for 2002.

The employed FEER model adopted the following assumptions. Trade elasticities were calibrated using various trade equation estimations undertaken for Poland and long-run trade elasticities estimated for G-7 countries in the paper by Hooper *et al.* (1998). As imports and exports in the balance of payments are nominal variables, price indices had to be chosen so as to translate export/import volumes estimated in trade equations into nominal values needed for equalisation of the current and financial accounts in the balance of payments framework. For the sake of simplicity, we assumed the prices of foreign trade (denominated in US dollars) were proxied by the product of the CPI in the EU and changes in the dollar-euro exchange rate. The rationale behind such approximation is that Polish

exporters and importers are believed to be price takers and the major bulk of imports/exports are invoiced in euros (see Table 1 and Table 2), whereas the data in the Polish balance of payments is denominated in US dollars. In order to incorporate other items of the current account of the balance of payments, estimated imports and exports covered not only merchandise trade but also trade in services and unclassified current transactions (the proxy for cross-border trade and trade in services). As inflows and outflows of unclassified current transactions are not available – only net value, the net item was added to exports. Other assumptions – those on potential output in Poland and the EU12, the corresponding price indices, sustainable capital flows as well as income, transfers and errors and omissions needed to close the balance of payments accounting – were chosen based on expert knowledge (see Table 3). Equilibrium capital flows were set so as to equal approximately to 2%, 3% and 4% of GDP in the subsequent variants (1,2 and 3).

Table 3. FEER calculations for 2002

	Variant 1	**Variant 2**	**Variant 3**
GDP in the EU12, % change	2.7	2.7	2.7
CPI in the EU12, % change	2.0	2.0	2.0
CPI in the US, % change	2.5	2.5	2.5
USD/EUR	1.000	1.000	1.000
GDP in Poland, % change	3.0	4.0	5.0
CPI in Poland, % change	3.0	3.5	4.0
Capital Account, US$ billion	3.5	5.5	7.5
Other BoP flows, US$ billion	1.3	1.3	1.3
FEER, % change	**6.9**	**5.3**	**3.7**
EUR/PLN (REER=EUR + USD)*	**4.08**	**4.04**	**4.00**
EUR/PLN (REER = EUR)**	**3.96**	**3.92**	**3.88**

Source: Author's calculations.

Notes: 1. All calculations based on constant trade elasticities (see Table 4). Annual data.

2. Other balance of payments (BoP) flows comprise: income, transfers, and errors and omissions (forecast value for 2002).

3. * – nominal zloty-euro exchange rate based on the REER comprising the euro and the US dollar;
** – nominal zloty-euro exchange rate based on the REER comprising only the euro.

Table 3 demonstrates possible FEER values for alternative scenarios. They differ only with regard to assumptions for Poland, i.e. potential GDP, corresponding inflation, and sustainable capital inflows. Variant 2 is a baseline scenario, which is believed to be most probable. As it is clearly visible the differences are not that large. All variants indicate that the REER must depreciate in order to reach the equilibrium, but the level of misalignment

is not high – between 3.7% and 6.9%. Given the assumptions on prices, this means the depreciation of the nominal exchange rate. The implied nominal zloty-euro exchange rates as presented in Table 3 are higher than the forecast exchange rate for 2002 – 3.86. Therefore, these results suggest a nominal overvaluation of the zloty in 2002 by approximately 5.7-3.6%. In the case of calculations based on REER comprising only the euro, the misalignment is lower (2.6-0.5%).

Table 4. Sensitivity analysis of FEER calculations for 2002

	Variant 2	**Alternative**	**Variant 2**	**Alternative**	**% change**
	assumption	assumption	PLN/EUR	PLN/EUR	in PLN/EUR
GDP in Poland, % change	4.0	5.0	4.04	4.09	1.1
CPI in Poland, % change	3.5	4.5	4.04	4.08	1.0
Capital Account, USD bn	5.5	7.5	4.04	3.93	-2.7
USD/EUR	1.00	0.95	4.04	3.96	-1.9
Export price elasticity	0.90	1.90	4.04	3.96	-1.9
Export income elasticity	1.60	3.40	4.04	3.95	-2.4
Import price elasticity	-0.60	-1.60	4.04	3.95	-2.1
Import income elasticity	1.40	2.60	4.04	4.16	2.8

Source: Author's calculations.

In order to demonstrate in a better way the sensitivity of obtained results, the differences in nominal exchange rate stemming from a change in only one assumption as compared to variant 2 are computed and presented in Table 4. The results indicate that FEER calculations are very sensitive to the trade equations' parameters. The estimated equilibrium capital flows and the dollar-euro exchange rate play a significant role too. It should be also stressed that the calculations are biased to a large extent by the equilibrium or disequilibrium of the dollar-euro exchange rate, i.e. the factor that is exogenous to the Polish economy.

The results presented in Table 4 allows to draw general conclusions on the potential bias of the calculated FEER given the *ceteris paribus* assumption. The higher potential output in Poland, corresponding inflation, dollar-euro exchange rate, and import income elasticity as well as the lower export price and income elasticity, and import price elasticity (in absolute values), the more depreciated (higher) zloty-euro exchange rate.

While interpreting the above results (Table 3 and Table 4) it must be underlined that the nominal zloty-euro exchange rate consistent with the FEER is calculated on the basis of

annual changes in the variables used in the model, in particularly in the REER. Thus, they are dependent on the nominal zloty-euro exchange rate in 2001, which was used for calculations as a base period. It stood at 3.67 zlotys per euro and as it will be discussed later (see Section 3.2) this value may be judged as too appreciated. This finding is consistent with the estimates of the FEER for Poland for 2001 done by Baude et al. (2002). They assessed the overvaluation of the real effective exchange rate of the zloty at 6%. Therefore, using any higher value for the reference euro-zloty exchange rate would result in higher FEERs (i.e. more depreciated). But on the other hand, the employed dollar-euro exchange rate seems rather high as compered to forecast value for 2002. Consequently, the results are biased upwards (i.e. to depreciated) as it can be indicated by the FEER value based on the REER comprising only the zloty-euro exchange rate. These considerations, however, do not affect the assessment of the REER misalignment. At this point it also would be desirable to take into account the issues of the global consistency and of assessment of the dollar-euro exchange rate misalignment.

3.2. BEER Estimations

The estimated BEER model in this paper draws on models of Baffes *et al*. (1997), Clark and MacDonald (1998), and MacDonald (2001). It can be described as follows:

$$BEER = f(\overline{prod}, \overline{tot}, \overline{rir}) \qquad (3)$$

where the explanatory variables are: relative productivity (total labour productivity in Poland and in the EU12), Polish terms of trade, and difference between real interest rates in Poland and the euro zone (3M WIBOR and 3M EURIBOR – synthetic, OECD data). The relative labour productivity refers to the PPP notion of competitiveness and could also proxy the HBS effect. Although no distinction between labour productivity in the tradable and nontradable sectors is made, this can be consistent with the assumption that labour productivity growth in the latter sector is the same in the EU12 and Poland). The higher labour productivity in Poland relative to the EU12, the more appreciated zloty. Thus, the expected sign on this variable should be negative. Terms of trade stand for commodities price shocks and also should be negatively correlated with the REER. Finally, differences in real interest rates refer to the notion of uncovered interest rate parity.

The variables of the model were tested for stationarity (see Statistical Appendix). The REER and real interest rate differential turned out I(1) variables, though in the former case there is marginal evidence in favour of trend stationarity hypothesis. The relative

productivity variable seems to be I(2) based on ADF test, but the Phillips-Perron test proves I(1) properties. On the other hand, terms of trade was detected to be I(0).

Given the quarterly data for the period 1Q95-2Q02, based on the Johansen method one cointegration vector was found for the VAR(2) system. It has the following form (asymptotic standard errors in the parenthesis):

$$\underset{}{reer} = 1.471 - \underset{(0.23782)}{1.322 * prod} - \underset{(0.31186)}{1.028 * tot} - \underset{(0.20328)}{2.221 * rir} \qquad (4)$$

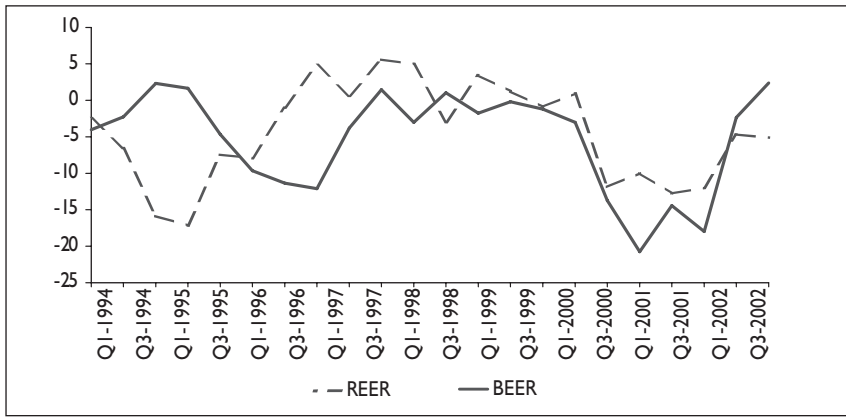
where *reer* is the log of REER, *prod* the log of relative productivity, *tot* the log of Polish terms of trade, and *rir* the log of differences between Polish and euro zone's (synthetic) real interest rates. The signs of coefficients turned out as expected (see equation 3). The obtained results should be treated with caution as some statistical properties of the variables and the system may raise reservations with regard to econometric standard inferences.

Prior to the discussion of the results, the reservation must be made that the above equation does not pretend to be a perfect model of exchange rate determination in Poland. Its parsimonious specification may suffer from the omitted variable problem and consequently the obtained coefficients may be biased. For instance, the model could be augmented by variables like net foreign assets, long-term interest rates, budget deficit or FDI inflows. The augmentation of the model and formal testing of omitted variable problem is, however, limited by short time series. Also the employment of current variables could be discussed in more details. For example, more attention could be devoted to the disparity between the Polish and euro-zone interest rates. The reference to interest rates in other emerging markets rather than to those in the EU12 may be more indicative of zloty exchange rate changes. In the run-up to the EMU also the convergence play should be taken into account. In addition, the results may be biased due to structural changes. The evolution of restrictions on capital flows or the Russian crisis serves as good examples. The short time series once again is the impediment for formal testing of such events. The potential solution is to employ panel models, for instance for all CEECs that are to become EU/EMU members soon. As indicated in the survey by MacDonald (1998), panel estimations tend to render better results in a economical and statistical sense, than a single-country estimations (for instance as proved in Chinn (1996) and Chinn and Johnson (1996)).

It should be stressed that the obtained equation indicates only the current misalignment. No attempt was made to calibrate long-run values for the explanatory variables. Therefore, the results point a trend value for REER rather than equilibrium in the notion of FEER approach.

Figure 3 shows that in 1997 and 1998 the estimated BEER and actual REER were changing in the opposite directions. In 1997 there was a significant increase in interest rates in Poland accompanied with falling inflation. This factor caused the appreciation of the estimated BEER, whereas the actual REER depreciated. In 1998 the trends were reversed. Starting from 1999 the estimated and actual exchange rates tend to move together. The strong appreciation of the zloty in 2001 is not fully explained by the model that points to a more moderate strengthening. Thus, if we believed in our model, the 2001 appreciation can be treated as caused by transitory/speculative factors. The results for 2002 are more in line with the actual values. The BEER tend to indicate slightly more appreciated exchange rate than the actual one, but this comparison is biased due to the low-base effect in the case of actual REER.

Figure 3. Estimated BEER and actual REER, 1997-2001 (% change, yoy)



Source: Author's calculations.
Note: The REER is based on euro-dollar currency basket deflated with consumer prices.

4. What Should Be the Entry Exchange Rate?

Having surveyed theoretical concepts of equilibrium exchange rate and attempt some empirical calculations, we will turn to the discussion of practical guidelines for setting the euro parity. We start with stressing the fact that equilibrium exchange rate concepts refer to real (effective) exchange rates and upon the ERM2/EMU entry a nominal exchange rate will be set. This differentiation highlights important conceptual issues surrounding

equilibrium exchange rates. In this context, the interactions between nominal exchange rate and prices should be thoroughly investigated. Thus, in assessing the misalignment, the focus should not be placed merely on nominal exchange rate, but also on price developments. In a perfect world with immediate adjustments, changes in nominal exchange rate would induce corresponding changes in prices of tradables and there would not be deterioration in competitiveness. However, such a textbook scenario is not the case in reality. Price adjustments to exchange rate changes are believed to be slow, and real exchange rates are driven primarily by nominal exchange rates (at least in the short and medium run). Apparently, the speed of the exchange rate pass-thorough to domestic prices differs among countries and this issue requires formal testing in order to draw any profound conclusions on the consequences of choosing a particular exchange rate. Theoretical and empirical evidence (more pervasive pricing-to-market effect in economies with monopolistic competition markets, and higher share of nontradables in the structure of the economy and consumption) suggest a weaker pass-through in developed economies as opposed to developing countries.

The bottom line of the estimations pursued in this paper is that it is difficult to provide precise and reliable empirical estimates of the unobservable variable like the equilibrium exchange rate. Empirical estimations are intrinsically uncertain. The estimates are sensitive to the adopted assumptions and model specifications. Besides each concept of equilibrium exchange rate has different interpretation and conveys slightly different information for policy makers. Given the above considerations, it is important to mull over if model-based equilibrium exchange rates are still good indicators for selecting the euro parity, which is supposed to be the equilibrium exchange rate.

The problem with the FEER concept is that it states equilibrium exchange rate only for ideal conditions and it does not provide any information on "appropriate" exchange rate for current economic situation. The concept says nothing how the equilibrium can be achieved, though the adjustment is implicitly embedded in this approach. It would be naive to expect in the real world that by moving the exchange rate (in particular the nominal) to its equilibrium level is enough to achieve the internal and external equilibrium for the entire economy. There are at least two reasons behind this. First, changing nominal exchange rate may induce price adjustments mentioned before and real effects will be muted. This effect depends on the price stickiness and mobility of production factors across the economy. Second, the change in the exchange rate may help to reach the potential growth and full employment, but does not have to, as this is not the only factor determining the equilibrium in the economy. For instance, the exchange rate change is rather unlikely by itself to force changes in fiscal policy: to cut a high budget deficit structural reforms are more required than the depreciation of domestic currency.

In the context of setting nominal parity, it is better, however, to think about the "equilibrium exchange rate" as a level of exchange rate that is consistent with other macro variables for the given point in time and not necessarily as a steady state exchange rate in a sense of sustainable equilibrium. In this respect, the BEER approach is better suited. It also solves to some extent the problem of endogeneity by employment of VAR models. However, given the uncertainty about exact model of exchange rate determination, the current misalignment assessed based on the BEER model may indicate a misspecification problem and not the misalignment stemming form random effects (i.e. everything which is not explained by the "true" model).

The aim of equilibrium exchange rate estimations is the assessment of the exchange rate misalignment with regard to its equilibrium value (i.e., if it is under- or overvalued). However, as pointed by IMF (1998), a complete assessment of exchange rate misalignment should not be based simply on model estimates, but take into account a broader range of macroeconomic issues like policy-mix, structural factors, etc. It is reasonable to expect that not all short and medium run misalignments are destabilising and need a remedy policy action. Some deviations from equilibrium exchange rates may be due to cyclical fluctuations in macroeconomic variables and should not be treated as harmful to the economy.

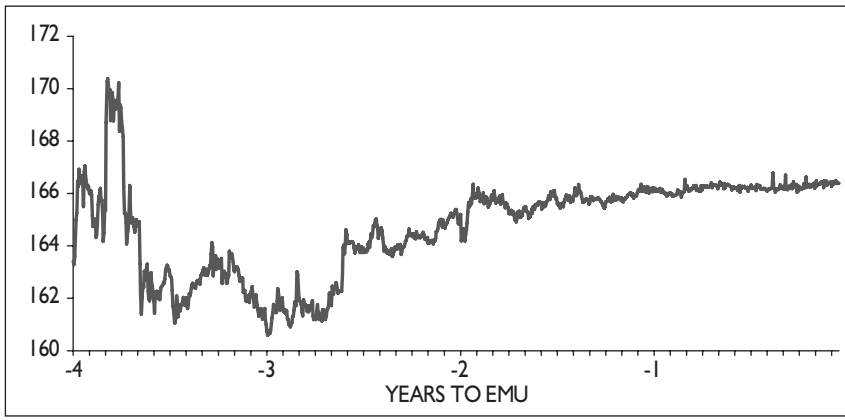
At this point it is important to apprehend what are the consequences of choosing under/overvalued exchange rate. Unfortunately, the answer is not an easy one because it would require a detailed identification of relations between the exchange rate and other macro variables (such as output growth, employment, inflation, etc.). According to a conventional macroeconomic analysis, an overvalued exchange rate spurs recessionary effects and the undervalued currency expansionary ones. However, empirical research does not provide such clear-cut evidence. The extent to which the exchange rate is misaligned seems to be more important than the fact of misalignment *per se*. This hypothesis is the key finding of the empirical work by Collins and Razin (1997). They discovered that only very high overvaluation leads to slower GDP growth, and medium and high under-valuation to higher growth. This very fact coupled with the intrinsic uncertainty of equilibrium exchange rate estimates gives support to the conjecture that the range of "optimal" exchange rates at which Poland can switch to the euro is quiet wide.

When analysing the consequences of setting the nominal exchange rate it would be also interesting to investigate the microeconomic and structural effects. Kowalski (2002) notes the asymmetric sectoral impact of the zloty devaluation in the run-up to EMU. He provides arguments that domestic industries with the smallest shares in the domestic and foreign sectoral consumption could benefit most out of the depreciation. Given the structure of the Polish industry, these are branches characterised with relatively low labour productivity.

At this point, it is important to differentiate between the short-run and long-run consequences of the entry rate choice. In the long-run the choice of nominal entry exchange rate will not be significant. Equilibrium will be achieved via appropriate adjustment in prices and wages. This conjecture is valid only if no changes in the structure of the economy take place. Otherwise, there could be long-term effects as well.

Against this background, we would like to stress once again that the correcting the current exchange rate misalignment does not solve the problem of reaching the equilibrium. This also refers to the issue of hysteresis in exchange rates discussed by Bayoumi *et al.* (1994). The hypothesis states that the current misalignment and the adjustment process impact on the final value of equilibrium exchange rate. So it is important not only to know where we are standing now, but also how to get to the equilibrium.

Figure 4. Peseta-euro exchange rate (daily quotations)

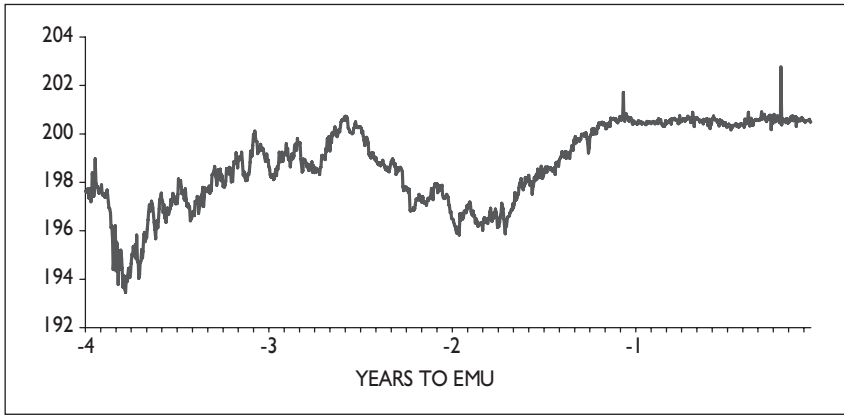


Source: Reluga and Szczurek (2002).

Understanding this problem is very important in the context of joining EMU. Accession countries will have to meet Maastricht criteria, so while devising the path of approaching equilibrium exchange rate other macro objectives than simply correcting the nominal exchange rate misalignment will have to be taken into account (for instance inflation, interest rates, and debt targets). Also the reaction of financial markets should be considered. As Reluga and Szczurek (2002) pointed out, it is possible that the market exchange rate will converge quite rapidly to the announced nominal exchange rate parity if this announcement is fully credible. Such conclusions are based on Ichikawa *et al*. (1990) and Krugman (1988) models of credible exchange rate band. Thus, the credibility of announcement may break the relation between the nominal exchange rate and its

fundamental determinants. The nominal convergence of exchange rates was clearly visible in the case of Club Med countries (i.e. economies that resemble pretty well the Polish economy) prior to their joining to EMU. Figure 4 and Figure 5 depict these phenomena in the case of Spain and Portugal.

Figure 5. Escudo-euro exchange rate (daily quotations)



Source: Reluga and Szczurek (2002).

In order to demonstrate possible policy options of dealing with exchange rate misalignment we will consider the case of the overvalued zloty prior to entering ERM2 (as it could be assessed based on FEER calculations). Polish authorities if convinced about zloty overvaluation may set the ERM2 parity at a depreciated zloty-euro exchange rate. Given the credibility of this announcement, the nominal exchange rate will be converging gradually to this level and thus real exchange rate may also follow suit. However, the degree of the parity depreciation will be crucial for credibility and ensuing price adjustments. The bigger depreciation, the larger potential increase in inflation. Given faster reaction of producer prices to changes in nominal exchange rate than of consumer prices, the competitiveness in the tradable sector would start to erode pretty fast, reversing the positive effect of the initial depreciation. In addition, the possible hike in inflation could spur monetary tightening in order to secure meeting the Maastricht inflation criterion. Interest rates hikes could in addition make it more difficult to fulfil the interest rate criterion. The nominal depreciation of the zloty could also increase significantly costs of foreign debt servicing (denominated in foreign currencies). Such a move is certainly not desirable for Poland. It runs a very high budget deficit (forecast of 5.8% of GDP in 2002 and 5.5% in 2003) that will have to be reduced when it becomes a EU member. Moreover,

the ensuing higher interest rates (on the event of inflation pick-up) would additionally increase the burden of domestic debt servicing. Also the impact on the private sector repayments of loans denominated in foreign currencies should be accounted for. Thus, the scope for setting the too-depreciated parity is limited.

When setting the parity exchange rate it is also important to analyse political economy of this choice. The ERM2 parity and the ultimate fixing rate in EMU must be agreed upon both by the ECB and Polish authorities. On the one hand, the Polish government will have incentives to depreciate nominal exchange rate (based on believes that at least in the short-run it will be beneficial to the Polish economy), and on the other hand the ECB will be insisting on appreciation of the zloty in order to prevent the lost in competitiveness of its present member states (also in the short-run). Given the relative size of the economies, the Polish side will be more interested in this bargain as Poland may potentially gain or loose relatively more then the euro-zone countries.

Finally, the analysis of selecting euro parity should be put into time perspective. All empirical estimations and the quantitative assessments undertaken in this paper referred to 2002 and the recent years. They would be helpful in setting the euro parity in very near future, but Poland's entry to ERM2 is rather not going to happen soon. According to various official statements, 2004-2005 seems to be the earliest possible date. Thus, model-based calculations should be repeated prior to making the biding decision on the euro parity. This, however, does not invalidate all the aforementioned qualitative considerations.

5. Conclusions

Poland, upon entry to ERM2 and then to EMU, will have to choose the exchange rate parity. The nominal zloty-euro exchange rate should be selected based on some concept of equilibrium exchange rate. Two out of three most common approaches to estimating equilibrium exchange (rate fundamental and behavioural equilibrium exchange rates) were pursued for Poland. According to these estimations, the zloty-euro exchange rate in 2002 is not far from the level consistent with the current state of fundamentals (as indicted by BEER) and requires some depreciation to be in line with the equilibrium level of fundamentals (as indicated by FEER). The possible FEERs for 2002 range between 3.88 and 4.08 zlotys per euro depending on the variant and REER definition. Because the zloty exchange rate in 2001 (deemed as too appreciated – based on our BEER estimation and Baude *et al.* (2002) FEER assessment) was used as a reference value, this range could be biased downwards. The results should be treated with caution as they were demonstrated

to be sensitive to the adopted assumptions and model specifications. In addition, they do not take into account the global consistency and equilibrium in dollar-euro exchange rate.

Because the consequences of exchange rate misalignment depend primarily on the degree of this misalignment and due to the intrinsic uncertainty about equilibrium exchange rate estimates, the range of "optimal" exchange rates at which Poland can switch to the euro is quiet wide. In qualitative terms, the lower band of this range could be approximated by the estimated BEER, while the upper by the FEER (given that output growth is below the potential). In addition, the scope for depreciation of the nominal zloty-euro exchange rate is limited by the ensuing costs to the economy, needs to meet Maastricht criteria, and political bargain.

As in Poland the need to set the euro parity is not a close call (the 2004-2005 seems the earliest dates of entering to ERM2), there is time to refine and update empirical research on equilibrium exchange rates. In particular, there is scope for strengthening empirical analyses of the models' underling assumptions. These exercises would not only contribute to more reliable estimates of equilibrium exchange rates for Poland, but also augment the empirical evidence on the functioning of the entire economy, and thus facilitate the conduct of more informed economic policy.

Finally, it must be highlighted that in the long-run, the competitiveness of the Polish economy will be dependent on the micro-efficiency, flexibility of the markets and macroeconomic policies (in particular fiscal and structural), and not on the EMU nominal zloty-euro parity.

References

Baffes, J., I.A. Elbadawi, and S.A. O'Connell (1997), *Single-Equation Estimation of the Equilibrium Real Exchange Rate*, World Bank Country Economics Department Paper, No.1800

Baude, J., V. Coudert, and C. Couharde (2002), *Exchange Rate Regimes and sustainable Parities for CEECs in the Prospect of joining the EMU*, paper prepared for the international conference Towards Regional Currency Area, 26-27 March

Bayoumi, T., P. Clark, S. Symansky, and M. Taylor (1994), *The Robustness of Equilibrium Exchange Rate Calculations to Alternative Assumptions and Methodologies*, in Williamson, J. (ed.) (1994), pp. 19-59

Buiter, W.H. (1999), *Optimal Currency Areas: Why Does the Exchange Rate Regime Matter? With an Application to UK membership in EMU*, Sixth Royal Bank of Scotland/Scottish Economic Society Annual Lecture, November

Canzoneri, M.B, R.E. Cumby, and B. Diba (1996), *Relative Productivity and the Real Exchange Rate in the Long Run: Evidence for a Panel of OECD Countries*, CEPR Discussion Papers, No. 1464

Chinn, M. (1996), *Sectoral Productivity, Government Spending and Real Exchange Rates: Empirical Evidence for OECD Countries*, in MacDonald and Stein (eds) (1999)

Chinn, M. and L. Johnston (1996), *Real Exchange Rate Level, Productivity and demand Shocks: Evidence from a Panel of 14 Countries*, NBER Discussion Paper, No. 5709

Chinn, M.D. and E.S. Prasad (2000), *Medium-Term Determinants of Current Accounts in Industrial and Developing Countries: An Empirical Exploration*, IMF Working Paper, No. WP/00/46

Clark, P.B. and R. MacDonald (1998), *Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs*, IMF Working Paper, WP/98/67

Collins, S.M. and O. Razin (1997), *Real Exchange Rate Misalignments and Growth*, NBER Discussion Paper, No. 6174, September

De Masi, P.R. (1997), *IMF Estimates of Potential Output: Theory and Practice*, IMF Working Paper, WP/97/177, December

Doisy, N. and K. Herve (2001), *The Medium and Long Dynamics of the Current Account Positions in the Central and Eastern European Countries: What are the Implications for their Accession to the European Union and the Euro Area?*, preliminary version

Elbadawi, I.A. (1994), *Estimating Long-Run Equilibrium Real Exchange Rates*, in Williamson, J. (ed.) (1994), pp. 93-131

Faruqee, H. (1995), *Long-Run Determinants of the Real Exchange Rate: A stock-Flow Perspective*, IMF Staff Papers, Vol. 42, March, pp. 80-107

Faruqee, H. (2002), *Empirical Analysis of Exchange Rates*, IMF Research Bulletin, Vol. 3, No. 2, June

Hooper, P., K. Johnson, and J. Marquez (1998), *Trade Elasticities for G-7 Countries*, International

Finance Discussion Papers, No. 609, Board of Governors of the Federal Reserve System, April

Ichikawa, M., M. Miller, and A. Sutherland (1990), *Entering a Preannounced Currency Band*, Economics Letters, Vol. 34, p. 363-368

IMF (1998), *World Economic Outlook, Ch. III - The Business Cycle, International Linkages, and Exchange Rates*, May, pp. 55-73

Isard, P. and H. Faruqee (eds) (1998), *Exchange Rate Assessment. Extensions of the Macroeconomic Balance Approach*, IMF Occasional Paper, No. 167, December

Isard, P., H. Faruqee, G.R. Kincaid, and M. Fetherston (2001), *Methodology for Current Account and Exchange Rate Assessments*, IMF Occasional Paper, No. 209, December

Kowalski, P. (2002), *Polish accession to the EMU: do levels of the central parity and the ultimate conversion rate matter?*, paper presented at the ING - Bank conference, March

Krugman, P. (1988), *Target Zones and Exchange Rate Dynamics*, The Quarterly Journal of Economics

MacDonald, R. (1997), *What Determines Real Exchange Rates? The Long and Short of It*, IMF Working Paper, No. WP/97/21, January

MacDonald, R. (1998), *What Do We Really Know About Real Exchange Rates?*, Oesterreichische Nationalbank Working Paper, No. 28

MacDonald, R. (2000), *Concepts to Calculate Equilibrium Exchange Rates: An Overview*, Economic Research Group of the Deutsche Bundesbank Discussion Paper, No. 3/00, July

MacDonald, R. (2001), *Modelling the Long-run Real Effective Exchange Rate of the New Zealand Dollar*, Discussion Paper, DP2002/02, October

Maeso-Fernandez, F., C. Osbat, and B. Schnatz (2001), *Determinants of the Euro Real Effective Exchange Rate: A BEER/FEER Approach*, ECB Working Paper, No. 85, November

Montiel, P. (1997), *The Theory of the Long-Run Equilibrium Real Exchange Rate*, Mimeo, World Bank

Reluga, M. and M. Szczurek (2001), *Financial Markets and the Process of /PLN Parity Setting*, paper presented at the ING - Bank conference, March

Williamson, J. (1985), *The Exchange Rate System*, Policy Analyses in International Economics, Vol. 5, Institute for International Economics, Washington

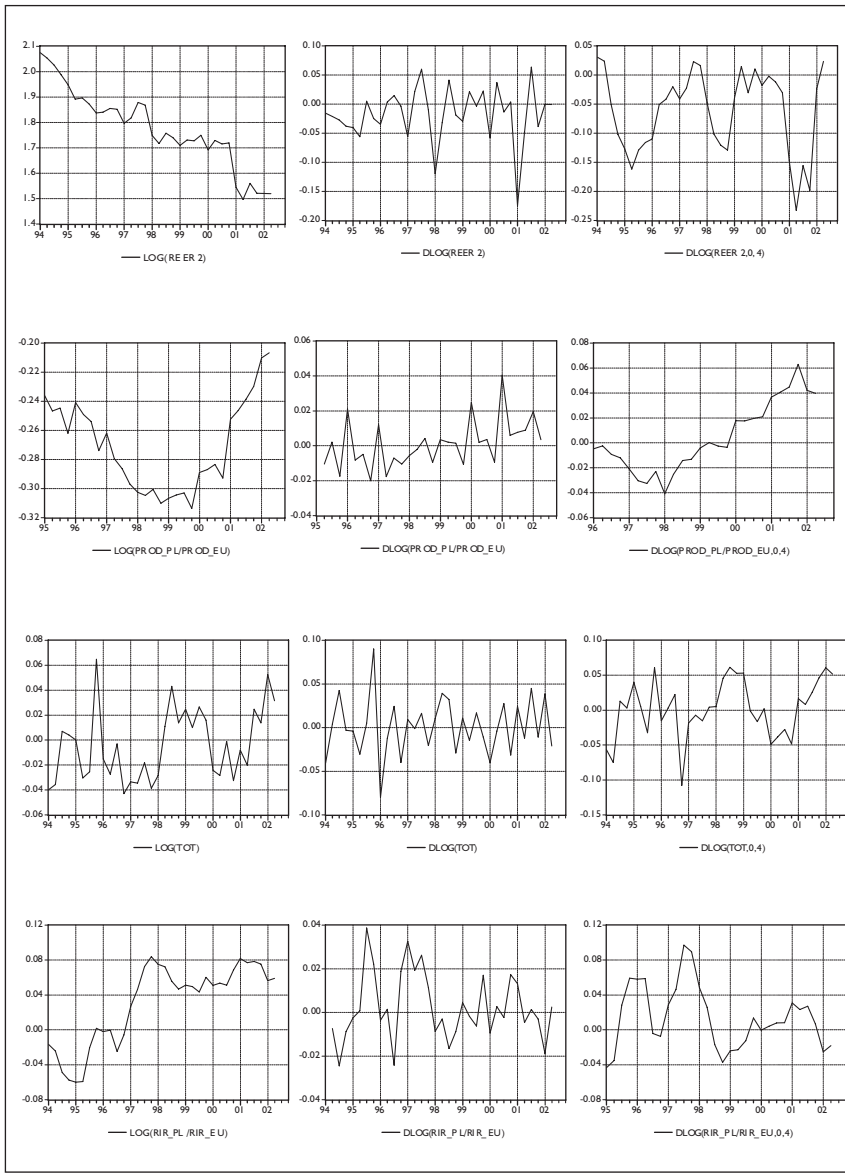
Williamson, J. (ed.) (1994), *Estimating Equilibrium Exchange Rates*, Institute for International Economics, Washington

Williamson, J. (1994b), *Estimates of FEERs*, in Williamson, J. (ed.) (1994), pp. 177-243

Wren-Lewis, S. (1992), *On the Analytical Foundations of the Fundamental Equilibrium Exchange Rate*, in C.P. Hargreaves (ed.), Macroeconomic Modelling of the Long Run, E. Elgar

Statistical Appendix

1. Visual inspection of the BEER model's variables (as in equation (3))



2. Unit root tests for variables of the BEER model – equation (3)

LL = Maximized log-likelihood; AIC = Akaike Information Criterion;
SBC = Schwarz Bayesian Criterion; HQC = Hannan-Quinn Criterio

Unit root tests for variable LREER2
The Dickey-Fuller regressions include an intercept but not a trend
37 observations used in the estimation of all ADF regressions.
Sample period from 1993Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF.	**-.52910**	62.4429	60.4429	58.8320	59.8750
ADF(1)	**-.51813**	62.4436	59.4436	57.0272	58.5917
ADF(2)	-.060887	64.7742	60.7742	57.5524	59.6384
ADF(3)	.020888	64.9297	59.9297	55.9024	58.5099
ADF(4)	-.14193	65.0734	59.0734	54.2407	57.3697

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9422**

Unit root tests for variable LREER2
The Dickey-Fuller regressions include an intercept and a linear trend
37 observations used in the estimation of all ADF regressions.
Sample period from 1993Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	**-3.1235**	67.0129	64.0129	61.5965	63.1610
ADF(1)	**-3.5421**	68.3114	64.3114	61.0896	63.1756
ADF(2)	-2.6399	68.5671	63.5671	59.5398	62.1473
ADF(3)	-2.6093	68.7720	62.7720	57.9393	61.0682
ADF(4)	-3.4128	71.2443	64.2443	58.6061	62.2566

95% critical value for the augmented Dickey-Fuller statistic
= **-3.5348**

Unit root tests for variable DLREER2

The Dickey-Fuller regressions include an intercept but not a trend
36 observations used in the estimation of all ADF regressions.
Sample period from 1993Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-5.8932	60.1212	58.1212	56.5377	57.5685
ADF(1)	**-5.9031**	62.5285	59.5285	57.1532	58.6994
ADF(2)	**-4.4482**	62.6830	58.6830	55.5160	57.5777
ADF(3)	-3.0701	62.8255	57.8255	53.8667	56.4438
ADF(4)	-2.9561	63.0558	57.0558	52.3053	55.3978

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9446**

Unit root tests for variable DLREER2

The Dickey-Fuller regressions include an intercept and a linear trend
36 observations used in the estimation of all ADF regressions.
Sample period from 1993Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-5.8231	60.1769	57.1769	54.8016	56.3479
ADF(1)	**-5.8608**	62.6847	58.6847	55.5176	57.5793
ADF(2)	-4.4382	62.8738	57.8738	53.9151	56.4921
ADF(3)	-3.0648	62.9681	56.9681	52.2175	55.3100
ADF(4)	-2.9775	63.2837	56.2837	50.7414	54.3493

95% critical value for the augmented Dickey-Fuller statistic
= **-3.5386**

Unit root tests for variable LPROD

The Dickey-Fuller regressions include an intercept but not a trend
25 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-.17718	73.0242	71.0242	69.8053	70.6861
ADF(1)	.027181	73.1120	70.1120	68.2837	69.6049
ADF(2	-.48524	74.3612	70.3612	67.9235	69.6851
ADF(3)	-.61527	74.5543	69.5543	66.5071	68.7091
ADF(4)	**-2.2717**	86.3416	80.3416	76.6850	79.3275

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9850**

Unit root tests for variable LPROD

The Dickey-Fuller regressions include an intercept and a linear trend
25 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-.88747	78.0598	75.0598	73.2315	74.5527
ADF(1	-.017658	80.2240	76.2240	73.7863	75.5479
ADF(2	.22891	80.4487	75.4487	72.4015	74.6035
ADF(3)	1.0068	82.2822	76.2822	72.6255	75.2680
ADF(4)	**-.86862**	87.3665	80.3665	76.1004	79.1833

95% critical value for the augmented Dickey-Fuller statistic
= **-3.6027**

Unit root tests for variable DLPROD

The Dickey-Fuller regressions include an intercept but not a trend
24 observations used in the estimation of all ADF regressions.
Sample period from 1996Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-4.9868	69.8988	67.8988	66.7207	67.5862
ADF(1)	-2.4456	70.8152	67.8152	66.0482	67.3464
ADF(2)	-1.8391	70.8960	66.8960	64.5399	66.2709
ADF(3)	**-.25962**	79.5221	74.5221	71.5770	73.7408
ADF(4)	-.30999	79.5591	73.5591	70.0250	72.6215

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9907**

Unit root tests for variable DLPROD

The Dickey-Fuller regressions include an intercept and a linear trend
24 observations used in the estimation of all ADF regressions.
Sample period from 1996Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-8.2026	78.0654	75.0654	73.2983	74.5966
ADF(1)	-5.2923	78.4033	74.4033	72.0471	73.7782
ADF(2)	-5.4443	80.4717	75.4717	72.5266	74.6904
ADF(3)	**-2.9095**	84.9396	78.9396	75.4055	78.0020
ADF(4)	-2.8761	85.0781	78.0781	73.9549	76.9842

95% critical value for the augmented Dickey-Fuller statistic
= **-3.6119**

Phillips-Perron Unit Root test for dlog(PROD_PL/PROD_EU)

PP Test Statistic -6.023337	1% Critical Value*	-3.6852
	5% Critical Value	-2.9705
	10% Critical Value	-2.6242

*MacKinnon critical values for rejection of hypothesis of a unit root.

Lag truncation for Bartlett kernel: 4 (Newey-West suggests: 3)

Residual variance with no correction 0.000174

Residual variance with correction 0.000302

Unit root tests for variable LTOT

The Dickey-Fuller regressions include an intercept but not a trend

33 observations used in the estimation of all ADF regressions.

Sample period from 1994Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	**-3.7783**	73.6542	71.6542	70.1577	71.1507
ADF(1)	-2.8471	73.6562	70.6562	68.4115	69.9009
ADF(2)	-2.1116	73.7873	69.7873	66.7943	68.7802
ADF(3)	-2.0947	73.9769	68.9769	65.2356	67.7181
ADF(4)	-2.0933	74.1489	68.1489	63.6593	66.6383

95% critical value for the augmented Dickey-Fuller statistic = **-2.9528**

Unit root tests for variable LTOT

The Dickey-Fuller regressions include an intercept and a linear trend

33 observations used in the estimation of all ADF regressions.

Sample period from 1994Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	**-4.0037**	74.4678	71.4678	69.2231	70.7125
ADF(1)	-3.1034	74.4715	70.4715	67.4784	69.4644
ADF(2)	-2.3775	74.5463	69.5463	65.8050	68.2875
ADF(3	-2.3222	74.7172	68.7172	64.2277	67.2066
ADF(4)	-2.3025	74.8973	67.8973	62.6595	66.1349

95% critical value for the augmented Dickey-Fuller statistic = **-3.5514**

Unit root tests for variable LRIR

The Dickey-Fuller regressions include an intercept but not a trend
29 observations used in the estimation of all ADF regressions.
Sample period from 1995Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	**-2.6672**	84.1298	82.1298	80.7625	81.7016
ADF(1)	-2.6483	85.3697	82.3697	80.3188	81.7274
ADF(2)	-2.5347	85.3802	81.3802	78.6456	80.5237
ADF(3)	-2.3228	85.4317	80.4317	77.0135	79.3612
ADF(4)	**-1.9840**	89.0392	83.0392	78.9373	81.7546

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9665**

Unit root tests for variable LRIR

The Dickey-Fuller regressions include an intercept and a linear trend
29 observations used in the estimation of all ADF regressions.
Sample period from 1995Q2 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-1.8714	84.1881	81.1881	79.1371	80.5457
ADF(1)	**-2.4135**	86.0000	82.0000	79.2654	81.1435
ADF(2)	-2.2786	86.0439	81.0439	77.6257	79.9734
ADF(3)	-2.0415	86.0513	80.0513	75.9494	78.7667
ADF(4)	**-1.0219**	89.0503	82.0503	77.2648	80.5515

95% critical value for the augmented Dickey-Fuller statistic
= **-3.5731**

Unit root tests for variable DLRIR

The Dickey-Fuller regressions include an intercept but not a trend
28 observations used in the estimation of all ADF regressions.
Sample period from 1995Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	**-3.8447**	78.5976	76.5976	75.2654	76.1903
ADF(1)	-3.3147	78.7627	75.7627	73.7644	75.1518
ADF(2)	-3.2857	79.2912	75.2912	72.6268	74.4766
ADF(3)	**-4.6658**	83.5100	78.5100	75.1795	77.4918
ADF(4)	-2.8640	83.8735	77.8735	73.8769	76.6517

95% critical value for the augmented Dickey-Fuller statistic
= **-2.9706**

Unit root tests for variable DLRIR

The Dickey-Fuller regressions include an intercept and a linear trend
28 observations used in the estimation of all ADF regressions.
Sample period from 1995Q3 to 2002Q2

Test	Statistic	LL	AIC	SBC	HQC
DF	-4.2250	79.8436	76.8436	74.8453	76.2327
ADF(1)	-3.7640	80.1952	76.1952	73.5308	75.3807
ADF(2)	-3.8147	81.0268	76.0268	72.6963	75.0086
ADF(3)	**-5.4225**	86.1175	80.1175	76.1209	78.8957
ADF(4)	-3.5343	86.2880	79.2880	74.6253	77.8626

95% critical value for the augmented Dickey-Fuller statistic
= **-3.5796**

3. Cointegration test for model (3)

Sample: 1992:1 2002:4
Included observations: 27
Test assumption: Linear deterministic trend in the data
Series: LOG(REER2) LOG(PROD_PL/PROD_EU) LOG(TOT) LOG(RIR_PL/RIR_EU)
Exogenous series: DUM0101
Warning: Critical values were derived assuming no exogenous series
Lags interval: 1 to 2

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.653370	51.82194	47.21	54.46	None *
0.424845	23.21551	29.68	35.65	At most 1
0.261943	8.281376	15.41	20.04	At most 2
0.002979	0.080557	3.76	6.65	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

LOG(REER2)	LOG(PROD_PL/PROD_EU)	LOG(TOT)	LOG(RIR_PL/RIR_EU)
6.268756	8.288201	6.441802	13.92151
1.374462	-1.088619	-11.31202	-2.812556
-0.676500	6.405995	-3.760919	5.359432
0.903637	8.362007	5.745279	0.929307

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

LOG(REER2)	LOG(PROD_PL/PROD_EU)	LOG(TOT)	LOG(RIR_PL/RIR_EU)	C
1.000000	1.322145	1.027605	2.220777	-1.471078
	(0.23782)	(0.31186)	(0.20328)	

Log likelihood 313.5738

4. Residuals of the VAR(2) system for model (3)