'Fiscal Deficits and Exchange Rate Misalignment in Poland: An Econometric Analysis 1996-2004'[1]

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Abstract
A serious problem in the research of the CEECs' currencies may arise from the linking of estimates of the real equilibrium exchange rate with the Balassa-Samuelson model. The doubts follow from the assumption on the stationarity of the RER defined for tradables' prices. On the other hand, effects of the risk premium have not become a subject of a broader research. In the paper, the analysis of the relationship between the exchange rate and the risk premium covers the Polish zloty/euro exchange and substantiates the thesis that the risk can be a significant variable affecting real exchange rates in CEECs.

Keywords: exchange rate misalignment, risk premium, cointegration analysis

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1. Introduction

The turning point in the research on exchange rates of the CEECs' currencies is the work by Halpern and Wyplosz (1997), presenting results of empirical investigations into relationships between the countries' exchange rates and structural changes in their economies. The interest in the influence exerted by mechanisms described by the Balassa-Samuelson model (hereinafter BS) on inflation in the transition countries and consequently on the evolution of the real exchange rates has resulted in numerous studies predominantly concentrated on the empirical verification, whether the BS effect was present and on the identification of its scale (see Égert (2003) for review of he literature and references). However, conclusions derived from the existing research are far from being unambiguous, as verification of the relationship between the ratio of the domestic to foreign relative price of non-tradables (relative productivities) and appreciation of the CEECs' currencies turns out to be sensitive to extensions of the real exchange rate (RER) models aimed to include demand variables. Of equal importance is how the sectors of tradables and non-tradables is defined, and particularly how the analysis accounts for the distribution sector (see MacDonald and Ricci (2001), MacDonald and Wójcik (2002)).

The interest in the analysis of the BS effect in the transition countries is not surprising. Because of the EU enlargement in May 2004, the sustainable fulfilment of five nominal convergence criteria laid down in the Maastricht Treaty has become the key problem faced by the economic policy in EU-10. One criterion is inflation rate and therefore it is crucial to identify to what degree the supply-side factors affect the CEECs' inflation path. Regarding EU-10 countries that are still outside ERM2, it is also necessary to make a detailed analysis of the local currency/euro exchange rates that in research involving CEECs typically concentrates on the estimates of the real equilibrium exchange rates (REER hereafter).

The REER estimation methods are well known, but their empirical application faces serious problems, typically arising from the unavailability of adequately detailed and comparable data. An equally important problem, and definitely underestimated in our opinion, is the somewhat automatic linking of estimates of the equilibrium exchange rates in the CEECs' with the BS effect modelling. Critical comments against this approach can be raised on many levels, but two seem essential. Firstly, the BS model is in fact a model of prices and its application to the exchange rate analyses can be reduced to correcting the real exchange rate (RER) estimates based on overall price indexes. Secondly, extending the analysis of the exchange rate determinants to include the supply-side factors is equivalent to taking many

restrictive assumptions, among which at least one is not fulfilled in terms of the zloty/euro exchange rate (hereafter PLN/euro) analysis: the purchasing power parity hypothesis is not met at the level of tradables' prices.

It would be a cliché to say that proper determination of the central parity exchange rate is a prerequisite to economic policy optimization in ERM2. Our opinion on the estimates of the PLN/euro equilibrium exchange rate is, however, somewhat ambivalent. Indeed, the central exchange rate set at a level close to the equilibrium exchange rate minimises the risk of speculative attacks and makes it easier to pursue a policy-mix preventing the emergence of stronger tensions in the foreign exchange market and the balance of payments. But a reasoning can be proposed, which leads to a thesis that even the most accurate REER estimates are not sufficient to ensure effective economic policy in ERM2: since April 2000 the PLN exchange rate has been determined by the market mechanisms only and today the most probable scenario should assume continuation of the floating exchange rate until ERM2 is joined and the central parity exchange rate set at a level close to the market rate. Taking this point of view significantly enhances the thesis that identification of variables responsible for the short-term and medium-term fluctuations of the PLN/euro exchange rate and quantification of parameters measuring the fluctuations' impacts on the rate are the key element of economic policy prior to ERM2. It is the only case when the policy-mix can help stabilize the exchange rate determinants on paths possibly close to their long-term trajectories.

There are several hypotheses explaining possible non-stationarity of the real exchange rate defined for the tradables' prices in European transition countries. The natural appreciation hypothesis assumes that the PPI-based exchange rate can be appreciated, because of significant undervaluation of CEECs' currencies in the beginning of the transition period (Halpern and Wyplosz (1997), Krajnyák and Zettelmeyer (1998)). Égert and Lommatsch (2003) formulate a hypothesis that appreciation can have its roots in tradables prices' growth caused by the improving quality of domestic goods and the consumers' preferences refocused on the domestic goods. The basic drawback of both models is that they accentuate the importance of adjustment processes observed in the early transition period that are empirically undistinguishable, at least in the Polish case, from the effects of economic policy that used the exchange rate as its anti-inflationary anchor. In addition, the variability of the PPI-based PLN/euro exchange rate indicates that from 1995 the causes of the rate's non-stationarity should not be analysed using models predicting systematic appreciation of the zloty, but applying systems that enable to identify the sources of the strong appreciation in years 2001-

2002 only. The natural and simplest solution examines the RER/risk relationships and generalizes the research to uncovered interest rates parity with varying risk premium.

Effects of the exchange rate risk on the deviations of the CEECs' currencies from their long-term paths are a problem that has not become yet a subject of a broader empirical research. In the paper, the econometric analysis of the relationship between the exchange rate and fluctuations in the risk premium covers the Polish zloty/euro exchange rate in a period ranging from January 1996 to December 2004. Its results substantiate the hypothesis that the risk premium can be a significant variable that affects variability of the zloty exchange rate, especially after a floating exchange rate system was introduced in Poland in April 2000. From this angle, it seems quite important to note that according to the estimates the fiscal policy factors contribute to changes in the level of the equilibrium exchange rate the most strongly. This conclusion directly corresponds to the position of the EU agencies that the shape of the pursued fiscal policy is crucial to the exchange rate stability within ERM2.

The structure of the paper is following. A brief description of the basic equilibrium exchange rates models is presented in section 1. Section 2 focuses on the evolution of the exchange rate system in Poland during transition period and reports the preliminary results for PPP and UIP models. Risk-premium proxies' and fundamental variables' selection are discussed in Section 3. The model specification, the assumptions made, estimation results of the final model as well as outcomes of selected multiplier experiments are reported in section 4. The last section provides the conclusions.

2. Theoretical framework

A theoretical framework allowing to analyse the deviation of the Polish zloty exchange rate from the equilibrium is well recognized, as in the recent years exchange rates modelling and its equilibrium level estimation methods have drawn plenty of attention and they are expanding dynamically (see Williamson (ed.) (1994), MacDonald and Stein (eds) (1999), MacDonald (2000), recently: Égert (2003) and Maeso-Fernadez et al. (2004)). In the most general case, three general types of models used to analyse the exchange rates can be represented by purchasing power parity (PPP), the behavioural equilibrium exchange rate (BEER) and fundamental equilibrium exchange rate (FEER) models[4]. A brief overview of

[4] The listed models make up only a segment of the set of solutions used in analyses of the causes of the exchange rates' variability and in estimations of the equilibrium exchange rates. The list of omitted approaches is long and it includes, among others, Stein's (1999) NATREX approach, capital enhanced equilibrium exchange rates (CHEER, Juselius (1995)) and several variants of the monetary model of exchange rate. This section did not aspire, though, to review all possible empirical approaches, but to highlight these properties of the selected

these approaches makes a good start for the econometric analysis of the PLN/euro exchange rate.

2.1 PPP and BEERs

Conceptually, this is the simplest solution, although producing outcomes provoking the most doubts about their reliability, that takes advantage of the purchasing power parity[5]:

$$e - p' + p'^{*} = q' = 0, \qquad (1)$$

where: e - nominal exchange rate defined as a foreign exchange unit price in the domestic currency, p', p'^{*} - indices of domestic and foreign prices. Equation (1) defines the long-term equilibrium conditions in the tradables market and is central to most detailed discussions of adjustment processes in the shorter time horizons. Nevertheless, limiting the analysis of the PLN/euro exchange rate to the PPP model would be too principled and the reasons for criticism are commonly known (see reviews: Officer (1976), Froot and Rogoff (1995) and recently Sarno and Taylor (2002)).

Serious reservations arise due to the very concept of generalising the law of one price on aggregated price indices and assuming arbitrage effectiveness in the tradables market. Using the PPP model as the basis for analysis is equivalent to making a series of usually overly restrictive assumptions: the homogeneity of tradables, international tradability of all goods used to define the aggregated price indices, insignificant influence of the transportation costs and information gathering and processing costs, inexistence of customs barriers and protectionism. Ignored are equally important problems of market monopolisation, pricing-to-market hypothesis and the significance of the short-term nominal rigidities that decelerate price adjustments.

Another challenge faced in research exploring a relatively short period is effects of the supply-side factors on the exchange rate frequently explained in terms of the Balassa-Samuelson effect.

It is not very difficult to extend the analysis to include the BS effect, when the exchange rate equation is being specified: the general level of domestic and foreign prices is defined as a weighted average of tradables and non-tradables prices. Then the relation between the real exchange rate determined using tradables and non-tradables deflators is following:

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models that typify groups of approaches that can be viewed as particularly important for modelling the zloty exchange rate after 1996.

[5] Lower case letters stand for logarithms in the paper.

$$q'_t = q_t - (1-\tau_t)(p_t^N - p_t) + (1-\tau_t^*)(p_t^{N*} - p_t^*) \quad (2)$$

where: q', q - real exchange rate deflated by tradables prices(e.g. deflator of production in the manufacturing industry) and overall price index (e.g. CPI or GDP deflator), respectively, p, p^* - indices of tradables prices at home and abroad, p^N, p^{N*} - indices of non-tradables prices, τ, τ^* - share of tradables in the overall price index at home and abroad.

An alternative approach derives the relationship from two-factor Cobb-Douglas production function with constant returns to scale:

$$q'_t = q_t - (1-\tau_t)(a_t - a_t^N) + (1-\tau_t^*)(a_t^* - a_t^{N*}) + c_t, \quad (3)$$

where a, a^N, a^*, a^{N*} - natural logarithms of TFP in the tradables and non-tradables sectors at home and abroad, c - residual variable resulting from shares τ and τ^* and from parameters of the production function for sectors of tradables ($Y = AK^{\beta}L^{1-\beta}$) and non-tradables ($Y = AK^{\gamma}L^{1-\gamma}$) at home and abroad.

A review of results of the empirical research reveals that the prerequisite to accepting the PPP hypothesis is a very long sample span (e.g. Edison (1987), Diebold et al. (1991), Lothian and Taylor (1996)) or application of large panel data (e.g. Abauf and Jorion (1990), Taylor (2000)). The basic property of real exchange rates that result from the approaches is, however, a very slow mean-reverting process, which implies that the PPP model is unable to explain longer periods of the nominal exchange rate's deviations from the trajectory determined by the PPP.

A widely recommended solution to the above problem assumes that the analysis of exchange rates is typically medium-term and stretches the more detailed analysis over the capital account of the balance of payments (e.g. Juselius (1995), Clark and MacDonald (1999), MacDonald (2000)). By taking this angle it becomes possible to consider interdependencies between the real exchange rate and sustainable in the medium term imbalance of the capital account. The presence of the latter can be justified under the twin-deficit model that attributes external sector's imbalance to the fiscal sector's deficit**,** or under the internal-external balance approach that emphasises the relationship between the balance of payments and unbalanced domestic savings and investments.

The concept of BEERs can be illustrated by decomposing processes affecting the equilibrium exchange rate into long-, medium-, and short-term (LT, MT, ST, respectively):

$$\overline{q}'_t = \eta_1 LT_t + \eta_2 MT_t + \eta_3 ST_t + \varepsilon_t, \quad (4)$$

By taking the stationarity assumption of ST and disturbances ε:

$$(\eta_3 ST_t + \varepsilon_t) \sim I(0), \tag{5}$$

it becomes possible to formulate and test hypotheses about the equilibrium exchange rate in the long and medium term within a set of nested hypotheses:

$$H_0 : (q'_t - \eta_1 LT_t) \sim I(0) \text{ and } \eta_2 = 0, \tag{6}$$

$$H_1 : (q'_t - \eta_1 LT_t - \eta_2 MT_t) \sim I(0). \tag{7}$$

Therefore, the key to empirical application of the stochastic model of the real equilibrium exchange rate is making up a list of variables that affect the exchange rate in both time horizons. One of the possible starting points is the uncovered interest rates parity (UIP):

$$q'_t = E(q'_t) - (r_t - r_t^*) + \lambda_t, \tag{8}$$

where r and r^* denote the domestic and foreign real interest rates, respectively, λ - the risk premium, and the operator E marks expectations. Under relatively unrestrictive assumption stating that the expectations are formulated using information on the current characteristics of the balance of payment, the list of fundamental variables can be compiled within the stock-flow consistent approach (see Frenkel and Mussa (1986), also MacDonald (2000)):

$$q_t = -\delta_1 NFA_t - \delta_2 TOT_t - \delta_3 BS_t - \delta_4 (r_t - r_t^*) + \lambda_t + \varepsilon_t, \tag{9}$$

where NFA is relative net foreign assets, TOT - relative terms of trade and BS approximates the Balassa-Samuelson effect.

An alternative form of function (9) can be derived assuming that adjustment processes in the foreign exchange market adjust the exchange rate expectations to the equilibrium exchange rate (see Chortareas and Driver (2001)):

$$q'^e_{t+1} - E(\overline{q}'_{t+1}) = \gamma (q'_t - \overline{q}'_t), \tag{10}$$

where parameter γ measures the speed of adjustments, $0 < \gamma < 1$. If another possible assumption is that the expected real exchange rate remains in a constant relation to the path defined by the PPP hypothesis in its relative version, $E(\overline{q}'_{t+1}) = \overline{q}' = \delta_0$, the current level of the exchange rate is described by the equation:

$$q'_t = \delta_0 - \delta_1 (r_t - r_t^*) + \lambda_t + \varepsilon_t, \tag{11}$$

where $\delta_1 = (1-\gamma)^{-1} > 1$.

2.2 Supply- and demand-side effects

The application of BEERs is attractive, because their methodology for seeking an empirical model matches David Hendry's from-general-to-specific strategy. In the

specification phase, factors affecting the real exchange rate in the medium-term are decomposed into four homogenous groups: the exchange rate expectations, supply- and demand-side factors as well as the risk premium. The BEER models are also open in the sense that the way of including the fundamental variables is not decided *a priori* and requires in-depth investigations into the properties of the modelled system. Nevertheless, openness of the BEERs it may also result in constructing a system whose final structure will be overly dependent on indistinct criteria for selecting explanatory variables. This comment touches upon a broader problem that is the eclecticism of solutions found in modelling relationships linking the supply and the demand factors with appreciating trends of the real exchange rates in CEE countries. Therefore, two points are important in the discussion: approximations of the Balassa-Samuelson effect and the influence of the demand-side mechanisms.

Controversies in the estimation of the BS effect scale result from the unavailability of sufficiently detailed data and the impossibility of dividing an economy into clear-cut sectors manufacturing tradables and non-tradables. Equally important are problems with separating the BS effect from mechanisms described by the twin Baumol-Bowen model and the influence of the distribution sector. Accounting for the Baumol-Bowen effect is important, because even if the BS effect does not exist the conclusion about appreciation of the CPI-based real exchange rate may exclusively result from different shares of services in the basket of consumer goods. In that case, a positive verification of the PPP hypothesis is only possible, when an additional assumption about converging consumer preferences is met (see Froot and Rogoff (1995)). Exchange rate appreciation can also be observed, when roles played by the distribution sector at home and abroad show significant differences. In particular, higher productivity of labour in the domestic distribution sector can be accompanied by appreciation of the domestic currency if the volume of intermediate goods supplied to the tradables sector is larger than the volume of final goods addressed to households (more in: MacDonald and Ricci (2001)).

Other doubts arising from the empirical application of BEER models capturing relationships between the CPI-based exchange rate and the supply-side factors are due to the fact that assumptions about prices being formed exclusively by the market mechanisms (made in the PPP and BS models) are usually unmet, when exchange rates for the CEE currencies are being modelled. As a result the Balassa-Samuelson effect can lose its significance once the CPIs variability is „purified" of fluctuations produced by changes in the administered prices (for example MacDonald and Wójcik (2002)).

Regardless of the above reservations about the Balassa-Samuelson effect, the criticism against BEER models' eclecticism should predominantly focus on their extensions aimed at including variables representing the demand-side effects. The very list of variables that can be found in empirical applications (review in Égert (2003)), such as relative shares of total consumption, personal consumption, government spending, investments, FDI and the foreign debt in GDP, but also relative measures of an economy's openness, the velocity of money and various monetary aggregates at home and abroad, reveals quite advanced arbitrariness in explaining fluctuations of the real exchange rates.

The critical attitude to the BEER methodology eclecticism has its roots in the fact that adding variables representing all possible causes of deviations from the PPP-aligned path to the real exchange rate models produces systems with an excessive number of parameters. Of course, this approach fits in the FGTS modelling strategy. It can be argued therefore that running a sequence of statistical tests would allow to find simplification of the initial model equivalent with respect to observations and thus to identify the most important causes of the medium- and short-term misalignment of the exchange rate. It is pointless to oppose this conclusion, when the BEER model specification problems are considered conceptually. Such a position must be changed, however, when the FGTS strategy is applied to a case, where the available time series are relatively short and the definitions and estimates of the explanatory variables are doubtful. The final question of the reasoning must concern the conclusiveness of the results. In particular, it is probable that estimates of the scale of the BS effect can be biased by the effect's exposure to the BB effect, by the administered prices in the consumer basket or by the PPP hypothesis unmet at the level of tradables prices, but also because of introducing arbitrarily selected demand-side factors into the model. This argumentation can be reversed: because of the scarcity of information offered by the sample, which makes it impossible to view parameter estimates in "overparameterized" models as objectified on the grounds of the frequentist definition of probability, a „stable" relationship between the real exchange rate and variables representing the demand-side fluctuations can be a consequence of the arbitrary breakdown of an economy into sectors producing tradables and non-tradables.

2.3 FEERs

Regarding the fundamental equilibrium exchange rate model (see Williamson (1994)) built upon the internal-external balance approach, the analysis starts with the assumption about a possible medium-term differences between domestic savings and investments,

reflected in the deficit on the current account of the balance of payments and in deviations of the real exchange rate from the equilibrium path. Estimates of the equilibrium exchange rate are calculated using structural econometric models, under the assumption that conditions for both internal equilibrium (defined as the level of production at NAIRU level) and external equilibrium (interpreted as a path of the current account ensuring stabilisation of the foreign debt at an exogenously determined level) are met (more in: Wren-Lewis (1992), MacDonald (2000)).

In the criticism directed against the FEER models, the arbitrary character of the equilibrium exchange rate estimates is mainly raised. However, the most important shortcoming of the FEER methodology is the impossibility to identify why the exchange rate is varying over a shorter time horizons and how the equilibrium is restored.

In the empirical investigation into the PLN/euro exchange rate, the BEER methodology was ultimately employed. Two additional arguments speak for this approach. Firstly, BEER models are derived from the uncovered interest rate parity hypothesis, which formally allows to classify them as single-equation causal models. This is of significance for investigations based on short time series, when a full system estimation of larger structural models turns out unfeasible, or its results are unstable. Secondly, small sizes of the BEER models enable econometric analysis based on the cointegrating procedures, which is a standard approach today.

3. Zloty/euro exchange rate 1996-2004: preliminaries

Since 1990, when the Balcerowicz stabilisation scheme was launched, the currency system in Poland has made a full circle, evolving from a fixed to floating exchange rate. In the first phase of economic transition covering the period 1990:01–1991:05, a fixed exchange rate system was in force. Until May 1991, the zloty exchange rate was fixed at a level of 0.95 PLN per US dollar, and then, after a leaping devaluation of the zloty, a fixed exchange rate vis-à-vis a basket of currencies comprising US dollar plus other major European currencies was approved. In October 1991, the fixed exchange rate was replaced with a crawling peg system, with depreciation rates of the nominal exchange rate announced publicly on a monthly basis.

In that period the basic determinants of the exchange rate policy were: an initially very high but gradually declining rate of inflation (from almost 600% in 1990 to ca 33% in the first half of 1995), results of the foreign trade and then fluctuations of the monetary base caused by

the flows of foreign capital. Adjustments in the nominal exchange rate were reduced to three leaping devaluations of the zloty (by 14.4% in May 1991, 12.0% in February 1992 and 8.1% in August 1993) conducted in periods of growing trade deficit and shrinking reserves of foreign currencies, quite small at that time. The situation changed in 1994, when a considerable increase in the foreign currency reserves was noted for the first time. However desired because of the need to service foreign debt, the latter increased the liquidity of commercial banks and the monetary base, which in the opinion of the National Bank of Poland was conducive to the appearance of the demand-pull inflationary impulses.

In the first half of 1995, the above tendencies became even more intense, as a combined effect of FDIs, higher interest on securities denominated in the Polish zloty and consolidating expectations for the zloty's appreciation. Ultimately, the growing sterilisation costs of the additional supply of money were the most important reason for introducing the crawling band system in mid 1995 that permitted short-term fluctuations of the nominal zloty/ basket of currencies exchange rate around the central parity, which fluctuations amounted, at switching to the crawling band, to +/-7% against the central parity depreciated by 1.2% on a monthly basis, and to +/-15% and 0.35%, respectively, before full liberalisation of the foreign exchange market in April 2000.

Nevertheless, the aforementioned tendencies in the balance of payment could be observed still in the second half of 1995, which was primarily due to the maintaining large inflow of capital financing direct investments. In order to reduce strong expectations for appreciation the last leaping adjustment of the central parity was introduced in December 1995, appreciating the zloty by 6%. The links between the Polish exchange rate system and the regional and world markets were strongly marked in July 1997 during the crisis in Asia and even more obviously during the deep depreciation of the Russian rubble in August and September 1998.

The course of economic developments in the years 1996-1998 suggested that considering the growing inflow of foreign capital (associated with Poland's accession to the OECD in November 1996) the efficiency of the crawling band system was insufficient. Larger variations in the supply of money could still be observed, forcing large-scale open market operations. The decision to liberalise fully the exchange system in Poland was taken in April 2000.

The possibility of the Balassa-Samuelson effect influencing the real zloty exchange rate means that the key point in the analysis is a suitable choice of deflators representing price variability of tradables and non-tradables. In the research, the tradables price index p is

approximated by prices indices in the manufacturing industry (PPI), which is explicitly recognised by almost all empirical investigations as the most important component of the tradables' deflator, whereas consumer price index (CPI) represents overall price level p'[6]. An analysis of the PPI-based real exchange rate in the period 1995-2004 (see graph 1) suggests the possibility of distinguishing two relatively homogenous subperiods. In the first of them, spanning the years 1995-1999 the PPI-based exchange rate reveals short-term oscillations around a constant level qav. It is therefore justified to form two non-contradictory working hypotheses. Firstly, in the crawling band period, NBP's interventions could be effective enough to prevent longer-term deviations of the nominal rate from the PPP-set path. Secondly, the domestic PPI dynamics could be so high, and the NBP path of the nominal rate so congruent with the market expectations, that the foreign trade arbitrage was sufficiently effective to bring domestic prices to the PPP trajectory. In the years 2000-2004, oscillations of the PPI-based exchange rate are considerably stronger and attention is drawn to the extensive zloty appreciation in 2001 and the first half of 2002.

[graph 1 about here]

The situation becomes different when variability of the CPI-based exchange rate is being analysed. Then attention is attracted to the regular zloty appreciation in years 1995-2001 and a very similar shape of the CPI- and PPI-based exchange rates between 2002 and 2004. Conclusions provided by that comparison cannot be overestimated, when the empirical research concentrates on assessing the influence of mechanisms associated with the supply-side effects. For it can be assumed that regarding the zloty/euro exchange rate the empirical assessment of the scale of the supply effects remains conclusive until 2000; in the later period, the major factor determining q' variability is fluctuations in the real exchange rate defined for tradables' prices.

Conclusions arising from that discussion are clear: an empirical analysis has to commence with the verification of the PPP hypothesis at the level of tradables' prices and next, if the hypothesis is rejected, with the construction of an expanded model of the PPI-based real exchange rate fulfilling the $q \sim I(0)$ condition.

In the cointegration analysis, we used the standard vector error correction model (VEC, for example Johansen (1995)):

[6] See appendix for time series sources and definitions.

$$\Delta y_t = \alpha\beta' y_{t-1} + \sum_{s=1}^{S-1} \Gamma_s \Delta y_{t-s} + \mu + \Psi d_t + u_t , \qquad (12)$$

where: y - $M \times 1$ vector of endogenous variables, d - $J \times 1$ vector of deterministic variables, α - $M \times V$ matrix of adjustment parameters, β - $M \times V$ matrix of V orthogonal cointegrating vectors, Γ - $M \times M$ matrix of the short-term parameters, Ψ - $M \times J$ matrix of the deterministic variables' parameters, u - vector of error terms. The cointegration space is uniquely defined by matrix β, but the structural cointegrating vectors $\widetilde{\beta}$ can be identified up to a non-singular matrix transformation

$$\alpha\beta' = \alpha\xi^{-1}\xi\beta' = \widetilde{\alpha}\widetilde{\beta}' , \qquad (13)$$

which allows empirical verification of the economic theory-congruent or working hypotheses-based hypotheses on the equilibrium conditions of the system.

The use of the cointegrating procedures in the analysis of the PLN/euro exchange rate involves an important assumption about informativeness of the employed statistical sample being sufficient to identify and quantify relationships between the exchange rate and the fundamental variables. The heterogeneity of the period subject to empirical analysis may arouse doubts about the reliability of conclusions derived in the econometric analysis, which doubts are the stronger, the higher significance is assigned to the length of the time series. Even though potential criticism should not be ignored, one can highlight certain properties of the modelled system that blunt its edge. In particular, the assumption about sufficient informativeness of the monthly time series is equivalent to assuming that the dynamics of the foreign exchange system in Poland and of its adjustment processes in the examined period was so strong that it dominated over the discrete adjustments in the economic policy as well as disturbances generated in a later period by the exchange rate environment.

The starting point in the cointegrating analysis based on VEC with the nominal PLN/euro exchange rate e and production deflators for the manufacturing industry in Poland p and the eurozone p^* was a VEC model with a twelve-month lag horizon. Conclusions regarding the rank of the cointegrating space proving the existence of one cointegrating vector[7] are conclusive (see table 1); for $V = 3$ the joint Doornik-Hansen test does not give grounds for rejecting the hypothesis about the normality of the residuals ($p - val = 0.640$), whereas results of the LM tests explicitly confirm the lack of autocorrelation of the order 1

[7] The analysis was made for the case of VEC model with the constant term restricted to the cointegrating space.

and 4. At the same time, Wald's lag exclusion tests allow to shorten the lag horizon to 9 months even though the probability value (0.067) is then close to the lowest acceptable significance level.

[table 1 about here]

The long-term parameters were estimated by imposing the symmetry restriction (the homogeneity restriction was definitely rejected in all model variants) and assuming weak exogeneity of the foreign prices. Results of the normality and autocorrelation tests and tests of the over-identifying restrictions show that the specification is free of major errors and the equilibrium condition is as follows:

$$e = 2.075(p - p^*) + 1.360\,. \tag{14}$$

Irrespective of the fact that the above estimates of the domestic and foreign prices' elasticities correspond to results obtained in the research for other countries (e.g. MacDonald and Marsh (1999)), properties of system (14) cannot be accepted for two reasons at least. Firstly, even though the presence of the cointegrating vector can be interpreted in favour of the PPP model, because estimates of price parameters absorb effects of the unmet restrictive assumptions taken from the theoretical, the very existence of the equilibrium relationship does not provide a solution to the real exchange rate modelling problem. Secondly, an analysis of the parameters of adjustment matrix $\mathbf{A}$ leads to an equally lucid conclusion that the growing deviation of the nominal exchange rate from the path set by equation (14) is accompanied by a pressure that increases the disequilibrium.

Reasonable doubts about system (14) properties can be formulated already during a preliminary comparison of the estimates of price parameters (2.075) in equation (14) with adjustment parameters in domestic prices equation (0.043) and the exchange rate equation (0.136). The positive impulse generated by the nominal exchange rate will particularly contribute to deeper disequilibrium and the only system-stabilising mechanism can be an adequately high increase in the domestic prices. It is the only case when the considered system does not have explosive properties, which, however, does not change the fact that it will be entirely useless in analysing the PLN/euro exchange rates[8]. The above reservations are confirmed by results of the generalized impulse response analysis (graph 2).

[8] The occurrence of the positive price shock will result in a symmetric reaction, i.e. a drop in the nominal exchange rate and domestic prices.

[graph 2 about here]

Extending the research to include the uncovered interest rate parity hypothesis is troublesome, because consistent data on the inflationary expectations in the eurozone is not available, which results in the inability to define *ex ante* fully comparable real interest rates. Consequently, it becames necessary to make a simplifying assumption that the static inflationary expectations are equal to the observed rate of inflation defined for CPI (π), i.e. $R = (100 + I)/(100 + \pi)$, where the nominal interest rate I is approximated by three-month inter-bank WIBOR and LIBOR interest rates. This approach should not significantly burden the estimates, or adversely affect the tests' conclusiveness. Firstly, taking the assumption about static inflationary expectations in Poland is firmly justified by empirical research conducted by the NBP (see Łyziak (2002)). Secondly, the rate of inflation in Poland went down from about 33% in the first half of 1995 to slightly over 4% in the second half of 2004, whereas in the eurozone it oscillated around 2%. It means that the relative interest rates fluctuations will predominantly result from the varying domestic rates.

Verification of the UIP model had two variants; one assumed the same reaction of the real exchange rate to changes in the real interest rates at home and abroad, and the other allowed asymmetry of the reactions. Results of the cointegration tests suggest that regardless of the lag length as well as the structure of the vector of deterministic variables d it is not possible to identify any equilibrium condition.

4. Risk premium

Cointegration tests' results in the UIP model explicitly indicate that when the assumed exchange rate expectations correspond to the PPP level a correct risk variability approximation is a prerequisite for constructing a PLN/euro exchange rate model. The choice of proxies for the risk is empirical. Especially quite few recommendations concentrate on the analysis of the fiscal situation, typically accentuating the role of the total debt or the government sector's debt. In all cases, adding specific variables to extend a model presents a kind of a research hypothesis subject to testing within a set of hypotheses (6)-(7). Particularly Clark and MacDonald (1999) use the relative ratio of the domestic to foreign share of the government sector's debt in GDP to analyse the effective exchange rates of US dollar, Japanese yen and Deutsche Mark. They stress that their choice, being one of many possible

ways, is dictated by the positive outcomes (i.e. meeting their expectations) produced by analyses of exchange rates for selected countries (for Italy see Giorgianni (1997)).

When the zloty exchange rate is being modelled using the monthly data, an additional barrier appears: the unavailability of comparable risk characteristics of the euro zone countries makes it impossible to meet the requirement that demands all variables to be expressed as relative values. We reckon however that the problem is less weighty, when the investigation concentrates on risk measurement in the exchange rate models of CEECs' currencies and the point of reference is the economy of the eurozone. In this case it seems fully justified to assume that risk fluctuations in the reference countries are so small that their effect on the variability of the relative risk measure will be very limited, but a stronger thesis can be posed as well, that changes in the exchange rate risk in the reference country are unrelated to the investment risk in the CEECs, provided that their currencies are not perceived as „legitimate" substitutes of currencies dominating in international settlements. The assumption about asymmetry with which an exchange rate risk affects the PLN/euro exchange rate allows to limit the search for the risk premium proxies to the set of domestic variables.

Variables that need to be added to the model were preliminary selected by comparing their course with the risk premium $\lambda = q + r - r^*$ variability. The outcomes of empirical research by Clark and MacDonald (1999) and Giorgianni (1997) provide a starting point for preliminary selecting the vector of the risk-approximating variables, i.e. shares of the government domestic debt DD, foreign debt DF and total government debt DT in GDP.

[graph 3 about here]

Conclusions that we can derive from the graphic analysis (graph 3) are mixed. Consequently, results of the cointegration tests conducted within VEC systems covering either the PPI-based real exchange rate (model PPP) or the risk premium (model UIP) and, separately, the domestic debt DD and the total debt DT are congruent with expectations: identification of the cointegrating vectors cannot be done (table 2) in UIP system. The situation is different when the PPP and UIP models are extended to include the foreign government debt DF. This solution is challenged, however, by results of the weak exogeneity tests that explicitly prove that the corresponding adjustment parameters are statistically not significantly different from zero in both models. The above outcome is not surprising, because a model with foreign debt implicitly assumes that corrections of the

investment portfolio structure take place even when the exclusive source of the changes in the share of the government foreign debt in GDP is temporary variations in the nominal exchange rate. Thus, two points are important here. Firstly, when export and import react more slowly to the exchange rate shocks, an analysis concentrated on the relationships between the foreign debt and the real exchange rate leads to a system with explosive properties: a higher exchange rate makes the share of debt in GDP grow, which forces the nominal exchange rate grow even more. Secondly, an enlarged foreign debt does not necessarily have to be interpreted in terms of higher foreign exchange risk, if investors perceive fluctuations in the exchange rates as a short-lived phenomenon. If so, the risk premium approximation problem remains open.

[table 2 about here]

The last item in the discussion of the role that could be played by the share of the government sector debt in GDP makes us put the problem in different terms. The basic reason for the unacceptability of the results can be an ill-defined cause-effect relation, where the exchange risk variations result from selected macrovariables, even though an equally legitimate approach is reversing the cause-effect relation and selecting variables whose run should reflect changes in the risk premium. Because of that, we concentrated the analysis on the fourth variable, i.e. shares of the government's short-term debt in GDP, DS . In particular, we hypothesized that a building up debt due to more intense issues of treasury notes indicates heavier and heavier problems with financing the budget's current spending or investors' declining trust in government securities with longer maturity. The problem can be treated also from the issuer's point of view: a safer way of financing the budget is sales of long-term securities and then values of the treasury notes issues grow, if the demand for bonds faces a barrier. This situation can be caused by a growing exchange rate risk. An important supplement to the above reasoning is the assumption about possibly lagged effects of the declining exchange rate risk, which corresponds to a situation where all major long-term investments are initiated provided that a fall in the risk is perceived as a relatively longer-lasting phenomenon.

A graphic analysis and results of the cointegration tests clearly suggest that it is possible to identify equilibrium condition that links the risk premium and the short-term debt. At the same time, replacing the foreign debt with the short-term debt results in a system, where the short-term exchange rate adjustments run around the identified equilibrium trajectory and the

variable representing the risk premium is weakly exogenous. This result suggests that solid arguments exist in favour of using variable DS in the model.

The last two variables included in the PLN/euro exchange rate model describe tensions in the national budget (budget deficit's share in GDP, DX) and on the current account of the balance of payment (trade deficit's share in GDP, TB).

Extending of the model to include the trade deficit' share in GDP is some kind of a working hypothesis and it results from the monetary policy's reaction to TB fluctuations in the years 1998-2000. In particular, it is argued that the growth of the current account deficit (approximated in the model by the trade balance) in years 1998-1999 above a level deemed secure (5% of GDP) resulted from the significant reduction in NBP's nominal interest rates in 1998, whereas the improving foreign trade results observed from the year 2000 should be attributed to rising interest rates in the second half of 1999. Such an interpretation concentrates on the tensions' indirect influence on the real exchange rate via changes in NBP's interest rates.

In the case of the share of the state budget deficit in GDP (DX) two other arguments can be raised. Firstly, a positive correlation between the surplus spending and the appreciation of zloty may result from the government sector's excess demand for the domestic currency. This short-term mechanism can be interpreted within the simple Mundell-Fleming model and then the budget deficit' share in GDP represents effects of the demand-side factors affecting domestic interest rates. Secondly, interpretation of relationships between the deficit and the exchange rate can also build on the mechanism already examined in the context of the short-term debt. If the deficit is sustainable in the analysed period, most budget expenditures are rigid and the structural changes are slow, then a hypothesis can be formulated that a higher foreign exchange risk limits the sources of finance and, ultimately, reduces the deficit.

5. Model: estimation and properties

The above discussion is summarised by the VEC model, whose components are: the PPI-based real PLN/euro exchange rate (q), domestic real interest rate (r), real interest rate in the eurozone (r*), share of the short-term debt in GDP (BS), share of the trade balance (imports less exports) in GDP and the share of the national budget's deficit (expenditures minus revenues) in GDP (DX):

$$y = [q, r, r^*, BS, DX, TB]' . \tag{15}$$

The cointegration rank hypotheses were verified assuming initially $S = 6$[9].

[table 3 about here]

Outcomes of the cointegration tests are ambiguous (table 3). In the case of the maximum eigenvalue test, the presence of one system equilibrium condition is revealed, whereas the trace test suggests the presence of two cointegrating vectors. The presence of two cointegrating vectors was ultimately accepted. There are two arguments speaking for such a solution at least. Firstly, the simulation experiments indicate that the race test may have some power advantages in short samples (see discussion in Lütkepohl (2004)). Secondly, the presence of two cointegrating vectors is supported by the analysis of the stability of the trace test's indications made within a recursive estimation covering the period January 2003 – December 2004. The analysis expressly indicates that for significance level of 0.10 system (15) runs around two equilibrium trajectories at the minimum.

The presence of two cointegrating vectors is somewhat confusing, as an additional equilibrium condition has to be identified. A closer look at the vector (15) allows to conclude that the list of variables for which identification of the cointegrating vector can be undertaken includes trade balance/GDP ratio and domestic real interest rates. In the first case, it can be attempted to describe the trade balance equilibrium as a function of the real exchange rate and relative interest rates (that approximate sources used to finance import surplus over export). That the solution should be rejected is decided by the weak exogeneity tests indicating that in model (15) it is not possible to identify the trajectory around which short-term adjustments of TB run.

The conclusions are different when domestic interest rates are taken as the explanatory variable in the second cointegrating vector. A discussion closing previous section shows that the variability of the domestic interest rates can be described as a function of foreign interest rates and risk measures that the monetary authority considers, when adjusting the central bank's interest rates. In such a case, the first possible explanatory variable is the share of the budget deficit in GDP, an increase in which lead to tightening up the monetary policy. The second variable whose stronger fluctuations induced interest rates adjustments is the share of the trade deficit balance in GDP.

[9] Formally, the lag exclusion tests give grounds for considering *S*=5, but then solid arguments exist for rejecting the normality of residuals hypothesis.

The equilibrium relationships in the VEC model (15) require the imposition of minimum four just-identifying restrictions, that is two normalizing restrictions (against q and r) and two conditions meeting either economic theory or the assumptions made. Ultimately, five restrictions were initially imposed, which translates into the presence of one over-identifying restriction and makes it possible to test the correctness of all structuralizing restrictions. In particular, the budget and external trade imbalance effects are transmitted through the interest rates. Secondly, the specification of the interest rate equation assumes stable relationship between the domestic and foreign interest rates as well as a cause-effect relation linking interest rates with the short-term debt. The equilibrium conditions are therefore following:

$$q = \delta_0^1 + \delta_1^1 r + \delta_2^1 r^* + \delta_3^1 DS\,, \tag{16}$$

$$r = \delta_0^2 + \delta_1^2 r^* + \delta_2^2 DS + \delta_3^2 TB + \delta_4^2 DX\,. \tag{17}$$

Statistical verification covered not only the over-identifying condition, but also hypotheses about the value of the equilibrium parameters. In particular, interest rates' unit elasticities in the exchange rate equation were assumed:

$$\delta_1^1 = -\delta_2^1 = -1. \tag{18}$$

Estimates of the cointegrating vectors' parameters indicate that the direction of reactions of the real zloty/euro exchange rate and the real domestic interest rates to changes in the other variables meet the expectations (table 4, variant VEC1). Swelling short-term debt DS, budget deficit DX and trade deficit TB translate into higher interest rates; the growth in the risk premium approximated by debt DS is accompanied by a pressure on zloty depreciation. However, the LR test outcome indicating that the over-identifying restriction could be accepted under too low significance level is giving rise to doubts.

[table 4 about here]

Conclusions are different when we assume *a priori* weak exogeneity of foreign interest rates. Such an assumption is strongly supported by a very important argument: inexistence of weak exogeneity of r^* means that adjustments of the foreign interest rates have to run around trajectories (16) and (17) which is unacceptable, when equations (16) and (17) represent equilibrium conditions for the domestic variables. When r^* is weakly exogenous, the LR test allows to accept the examined over-identifying restrictions at the commonly used levels of significance ($\mathrm{p-val} = 0.11$, variant VEC2).

Then weak exogeneity of trade deficit was tested (variant VEC3). This approach is justified by our earlier comments on the identifiability of the TB equilibrium condition within model (15) and by the low values of the *t*-ratios of the adjustment parameters in equation ΔTB. Variant VEC4 includes three additional restrictions. Firstly, the imposition of a zero restriction on the short-term debt DS parameter in the second cointegrating resulted from the parameter's relatively imprecise estimate. Secondly, small and insignificantly different from zero estimates of the adjustment parameters in equations Δq and Δr justify giving some thought to an interpretatively attractive hypothesis that the short-term adjustments of the exchange rate and of the domestic real interest rates run exclusively around equilibrium conditions defined for those variables ($\tilde{\alpha}_{12} = \tilde{\alpha}_{21} = 0$, VEC4). Lastly, the weak exogeneity restrictions were imposed on short-term debt DS, which was also determined by statistical criteria (VEC5).

Reactions of the exchange rate subsystem to exogenous shocks were investigated under the generalized impulse response analysis (graph 4).

[graph 4 about here]

The impulse generated by the exchange rate dies out after two years and a half. This shows that a strong error correction mechanism is present. The permanent trajectory shift is caused by different speed of adjustment to the equilibrium paths. The simulation shows therefore that the adjustments of the real PLN/euro exchange rate are much faster than, for instance, the adjustments of exchange rates of the developed countries' currencies to the PPP trajectory. This finding is not surprising, because the equation of the PLN/euro exchange rate is medium-termed and in the period in question adjustment processes in the Polish economy showed much stronger dynamics than those in the industrialized economies.

In the analysis of the fiscal policy influence on the real PLN/euro exchange rate most interesting are effects of shocks generated by the state budget. The simulation results should be viewed as meeting the expectations: the DX -induced impulse translates into short-term appreciation of the zloty and it is transmitted through growing domestic interest rates. In a longer time horizon, the equilibrium is restored on the initial path of the real exchange rate. On the other hand, strong depreciating effects are produced when typical (as regards their scale) disturbances affect variable representing the risk premium. The consequences of growing risk are sustainable and they trigger the strongest reaction of the exchange rate.

Factors affecting the foreign interest rates r^* and trade balance TB induce similar responses of the system: after several months of zloty depreciation the exchange rate's path moves below the initial trajectory, which might seem surprising at first glance. A more in-depth analysis of the estimates shows, however, that the factor inducing such a system reaction under disturbance r^* is the strong transmission of impulses generated by the eurozone interest rates on interest rates in Poland. Interest rates' reaction to a shock produced by trade balance is similar.

[graph 5 about here]

Last two system reactions open therefore a discussion about parameters' values in equilibrium relationships. In particular, the application of a relatively short sample makes it relevant to answer the question whether the obtained estimates of equilibrium parameters are sensitive to changes in the period covered by the empirical research. Results of the recursive estimation of a system with weakly exogenous foreign interest rates, trade balance and short-term debt covering the period July 2002 – December 2004 do not allow to claim that estimates of the cointegrating vectors are sample-specific (graph 5).

Conclusions

Answers to the question about the scale of an exchange rate's deviation from the equilibrium path and the optimal exchange rate policy in the period preceding Poland's accession to the exchange rate system ERM2 can only be given by way of empirical research. An analysis focused on the PLN/euro exchange rate means that the choice of a theoretical model subject to econometric examination has to take into account not only economic processes observed in the transition period, but also the limited informativeness of the available time series. The consequences are clear: the identification of factors determining variability of the real Polish zloty exchange rate and estimation of parameters measuring impacts of the so-called fundamental variables have to be based upon a small-scale system, however meeting restrictive statistical criteria.

The economic analysis of the PPI-based real PLN/euro exchange rate within the BEER model (11) indicates that one source of the rate's short-term variations can be changes in the exchange risk. This problem is quite important, because Poland is obligated, as an EU

Member State and a member of the European Economic and Monetary Union, to join the monetary union, after she has permanently fulfilled the convergence criteria. Assuming that the dependence of the real exchange rate on the risk premium identified in the paper is a long-term one, three important points appear in the discussion of Poland's admission to the eurozone.

Firstly, in the context of the European Central Bank's recommendations, the crucial problem is ensuring adequate accuracy of the exchange rate estimates, which accuracy obviously hinges on the correct selection of the real exchange rate determinants. Considering the presented results, the risk premium has to be further investigated and the methods employed to examine or to approximate the premium should be fundamental for the monetary and fiscal authorities. This issue is particularly important for Poland, whose accession to ERM2 will require the floating exchange rate system (where no reference exchange rate exists) to be replaced by a system with a band of fluctuations.

Secondly, ignoring risk effects on the real exchange rate may cause inappropriate quantification of the relationships between the CPI-based exchange rate and other fundamental variables. Specification errors may then produce biased estimates of the equilibrium exchange rates, but also make pertinent authorities initiate actions in response to the exchange rate deviations from the parity, potentially escalating tensions in the foreign exchange market.

Thirdly, when risk variations exert strong influence on the PLN/euro exchange rate, the construction of an ERM2-joining scenario should be considered, in which the central exchange rate is determined in a period when the risk premium is at its "normal", medium-term level. An additional assumption that risk fluctuations match the cycle of parliamentary elections justifies the opinion that the best time for setting the central exchange rate is the second year of new government being in power. Thus, the optimal time interval for introducing the zloty to ERM2 and for monetary integration is years 2006 and 2009 or 2010 and 2013, respectively. A comparison of these periods with other periods, when the remaining nominal convergence criteria can be permanently satisfied allows to conclude that Poland will not switch to the euro in this decade. Additional monetary integration scenarios should take into account larger deviations of the risk premium from its medium-term trajectory, which increases the risk of setting an inappropriate central exchange rate, on one hand, and may produce inconsistent reactions of the monetary and fiscal policies to exogenous shocks, on the other.

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Appendix

The data comes from the monthly publications issued by Polish Central Statistical Office (CSO) and National Bank of Poland (NBP) publications, Reuters' Poland eXTRA services and OECD data bases. The data is seasonally adjusted by means X12 procedure available in EViews 5.0.

Definitions of variables:

Y - GDP monthly value, billions PLN, current prices (estimate),

DD - domestic debt of the government sector – GDP ratio: $DD = DD' / Y$,

DD' - domestic debt of the government sector, billions PLN, current prices (NBP),

DF - foreign debt of the government sector – GDP ratio: $DF = DF' / Y$,

DF' - foreign debt of the government sector, billions PLN, current prices (NBP),

DT - total debt of the government sector – GDP ratio: $DT = DT' / Y$,

DT' - total debt of the government sector, billions PLN, current prices (NBP),

DX - state budget deficit – GDP ratio: $DX = DX' / Y$,

DX' - state budget deficit, billions PLN, current prices (CSO), DX' = expenditures – revenues,

TB - trade balance – GDP ratio: $TB = TB' / Y$,

TB' - trade balance, billions PLN, current prices (NBP), TB' = imports – exports,

DS - domestic short-term debt of the government sector – GDP ratio: $DS = DS' / Y$,

DS' - domestic short-term debt of the government sector, billions PLN, current prices (NBP)

Graph 1. CPI- and PPI-based real PLN/EUR exchange rate

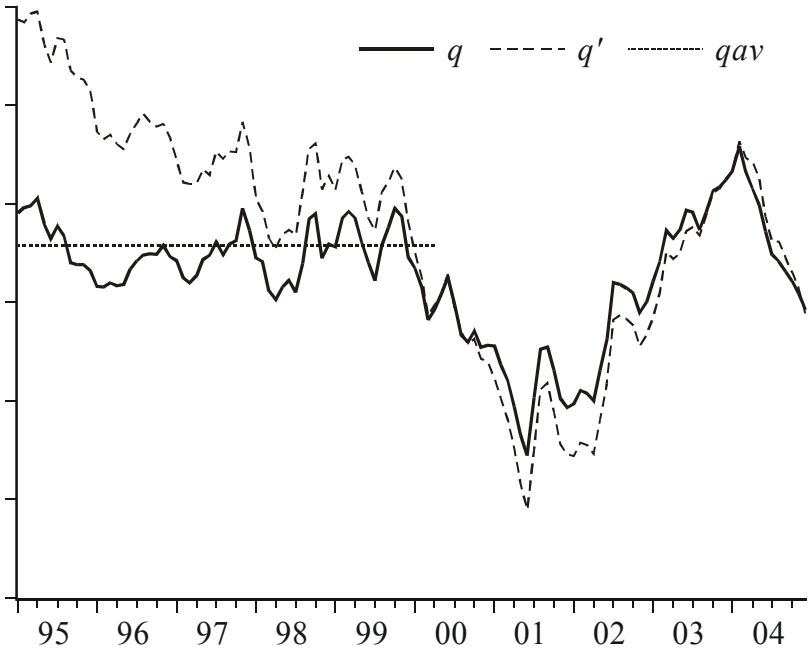
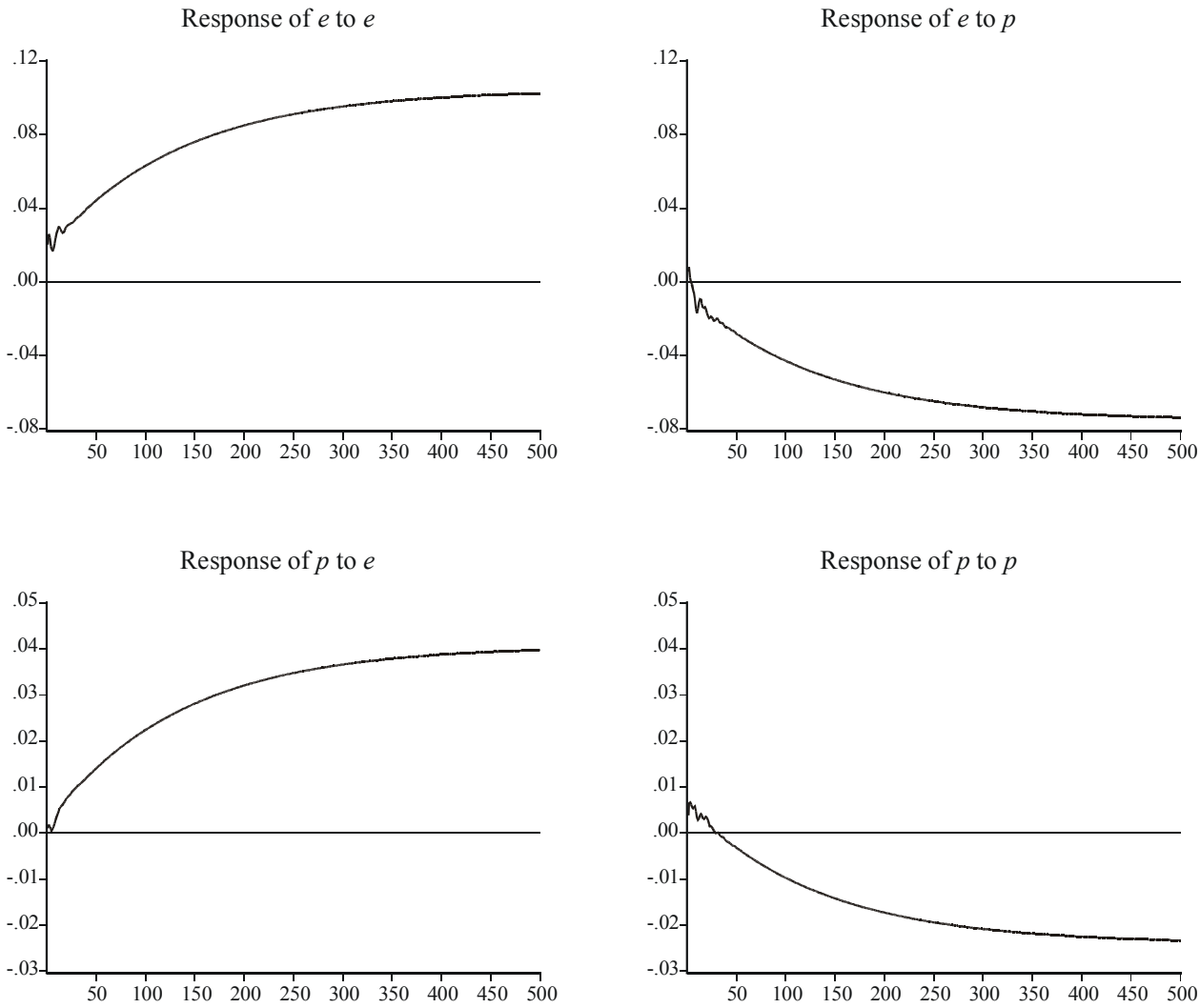


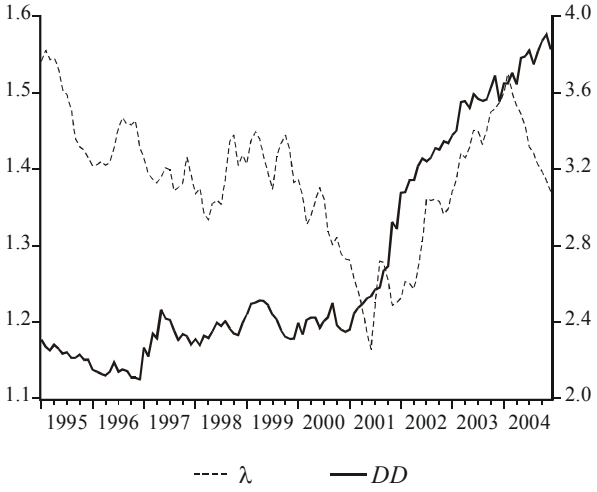
Table 1. PPP

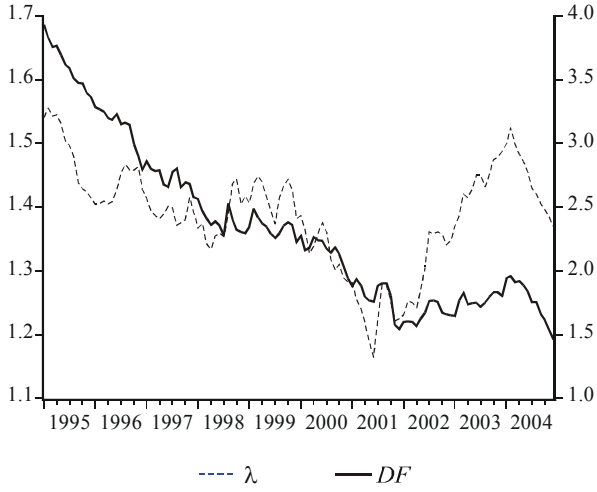
Lag		Estimates				Cointegration tests				Diagnostics					
		e	p	p^*	V	Trace	Trace* (0.10)	Max	Max* (0.10)	Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)	SBIC	HQ
12	$\widetilde{\beta}'$	1	-1.969	1.890	0	35.6	31.9	22.9	19.9	3.85 (0.697)	4.60 (0.868)	10.22 (0.333)	-	-28.15	-29.76
	$\widetilde{\alpha}'$	0.160 (2.4)	0.050 (4.1)	0.007 (0.8)	1	12.7	17.9	7.8	13.8						
9	$\widetilde{\beta}'$	1	-1.975	1.740	0	43.5	31.9	32.0	19.9	12.14 (0.059)	2.51 (0.981)	6.33 (0.706)	-	-29.14	-30.33
	$\widetilde{\alpha}'$	0.136 (2.9)	0.043 (4.9)	0.006 (1.0)	1	11.6	17.9	7.2	13.8						
	$\widetilde{\beta}'$	1	-2.075	2.075	-	-	-	-	-	10.74 (0.097)	3.03 (0.963)	6.00 (0.333)	1.11 (0.574)	-29.13	-30.33
	$\widetilde{\alpha}'$	0.144 (3.1)	0.036 (4.1)	0	-	-	-	-	-						

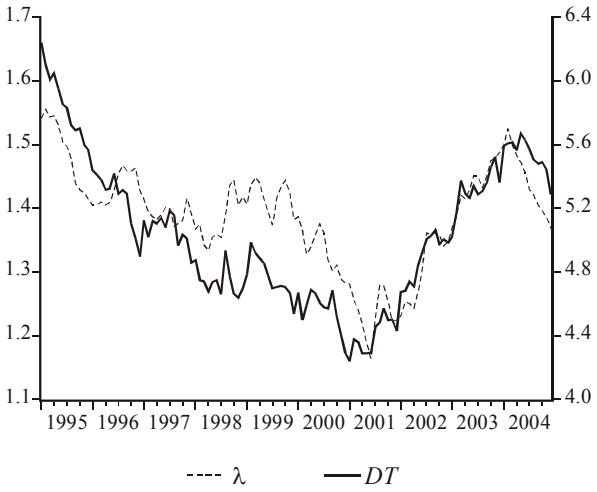
Graph 2. PPP: generalised impulse responses



Graph 3. Risk premium proxies







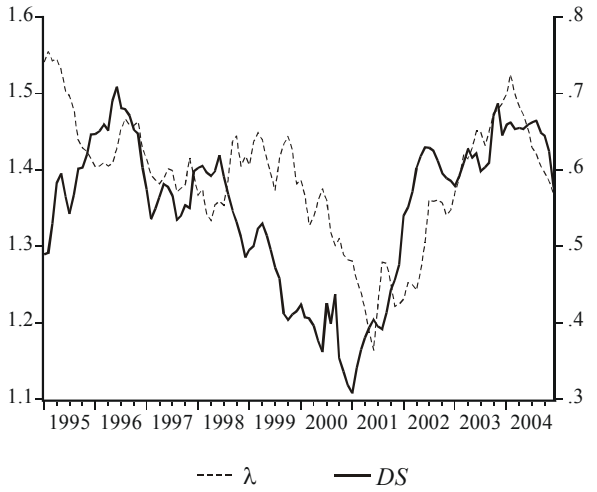


Table 2. Risk premium proxies: cointegration and weak exogeneity tests

Risk proxy	PPP model		UIP model	
	Trace	*Max*	*Trace*	*Max*
DD	1	1	0	0
	LT: $q = 0.065DD + 1.308$		-	
	$\widetilde{\alpha}(q) = -0.036$ (1.6)			
	$\widetilde{\alpha}(DD) = -0.299$ (4.6)			
DF	1	1	1	1
	LT: $q = 0.148DF + 1.187$		LT: $\lambda = 0.272DF + 0.990$	
	$\widetilde{\alpha}(q) = -0.030$ (1.8)		$\widetilde{\alpha}(\lambda) = -0.006$ (0.6)	
	$\widetilde{\alpha}(DF) = 0.159$ (2.4)		$\widetilde{\alpha}(DF) = 0.102$ (3.2)	
DT	0	0	0	0
DS	0(*)	0(**)	1	1
	LT: $q = 0.390DS + 1.208$		LT: $\lambda = 0.489DS + 1.104$	
	$\widetilde{\alpha}(q) = -0.123$ (3.6)		$\widetilde{\alpha}(\lambda) = -0.125$ (3.7)	
	$\widetilde{\alpha}(DS) = -0.018$ (0.4)		$\widetilde{\alpha}(DS) = -0.041$ (1.1)	

Cointegration tests are based on the critical values for the 10% significance level; (*) and (**) indicate the possibility of rejecting of the null hypothesis $V = 0$ at the p-values 0.116 and 0.143, respectively.

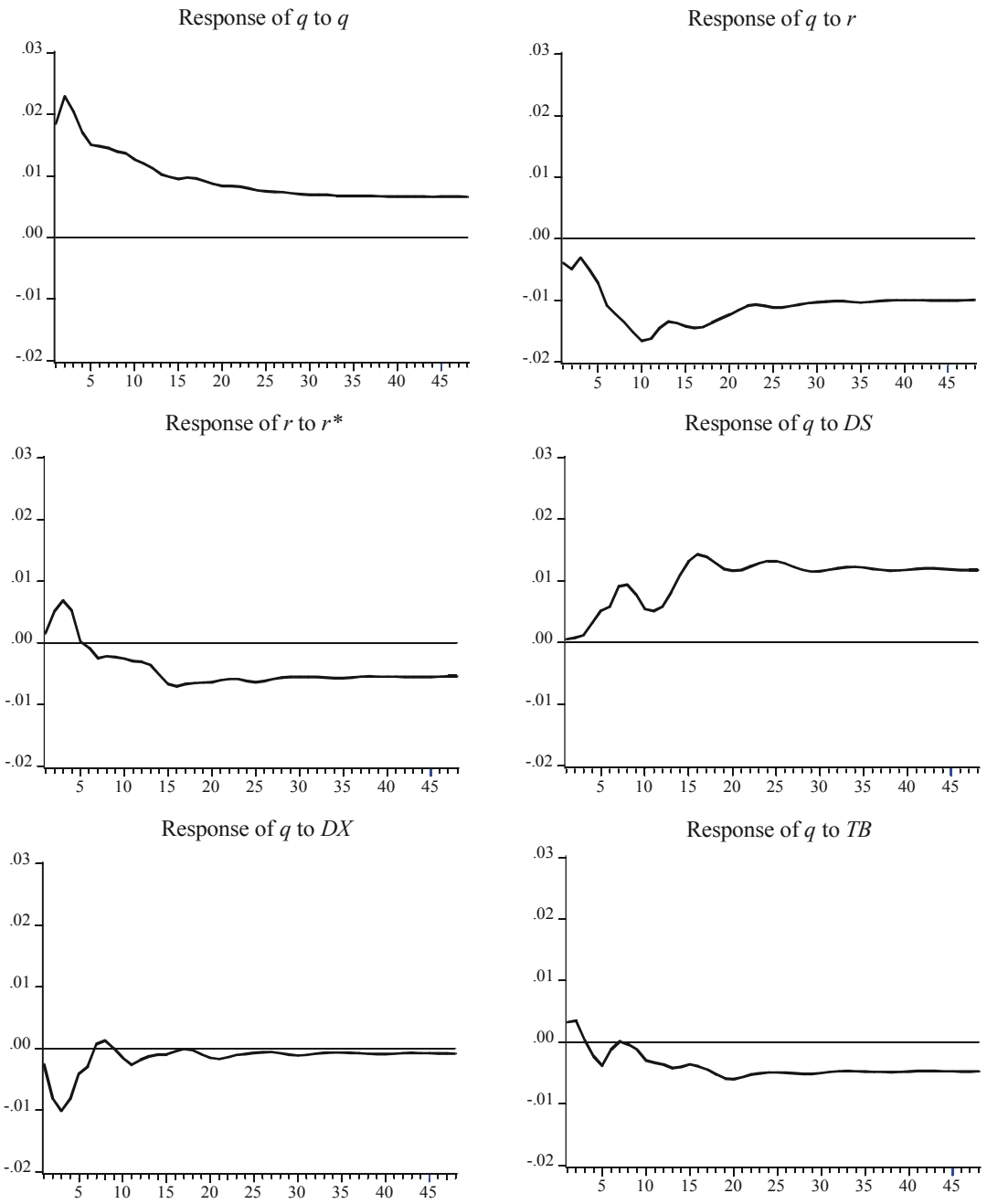
Table 3. Cointegration tests

V	Cointegration tests			
	Trace	Trace* (0.10)	Max	Max* (0.10)
0	119.0	97.9	46.0	37.7
1	72.9	71.8	28.3*	31.7
2	44.6*	50.0	.	.
	Diagnostics			
Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	SBIC	HQ
		$V = 6$		
18.1 (0.112)	30.2 (0.739)	27.3 (0.853)	-49.86	-53.26
		$V = 2$		
16.8 (0.157)	27.6 (0.842)	23.4 (0.948)	-50.33	-53.43

Table 4. VEC - Estimates and diagnostics

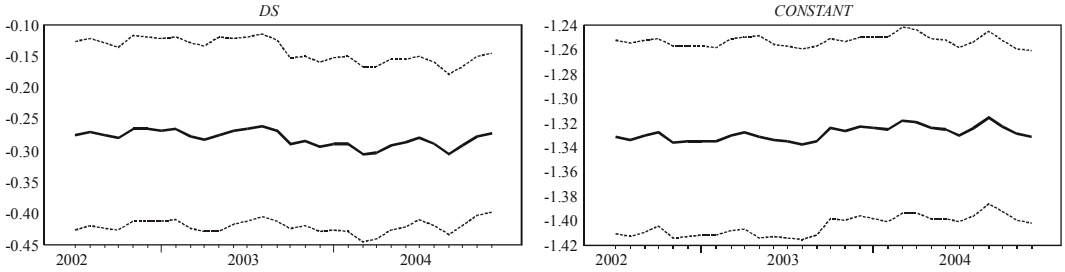
Model		*q*	*r*	r^*	*ds*	*dx*	*tb*
VEC1	$\widetilde{\beta}'$	1	1	-1	-0.310	0	0
		0	1	-3.109	-0.140	-1.901	-1.037
	$\widetilde{\alpha}'$	-0.118 (2.7)	-0.012 (0.9)	0.006 (1.2)	-0.091 (1.8)	-0.099 (5.5)	0.046 (1.6)
		-0.032 (0.4)	-0.040 (1.5)	-0.019 (1.8)	0.424 (3.9)	0.191 (5.2)	-0.129 (2.2)
		Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)		
		17.71 (0.12)	31.72 (0.67)	20.67 (0.98)	8.45 (0.04)		
VEC2	$\widetilde{\beta}'$	1	1	-1	-0.306	0	0
		0	1	-3.476	-0.090	-2.243	-0.818
	$\widetilde{\alpha}'$	-0.125 (2.6)	-0.011 (0.8)	0	-0.105 (1.8)	-0.115 (6.0)	0.049 (1.5)
		-0.003 (0.0)	-0.041 (1.3)	0	0.410 (3.2)	0.221 (5.2)	-0.118 (1.7)
		Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)		
		16.64 (0.08)	27.40 (0.34)	16.21 (0.91)	6.14 (0.11)		
VEC3	$\widetilde{\beta}'$	1	1	-1	-0.306	0	0
		0	1	-3.166	-0.048	-2.428	-0.860
	$\widetilde{\alpha}'$	-0.146 (2.9)	-0.008 (0.6)	0	-0.091 (1.5)	-0.116 (5.9)	0
		0.055 (0.5)	-0.051 (1.6)	0	0.362 (2.5)	0.225 (5.0)	0
		Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)		
		16.99 (0.07)	30.61 (0.20)	18.31 (0.83)	8.30 (0.14)		
VEC4	$\widetilde{\beta}'$	1	1	-1	-0.252	0	0
		0	1	-3.155	0	-2.479	-0.786
	$\widetilde{\alpha}'$	-0.134 (2.9)	0	0	-0.091 (1.1)	-0.121 (5.1)	0
		0	-0.068 (2.2)	0	-0.331 (1.8)	0.238 (4.3)	0
		Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)		
		.	.	.	9.60 (0.29)		
VEC5	$\widetilde{\beta}'$	1	1	-1	-0.271	0	0
		0	1	-3.309	0	-3.023	-0.899
	$\widetilde{\alpha}'$	-0.136 (3.0)	0	0	0	-0.129 (5.3)	0
		0	-0.060 (2.2)	0	0	0.236 (4.6)	0
		Norm. (p-val)	AR(1) (p-val)	AR(4) (p-val)	LR (p-val)		
		.	.	.	13.33 (0.21)		

Graph 4. Genaralized impulse responses



Graph 5. Recursive estimation

a. real exchange rate equation q



b. domestic real interest rates equation r