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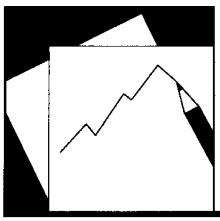

IMF Working Paper

Competitiveness in Bulgaria: An Assessment of the Real Effective Exchange Rate

Dimitar Chobanov and Piritta Sorsa

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Competitiveness in Bulgaria: An Assessment of the Real Effective Exchange Rate

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Abstract

This paper presents an empirical analysis of the medium and long-term determinants of the real (effective) exchange rate (RER) of the Bulgarian lev using elements from the natural real exchange rate (NATREX) and the behavioral equilibrium exchange rate (BEER) approaches. The results indicate that the RER is driven by fundamentals, including labor productivity, terms of trade, world real interest rates, gross savings, and foreign direct investment. The model also shows that there is no significant misalignment of the Bulgarian lev.

JEL Classification Numbers: F31, F41

Keywords: Real effective exchange rates, Fundamental determinants, NATREX, BEER, Bulgaria, Competitiveness

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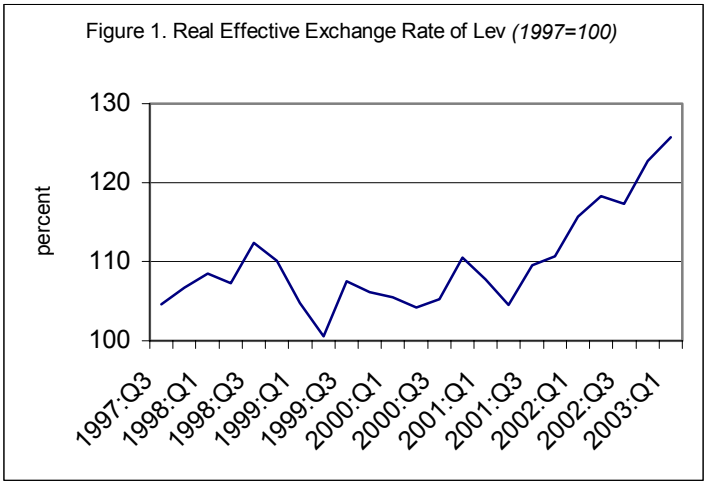
Contents

I. INTRODUCTION

Maintenance of competitiveness is an important concern in countries with currency board arrangements (CBAs) such as Bulgaria. Since the introduction of the CBA in 1997, the currency has appreciated by about 30 percent in real terms (Figure 1). Together with a widening in the current account to about 8½ percent of GDP in 2003, this has raised concerns about competitiveness. Indicators suggest that wage costs are rising in line with productivity and that Bulgaria continues to gain market share in partner markets (see IMF Country Report No. 03/206). However, there has not yet been an empirical assessment of the determinants of the real exchange rate or its equilibrium value.

Understanding the sources of the real appreciation is important for policy purposes. Studies on other transition countries have shown that much of the recent real appreciation is either due to changes in fundamentals or part of the real convergence process.[2] In transition countries, the introduction of market reforms and replacement of obsolete capital have often increased productivity faster in the traded-goods sectors than in nontraded ones, leading to rapidly appreciating RERs. This, in turn, has not been a cause of serious concern for policymakers, since competitiveness is preserved by the productivity increases. Many countries also began their transition with undervalued currencies, sometimes intentionally. Real appreciation occurs in response to changes in terms of trade, capital inflows, net foreign asset position, or savings. Appreciation of the real (effective) exchange rate (RER) in response to large, potentially temporary inflows of capital may adversely affect competitiveness of the external sector, posing a dilemma for policymakers. Furthermore, since many currency and financial crises in the 1990s originated in exchange rate misalignments in fixed exchange rate regimes, understanding the determinants and sources of real exchange rate movements and their impacts on competitiveness has become an important focus of policy.

Figure 1. Real Effective Exchange Rate of Lev *(1997=100)*



Source: Bulgarian National Bank

[2] See, for example, Frait and Komarek (2001), Vetlov (2002), and Bitans (2002). On Bulgaria, see IMF Country Report No.00/54/*www.imf.org/external/pubs/ft/ser/2000/cr0054*.

This paper will assess the long-term determinants of the RER of the Bulgarian lev in the period of the currency board arrangement and its potential misalignment. After a brief discussion of the estimation problems and data issues, the empirical analysis is presented. The methodology is a mixture of the behavioral real exchange rate (BEER) and natural real exchange rate (NATREX) methodologies that derive the RER from empirical relationships of key variables. The paper confirms the findings from other transition countries that the RER has mainly been driven by fundamentals and that there is currently no major misalignment in the lev.

II. COMPETITIVENESS, RER, AND TRANSITION COUNTRIES

There is a large body of empirical literature analyzing movements in the RER that has evolved over time with the development of new econometric techniques. The so-called macroeconomic balance approach compares current real exchange rates with a fundamental equilibrium exchange rate (FEER) that would exist when the economy is at full employment (internal balance) and in a current account equilibrium (external balance). [3] Divergence between the two indicates a misalignment. The problem in practice has been to calculate the real equilibrium, because the approach assumes that no other factors affect the exchange rate other than the determinants of internal and external balance. Another approach has been to analyze the actual behavior of real exchange rates with econometric analysis, BEER.[4] A reduced form equation is estimated with assumed longer-term fundamentals and shorter-term variables using cointegration analysis. The current RER value can then be compared to that estimated with the actual and longer-term fundamentals. The BEER approach has been further developed to exploit improving estimation techniques. One refinement has been the so-called PEER that extracts the permanent components from the BEER to get a better assessment of the permanent and transitory factors influencing the RER. Stein and Allen (1995) popularized the NATREX, which distinguishes between medium-and long-term factors influencing the RER.

The transition process adds a number of particular characteristics for RER analysis. Substantial real appreciation has been a normal part of the transition process, and may have been driven by non-standard factors that would need to be taken into account. Much of this is an equilibrium phenomenon as the introduction of a market economy improves productivity and incomes. In the first years of transition, initial devaluations may also have been excessive as demand for foreign assets rose, inflation galloped, and central banks set initial exchange

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[3] Williamson (1994), and Isard and Faruqee (1998).

[4] Clark and MacDonald (1998) The behavioral models usually identify group of exogenous variables, which determine the internal and external balance. The reduced form connects the real exchange rate with these determinants. Thus, there is no need to search for the sustainable levels of the current account and the external position, as they are endogenous to the system.

rates at undervalued levels. Any analysis of real exchange rates in transition countries like Bulgaria should take these factors into account.

Empirical studies of the RER in transition countries have indicated that much of the real appreciation is due to the Balassa-Samuelson effect or movements in fundamentals[5] (Table 1). Halpern and Wyplosz (1997), for example, in a study on the former socialist economies found that real appreciation rises due to an increase in productivity, elimination of intersectoral imbalances in the labor market and distortions in the capital market. Much of the real appreciation was attributed to (i) better quality of traded goods improving the terms of trade, (ii) wage adjustments in the non-traded goods sector (mainly services) exceeding those in the traded one, (iii) wages, initially, exceeding productivity in the traded goods sector, and (iv) the Balassa-Samuelson effect according to which productivity in traded goods rises faster than in non-traded sector driving wages in the latter up beyond productivity. A range of other studies have also explained RER movements in terms of productivity differentials, net foreign asset positions or other fundamentals. Many studies have used panel data due to short sample periods for individual countries, which makes inferences to individual countries more difficult.

The empirical assessment of the real exchange rate in Bulgaria needs to take into account the CBA.[6] The introduction of the CBA in July 1, 1997 marks an important structural break in the data. The CBA was adopted after a deep financial crisis to curb galloping inflation, which reached 312 percent in 1996 and 548 percent in 1997,[7] and to ensure financial stability. The exchange rate was initially fixed to the German mark and later to Euro. In 1997, Bulgaria also liberalized most capital movements - making it in theory more vulnerable to changes in market sentiment. However, most inflows of capital in the initial years were official finance and privatization-related foreign direct investment (FDI), reflecting the high perceived risks in the economy and relatively undeveloped capital markets. Another source of inflows has been current transfers from exported human capital. The post-CBA period was also the real start of transition reforms affecting productivity developments. The comprehensive structural reforms in this period are likely to have influenced productivity positively, potentially explaining much of the real appreciation.

The stable macroeconomy suggests that the real appreciation since the adoption of the currency board in 1997 reflects mostly fundamentals. The wide-ranging structural reforms and inflows of FDI have boosted productivity in the open sector, and a prudent fiscal

[5] For a critical overview see Egert (2003).

[6] The CBA was imposed through a special law, and a change in the fixed exchange rate is only possible if this law is amended by parliament. This legal framework does not allow the monetary authorities to devalue the exchange rate of the lev in order to have competitiveness gains. The main principles of the CBA in Bulgaria are: independence of the BNB from the government; proscription of any direct lending to the government; and clear and transparent mechanisms for the function of the lender of last resort.

[7] Source: Bulgarian National Bank.

management has helped reduce foreign debt, eased interest payments, and boosted domestic savings. However, the current account has widened to about 8 percent of GDP recently causing some concern about competitiveness. Thus, it is timely to assess the determinants of the real appreciation of the lev to ensure that the fixed exchange rate regime continues to be sustainable.

III. Empirical Analysis of the RER in Bulgaria

The major estimation problem is the short sample period since 1997. Many of the models discussed above analyze longer term trends in data, and the econometric techniques used tend to require long samples for robustness. To deal with these issues this study uses a mixture of the BEER and NATREX approaches (see Appendix I for details of the model and its shortcomings), as estimating the BEER is limited by the difficulty of constructing a long-term data series. Five variables are used, which are assumed to influence the RER in Bulgaria in the medium-term: *terms of trade, productivity, world real interest rates, foreign direct investment, and gross savings.*

A. Data

Quarterly data from 1997:3 to 2003:1 was used. It would be preferable to use semi-annual or annual data, but the short time period since the adoption of the CBA in Bulgaria limits the available time series. Even with quarterly data we have only 23 observations, which for cointegration is a short time series. Another problem with the estimation was poor data for the terms of trade, which had to be proxied, and the lack of sectoral productivity data. With the exception of the real interest rate, the time series of the variables were transformed to indices and converted into logarithm form.

The following time series were used:

- ***The real effective exchange rate (reer)***—a weighted average of bilateral real exchange rates (consumer price index (CPI) based). The quarterly indices were obtained from the Bulgarian National Bank website.[8] An increase in the index is a real appreciation of the lev.

- ***Terms of trade (tot)***—the numerator is the Bulgarian producer price index serving as a proxy for Bulgarian export prices. As a large part of production is exported this should be a close proxy for exports. The denominator is a weighted index of Bulgaria's main trading partner countries' price indices: Germany, Italy, Greece, and Russia representing about 50 percent of Bulgarian foreign trade in the post-CBA period. For the first three very open economies these are PPI indexes, which should closely approximate export prices. For Russia it is the Ural oil price index, which is the main commodity which Bulgaria imports from this country.[9]

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[8] www.bnb.bg

[9] Germany's PPI data are from the Deutsche Bundesbank website, Italy's PPI from the Bank of Italy's Economic Bulletin, and Greece's PPI from the Bulletin of Conjunctional Indicators of Bank of Greece. For Russia the data are from Bloomberg.

Table 1. Summary of Studies of RER Movements in Transition Countries

Authors	**Country Coverage**	**Methodology**	**Key Findings**	**Comments**
L. Maurin (2001)	12 transition countries, panel data		RER moves mainly with external debt and public consumption;	Measurement problems may explain the poor result for productivity and real interest rate
Vetlov (2002)	Lithuania	cointegration	RER moves with fundamentals (productivity differential, openness, interest rate differential, oil price	RER slightly undervalued in 2001
Bitans (2002)	Latvia	Single equation, macroeconomic balance approach	RER determined by fundamentals – openness, government expenditures, productivity differentials	Current RER appropriate and undervalued compared to long run equilibrium
Kim-Korhonen (2002)	Czech Republic, Hungary, Poland, Slovak Republic, Slovenia	Pooled mean group estimator	RER converging to long run fundamentals	Currencies overvalued
Smidkova, Barrell, Holland (2002)	Czech Republic, Slovenia	FEER		Signs of overvaluation except for Slovenia, RER do not move in the same direction in all countries
Dibooglu-Kutan (2000)	Poland, Hungary	Structural VAR model	Nominal shocks explain RER in Poland but not in Hungary	
Fischer (2002)	Several transition countries		RER explained by fundamentals (productivity, real world interest rates, consumption)	
Rahn (2003)	Estonia, Czech Republic, Poland, Hungary, Slovenia	BEER and FEER, cointegration	Productivity differential, net foreign assets significant. No cointegration found for some, other factors influence results	RER is overvalued in all countries
Beguna (2002)	Latvia	FEER, cointegration		RER overvalued by 2 percent compared to fundamentals
De Broeck-Sløk (2001)	Several countries including transition ones		Productivity differentials explain large real appreciation	

The structure of the terms of trade index makes it heavily dependent on oil prices. An increase in oil prices leads to a worsening in the terms of trade because Bulgaria is a net oil importer. The weight of oil is large because Russia's (and energy's) share in Bulgarian foreign trade is important. The data show an upward trend of the terms of trade reflecting increasing PPI in Bulgaria, which can be a sign of reduced competitiveness.

- ***Productivity (prod)***—This is estimated by a quarterly, seasonally adjusted, index consisting of real GDP in 1995 prices divided by the number of employees.[10] From a theoretical point of view, an estimate of total factor productivity should be introduced separately for tradable and non-tradable goods. One solution would be to use sectoral productivity of labor (e.g., in industry), which was not readily available. Another is to proxy total labor productivity for the whole economy. The use of the latter can be justified by (i) the assumed small Balassa-Samuelson (B-S) effect so far in Bulgaria (Nenovsky-Dimitrova 2002)[11] and (ii) a relatively large effort needed to construct sectoral, quarterly productivity data, which can be a topic for further research. The definition implies that the results would not capture as such the Balassa-Samuelson effect. Which may bias the results may be biased towards finding an overvalued exchange RER.

  The dynamics of labor productivity have varied over the sample period. The first part of the sample period was characterized by structural reforms consisting of privatization and liquidation of state owned enterprises. As a result, the number of employees in the whole economy decreased, so labor productivity rose. This pattern changed in 2001 with the initiation of many social programs - including hiring less productive, unskilled persons. This may be one reason for the observed decline in labor productivity since 2001 as the growth of employment was faster than that of GDP.

- ***Gross savings (savings)***—gross savings are obtained from nominal GDP.[12] The following formula :

  Gross Savings = National Disposable Income – Consumption Expenditures

  We calculate the National Disposable Income (NDI) as a follows:

  NDI = GDP + Current Income from Abroad + Net Current Transfers

[10] National Statistics Institute Data.

[11] They explain the absence of the B-S effect by lack of wage equalization between the traded and non-traded goods sectors in Bulgaria.

[12] Data are available at the NSI website *www.nsi.bg*.

Data for current income from abroad and net current transfers are obtained from the balance of payments statistics. The study uses gross savings in constant prices obtained by deflating nominal gross savings by a 1997 based CPI. There is clear seasonality in the gross savings data, and they were seasonally adjusted.

The initial level of gross savings was low reflecting the 1997 financial crisis. With the hyperinflation and large devaluation of the Bulgarian lev, savings denominated in lev almost disappeared. The low wages in general also influence propensity to save. After the initial period, gross savings started to grow also in absolute terms until the third quarter of 2002. Thereafter savings declined as Bulgarian banks loosened their credit policy in response to extra liquidity from abroad.

- ***The world real interest rate (real_libor)***—an index of quarterly average three-month LIBOR rates for the U.S. dollars[13] deflated by the index of quarterly inflation in the United States.[14] The evolution of **real LIBOR** reflects mainly developments in the United States: the real LIBOR increased until the asset bubble burst at end-2000 and interest rates started falling.

- ***Foreign direct investments (fdi)***—this is the index of foreign direct investment denominated in U.S. dollars with 1997 as a base year. It is derived from BNB balance of payments statistics. Careful analysis of the volume and structure of **foreign direct investments** shows that after 1997 Bulgaria has attracted sizeable direct investments, predominantly from non-privatization transactions. In 2001 privatization was virtually stopped by the political cycle, but Bulgaria still managed to draw the same volume of non-privatization FDI despite some political uncertainty.

The cointegrated equation of the real exchange rate is based on the following form:

$$r = f(tot, productivity, savings, real\_libor, fdi). \qquad (10)$$

The data was scanned for unit roots in all time series. All time series, except savings, are integrated at level one, and stationary in the first differential. According to the ADF test, the savings rate is integrated at level zero (Appendix II). The Phillips-Peron test was also performed, which, in contrast, does not reject the existence of unit roots in the level rank for savings. However, with the short time series, the determination of the level of integration is controversial.

[13] Data are taken from Bloomberg.

[14] Data from http://www.stls.frb.org/.

B. Estimation of Cointegrated Equation

To estimate the equation, the ARDL methodology of Pesaran et al (1996) was used. Its use is complicated by very short time series, but its advantage is that the long-term relationship between the selected variables can be directly identified (Frait and Komarek, 2002). The other advantage of the ARDL method is that it can be used irrespective of whether the regressors have the character I(1) or I(0). This is useful, especially for small samples, where the traditional test of unit roots are weak.

The method involves two steps. First, the existence of a long-term relationship is tested with the F-statistic, which indicates the significance of the lagged level of variables in the error correction form of the basic ARDL model. For the non-standard separation of this test statistic, the relevant critical values are given as two sets for the different systems (from the viewpoint of classifying the constant and trend). One set assumes that all variables belong to the I(1) type, the other that they are of the I(0) type. As long as the value of the test statistic is out of the range of the two benchmark values, the decision on the long-term relationship can be made without knowledge of the integration of the time series. If the value is in the range of these two benchmarks, it would be necessary to test the unit roots and the cointegration by the standard process. The second step of the Pesaran et al. method is to estimate the coefficient of the cointegrated equation and the error correction equation with the application of OLS to the ARDL.

The estimation shows that the coefficients of the cointegration equation have the expected signs. Those of the terms of trade, productivity and real LIBOR are significant at the 1 percent level, the coefficient of gross savings is significant at 10 percent level and that of foreign direct investment at the 5 percent level.

RER = 12.27 –0.24*lRER(-1) -0.98*lTOT +0.01*lSAVINGS –

0.32*lPRODUCTIVITY –0.08*REAL_LIBOR +0.003*lFDI

+1.36*dlTOT +1.46*dlTOT(-1) +1.15*dlTOT(-2) +0.37*dlTOT(-3)

+0.10*dREAL_LIBOR –0.04*dlSAVINGS(-2) +0.56*dlPRODUCTIVITY

+0.01*dREAL_LIBOR(-2) –0.08*SQ2

where l is the logarithm of the variable, d is the first difference, the numbers in brackets are the lags of the variables, and SQ2 is a seasonal variable.

The estimated equation of the long-run relationship is:

RER = -49.99 + 3.99ltot – 0.06lsavings + 1.3lproductivity + 0.34real_libor – 0.01lfdi [15]
(-27.96) (22.36) (-2.89) (19.74) (30.99) (-1.78)

[15] The t-values are given in brackets.

The coefficients of the long-run relationship are obtained by dividing the coefficients of the logarithms of independent variables by that of the first lag of RER of the previous estimated equation. The coefficient of the first lag of RER is –0.245, which means that the RER will reach the equilibrium level after approximately 4 periods, i.e. a year, if a shock occurs. The tests of serial correlation and normality are favorable, but heteroskedasticity cannot be tested because of the short data series. The estimation results show that the real exchange rate in Bulgaria is determined by fundamentals, e.g., productivity, terms of trade, gross savings, world interest rates, and foreign direct investment. However, these results should be interpreted with caution given the estimation problems with a small sample and problems with the data (see Appendix II for a discussion).

C. Misalignment of Real Exchange Rate

The above results can be used to determine deviations of the trend of the current real exchange rate from the equilibrium real exchange rate path. By using the equilibrium component of the real exchange rate from the ARDL method, one can compare the evolution of the actual real exchange rate with that of the equilibrium real exchange rate. With the BEER/NATREX approach, we can distinguish between two types of deviations or misalignments. The first deviation is the short-run *current* misalignment (speculative), which is determined by the deviation of the actual real exchange rate from the *actual equilibrium real exchange rate* that is estimated by virtue of the actual values of the fundamental determinants. The second deviation is the medium-run, *total* misalignment (cyclical and speculative), which is determined by the deviation of the actual real exchange rate from the estimated *sustainable equilibrium real exchange rate* based on the sustainable values of fundamental determinants. The sustainable values in turn are obtained by applying the Hodrick-Prescott filter to the original time series.

The calculations indicate that there is no significant deviation between the actual RER and the estimated short- and medium-term equilibrium levels. The current misalignment is estimated at -0.14 percent and the total misalignment at 1.77 percent for the first quarter of 2003. This suggests that there is no short-run or significant long-run misalignment,[16] and the evolution of RER is determined entirely by the fundamental factors. According to our calculations, there is an undervaluation of the real exchange rate from 1998 to the end of 2001. Since 2002 there has been some overvaluation but it has been decreasing. During the period of the study, the total misalignment is in the range from –6.2 percent to 7.1 percent and its trend is approaching zero. Hence, the long-run tendency is a convergence of the actual to the equilibrium level of the real effective exchange rate. The use of total productivity data instead sectoral may have biased the results towards finding overvaluation, which would strengthen the result of no overvaluation. But again, given the small sample and data problems, the results should be considered as tentative and subject to some uncertainty.

[16] The misalignment is estimated as follows: Misalignment = $(RER_{act} - RER_{eq})/RER_{eq}*100$. Positive values of the misalignment mean that the actual RER exceeds the estimated equilibrium level, so the RER is overvalued.

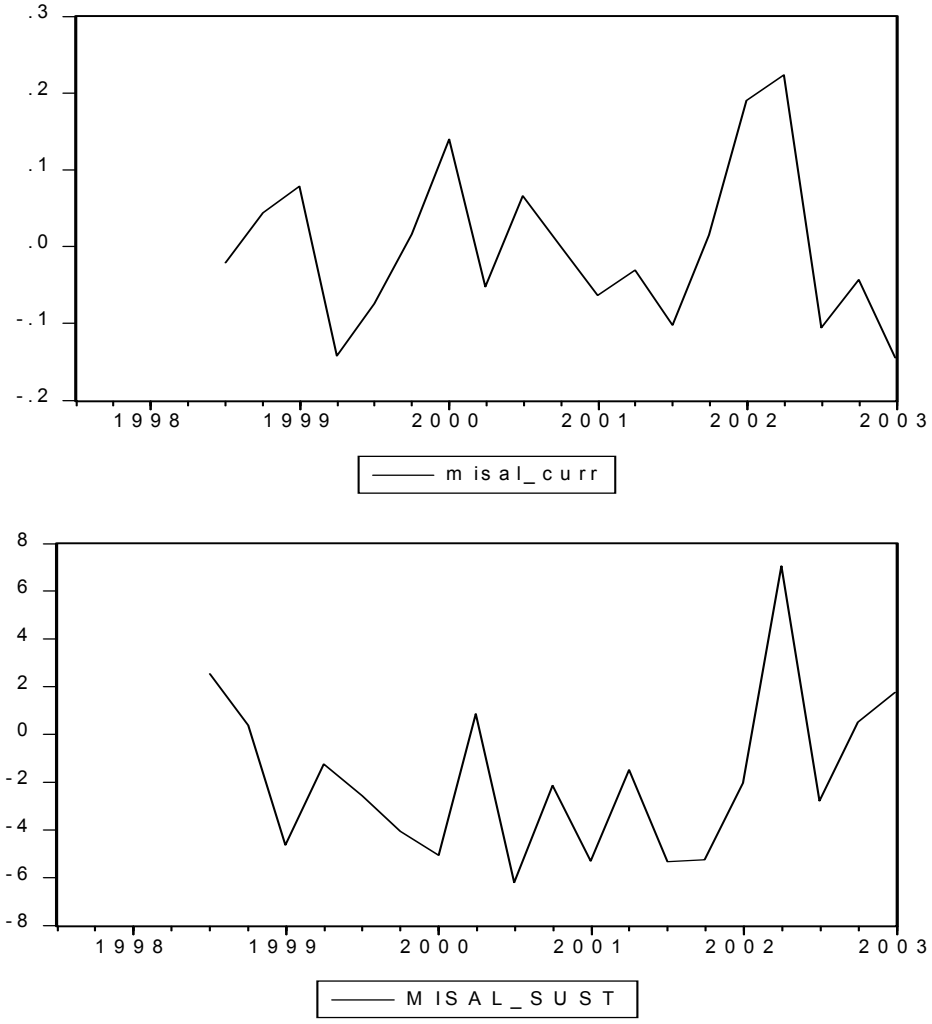
In practice this suggests that the widening current account deficit is not due to problems with competitiveness. This is also indicated by the continued growth of exports in recent years despite the sluggish demand in main partner markets in 2003. The rapid growth of imports is likely to reflect more demand pressures from increased capital inflows and growing bank credit. This would call for demand management policies, especially a cautious fiscal stance.

IV. CONCLUSIONS

The paper has analyzed the determinants of Bulgaria's real exchange rate, with emphasis on long-term aspects, and searched for the equilibrium path. It used a mixture of behavioral models of exchange rates (especially the BEER and the NATREX), which are the new complements to the often-used fundamental models of the FEER type. The paper constructed an econometric behavioral model to analyze the medium-term and long-term dynamics of the real exchange rate.

The paper has found that appreciation of the real exchange rate in Bulgaria reflects changes in fundamentals, such as productivity, terms of trade, gross savings, world interest rates, and foreign direct investment. This is in line with the results of RER studies on other transition countries, which show that real appreciation was generally a characteristic of a successful transition process. The small sample and data problems make the results tentative and subject to some uncertainty. Nevertheless, policymakers can assess undervaluation or overvaluation of the Bulgarian lev by using the variables and methodology identified in this study to monitor RER developments. At the same time, one must remember that the real exchange rate reacts to changes in these five variables with relatively complicated dynamics.

Figure 2: Actual and Total Misalignment of Real Lev Exchange Rate



Notes: misal_curr =short-run current misalignment; misal_sust=total misalignment

I. EXPLANATION OF THE MODEL AND ITS SHORTCOMINGS

The model for the RER is constructed by estimating a reduced-form equation. Such a reduced-form expression is represented in general terms by the following equation:

$$r_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \tau T_t + \varepsilon \qquad = r^E + \gamma T + \varepsilon \qquad (1)$$

Where r_t is the actual (current) value of the real exchange rate, Z_1 is a vector of economic fundamentals that are expected to have persistent effects, Z_2 is a vector of economic fundamentals that affect the real exchange rate over the medium term, which may coincide with the business cycle, while β_1, β_2 are vectors of reduced-form coefficients. T is a vector of transitory factors affecting the real exchange rate in the short term, τ - a vector of reduced-form coefficients, ε_t – a random disturbance term. The actual (current) equilibrium level of the real exchange rate, $r^{E,}$ is given by the current values of the groups of fundamental determinants:

$$r^E = \alpha Z_1 + \beta Z_2 \qquad (2)$$

Current values of fundamental determinants may differ from the sustainable or desirable levels (conforming with the FEER). The sustainable equilibrium level of the real exchange rate, r^F, is based on long-run levels of fundamental determinants (Z^F_1 and Z^F_2) and can be defined as:

$$r^F = \alpha Z^F_1 + \beta Z^F_2. \qquad (3)$$

The main problems with the method are the identification and choice of short-term factors, medium-term and long-term fundamentals, and the calibration of the sustainable level of these fundamentals. MacDonald (1997) divides the determinants of the real exchange rate into two groups. The first group consists of fundamental factors excluding real interest rates, i.e., group Z_1. The terms of trade *(tot)*, the sectoral or aggregate productivity *(prod)*, net domestic savings *(sav)*, the balance of public finance *(fisc)*, and net foreign assets *(nfa)* can be part of this group. Improvements in all of these factors lead to appreciation of the domestic currency in the long run (the real exchange rate rises). The second group comprises the real interest rate differential (RID) that reflects real uncovered interest parity.

$$r_t = r^e_{t+k} - (i_t - i^*_t) + \sigma_t = r^e_{t+k} - (i_t - i^*_t) + (\lambda_t + k) \qquad (4)$$

Where r^e_{t+k} is the expected real exchange rate in time t+k, i is the *ex ante* real interest rate, and $\sigma_t = (\lambda_t + k)$ is the risk premium of the domestic currency—with a time variable component and a component that is given by maturity. The symbol t+k defines the maturity of the bond. This equation describes the current real exchange rate as a function of the future expected real exchange rate, the real interest rate differential and the risk premium. The risk premium in turn is a positive function of the relative supply of domestic and foreign debt $\sigma_t = (debt_t/debt^*_t)$. An increase in domestic debt supply relative to foreign debt supply thus increases the risk premium, which requires depreciation of the current real exchange rate.

The BEER can be derived from the long-term fundamentals Z_{1t}. The general BEER equation r^E_t can be rewritten as:

$$BEER = r^E(tot, prod, fisc, sav, nfa, i-i^*, debt/debt^*) \qquad (5)$$

If there is a systematic relationship between the RER and the fundamental factors, then the variables are cointegrated, and the estimated BEER can be thought of as the equilibrium real exchange rate in the behavioral sense. Deviations of the actual real exchange rate from the BEER are not possible in the long run, because the cointegrating relationship brings the real exchange rate back to the trajectory corresponding to the long-term values of the fundamental factors.

A disadvantage of the BEER is that it does not identify which of the fundamental factors are sustainable and which are not. Therefore, the fundamental factors should be calibrated on their medium-term sustainable level,[17] which can be done using the Hodrick-Prescott filter. This technique shows characteristics of the FEER without losing valuable features of the BEER, and makes it possible to calculate total misalignment. Factors that ensure internal balance, like low inflation and potential income, can easily be calibrated. The calibration of fundamental factors is more difficult for the external balance, because the model is based on the uncovered interest rate parity, which may not hold in the presence of external financing constraints. Furthermore, the model includes a readjustment mechanism of the long-run reaction of the real exchange rate to changes in government debt and in net foreign assets.

Another problem with the BEER is that it reflects both long- and medium-term factors. If we would like to look at misalignment from the long-term point of view only, then we must also exclude the medium-term factors from the analysis (the real interest rate differential and risk premium). Under these assumptions, the BEER would be close to another measure of the real exchange rate, which is called the NATREX.

The NATREX is a fluctuating medium- to long-term equilibrium exchange rate, determined by the fundamental factors in the absence of speculative capital flows and changes in monetary reserves. The longer-term determinants can be savings, productivity, and foreign debt (and for small, open economies also exogenous terms of trade and world real interest rates). They influence desirable long-term capital flows and change the equilibrium real exchange rate to which the actual real exchange rate then accommodates.

The NATREX is determined by real fundamental factors and existing macroeconomic policies. These policies need not be optimal, and the NATREX therefore does not need to be the optimal real exchange rate from a welfare point of view. The NATREX emphasizes the trajectory of the real exchange rate, i.e., it distinguishes the initial and long-term effects of changing the fundamental determinants on the equilibrium real exchange rate.

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[17] MacDonald (1997) calibrates the sustainable values of the fundamental factors by means of the Hodrick-Prescott filter.

Models of the NATREX start in some hypothetical intracyclical medium run where prices are confirmed and real income returns to its intracyclical potential levels. The medium-term equilibrium is an artificial construction, to which the economy orients itself, though, without ever achieving it. For this reason, we cannot observe the NATREX, but only the current real exchange rate which adjusts itself to the NATREX. The medium-term equilibrium can be described by the following equation:

$$I - S + CA = 0 \qquad (6)$$

where *I* is intended investment, *S* intended savings and *CA* the intended current account.

The model assumes that there is equilibrium in the goods and services market and in the balance of payments.[18] Investment (I), savings (S) and net capital flows (I - S) produce changes in the stock of physical capital (k), net foreign debt (F) and wealth (W = k - F). This, in turn, changes intended savings, investment and the current account. The latter three factors have an impact on the real exchange rate. The exogenous changes of fundamental determinants (Z)[19] influence *I, S* and *C*A, leading to short-term NATREX changes. They also influence the rate of accumulation of k, *F* and W changing the NATREX trajectory (it shifts to a new long-term level). The complete model of the NATREX determines the medium-term equilibrium real exchange rate (R=NATREX), its consecutive trajectory and any long-term equilibrium real exchange rate in a steady state (R̲). The trajectory of the real exchange rate can be estimated as a function of the exogenous fundamental factors. However, the economy is permanently exposed to shocks to the fundamentals, which direct the NATREX to a new equilibrium level, and a steady state is never reached. In other words, the equilibrium real exchange rate is not stationary, because its fundamental determinants are not stationary.

The results from estimating the NATREX with quarterly data need to be interpreted with care. Exogenous changes of investment and savings generate a new trajectory for the real exchange rate, which the empirical analysis tries to catch. The cointegration analysis estimates the long-term effect of independent variables and deviations of dependent variables from the long-term equilibrium when the adjustment process requires a certain amount of time. The long-term cointegration equation of the NATREX can be interpreted as estimating the effect of the fundamental determinants on the NATREX in steady state, while the estimate of the correction term should show the medium-term reaction of the NATREX when the stock of real assets is changing.

The cointegrated equation can estimate the long-term relationship only if the data sample is long enough to demonstrate a readjustment of a large number of observations. If the time series is too short, the estimated equations reflect only short- and

[18] When real output reaches its potential level, inflation reaches its expected level and the real exchange rate clears the goods and services market.

[19] Changes in the propensity to save, productivity, the terms of trade and foreign real interest rates.

medium-term relationships. The correction term should ideally capture the medium-term reaction of the real exchange rate to a change in a fundamental determinant at a constant state of activity. In reality, the state of activity changes quickly after exogenous changes in savings and investments, i.e., before the conditions of the medium-term intracyclical equilibrium are satisfied. Therefore, the level of adjustment that the cointegration equation picks up cannot be known.

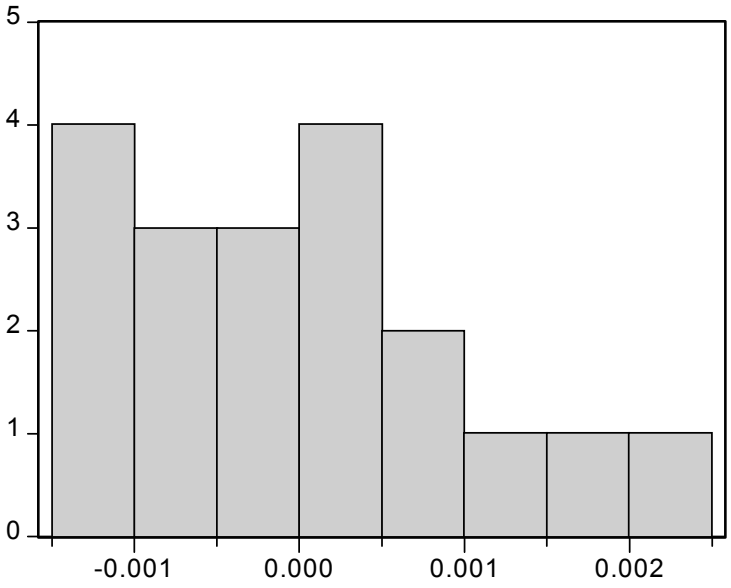
II. ESTIMATION RESULTS

Dependent Variable: LREER
Method: Least Squares
Date: 08/22/03 Time: 16:45
Sample(adjusted): 1998:3 2003:1
Included observations: 19 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.27347	0.438909	27.96357	0.0001
LREER(-1)	-0.245496	0.049092	-5.000715	0.0154
LTOT	-0.979524	0.043801	-22.36329	0.0002
LSAVINGS	0.013974	0.004839	2.887876	0.0631
LPRODUCTIVITY	-0.319561	0.016189	-19.73952	0.0003
REAL_LIBOR01	-0.084057	0.002712	-30.99380	0.0001
LFDI	0.003484	0.001957	1.780599	0.1730
DLTOT	1.361993	0.053704	25.36124	0.0001
DLTOT(-1)	1.460687	0.058488	24.97424	0.0001
DLTOT(-2)	1.153782	0.046670	24.72193	0.0001
DLTOT(-3)	0.365241	0.015666	23.31426	0.0002
DREAL_LIBOR01	0.099495	0.003583	27.77110	0.0001
DLSAVINGS(-2)	-0.036536	0.003485	-10.48348	0.0019
DLPRODUCTIVITY	0.560812	0.047237	11.87228	0.0013
DREAL_LIBOR01(-2)	0.014337	0.002207	6.497198	0.0074
SQ2	-0.077514	0.003659	-21.18219	0.0002

R-squared	0.999692	Mean dependent var	4.703222
Adjusted R-squared	0.998152	S.D. dependent var	0.059553
S.E. of regression	0.002560	Akaike info criterion	-9.259066
Sum squared resid	1.97E-05	Schwarz criterion	-8.463749
Log likelihood	103.9611	F-statistic	649.0900
Durbin-Watson stat	1.602860	Prob(F-statistic)	0.000088

Histogram—Normality Test



Series: Residuals	
Sample 1998:3 2003:1	
Observations 19	
Mean	5.50E-16
Median	-0.000211
Maximum	0.002239
Minimum	-0.001442
Std. Dev.	0.001045
Skewness	0.637096
Kurtosis	2.647878
Jarque-Bera	1.383482
Probability	0.500703

ARCH Test

ARCH Test:

F-statistic	0.983238	Probability	0.398504
Obs*R-squared	2.093767	Probability	0.351030

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/25/03 Time: 10:04
Sample(adjusted): 1999:1 2003:1
Included observations: 17 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.08E-06	4.68E-07	2.315382	0.0363
RESID^2(-1)	0.321397	0.262758	1.223168	0.2415
RESID^2(-2)	-0.266103	0.261703	-1.016812	0.3265

R-squared	0.123163	Mean dependent var	1.14E-06
Adjusted R-squared	-0.002100	S.D. dependent var	1.41E-06
S.E. of regression	1.41E-06	Akaike info criterion	-23.94999
Sum squared resid	2.78E-11	Schwarz criterion	-23.80296
Log likelihood	206.5749	F-statistic	0.983238
Durbin-Watson stat	1.839928	Prob(F-statistic)	0.398504

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.197464	Probability	0.846690
Obs*R-squared	5.379221	Probability	0.067907

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/25/03 Time: 10:02
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.054816	0.717426	0.076406	0.9515
LREER(-1)	-0.009483	0.078855	-0.120254	0.9238
LTOT	-0.006117	0.065035	-0.094052	0.9403
LSAVINGS	0.000173	0.008281	0.020850	0.9867
LPRODUCTIVITY	0.002726	0.026911	0.101284	0.9357
REAL_LIBOR01	-0.000737	0.004479	-0.164622	0.8961
LFDI	0.001530	0.007848	0.194943	0.8774
DLTOT	-0.009870	0.103420	-0.095439	0.9394
DLTOT(-1)	-0.007423	0.128741	-0.057655	0.9633
DLTOT(-2)	0.014951	0.096888	0.154310	0.9025
DLTOT(-3)	0.010595	0.035062	0.302187	0.8132
DREAL_LIBOR01	0.000228	0.009377	0.024329	0.9845
DLSAVINGS(-2)	-0.000672	0.009726	-0.069096	0.9561
DLPRODUCTIVITY	0.017191	0.081318	0.211404	0.8674
DREAL_LIBOR01(-2)	0.000888	0.003563	0.249214	0.8445
SQ2	-0.003470	0.007779	-0.446021	0.7329
RESID(-1)	1.219992	3.477866	0.350787	0.7852
RESID(-2)	-0.449703	1.897812	-0.236959	0.8519

R-squared	0.283117	Mean dependent var	5.50E-16
Adjusted R-squared	-11.903896	S.D. dependent var	0.001045
S.E. of regression	0.003755	Akaike info criterion	-9.381382
Sum squared resid	1.41E-05	Schwarz criterion	-8.486650
Log likelihood	107.1231	F-statistic	0.023231
Durbin-Watson stat	2.143525	Prob(F-statistic)	0.999995

Q-Statistics

Date: 08/25/03 Time: 10:09
Sample: 1998:3 2003:1
Included observations: 19

	AC	PAC	Q-Stat	Prob
1	0.145	0.145	0.4633	0.496
2	-0.237	-0.264	1.7855	0.410
3	-0.428	-0.381	6.3613	0.095
4	-0.176	-0.169	7.1828	0.127
5	-0.078	-0.310	7.3551	0.196
6	0.125	-0.174	7.8329	0.251
7	0.142	-0.168	8.5003	0.291
8	0.117	-0.145	8.9934	0.343
9	0.228	0.231	11.070	0.271
10	-0.218	-0.302	13.170	0.214
11	-0.236	-0.081	15.953	0.143
12	-0.137	-0.068	17.027	0.149

Squared Residuals

Date: 08/25/03 Time: 10:15
Sample: 1998:3 2003:1
Included observations: 19

	AC	PAC	Q-Stat	Prob
1	0.252	0.252	1.4083	0.235
2	-0.163	-0.242	2.0302	0.362
3	0.057	0.192	2.1114	0.550
4	0.026	-0.108	2.1296	0.712
5	-0.164	-0.107	2.8927	0.717
6	-0.116	-0.051	3.3039	0.770
7	-0.127	-0.167	3.8416	0.798
8	0.040	0.163	3.9000	0.866
9	0.086	-0.038	4.1958	0.898
10	-0.141	-0.149	5.0759	0.886
11	0.009	0.136	5.0795	0.927
12	0.162	-0.028	6.5716	0.885

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