AN ASSESSMENT OF THE EQUILIBRIUM EXCHANGE RATE FOR MOLDAVIAN LEU APPLYING THE BEER MODEL

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Abstract: *In order to analyze the long-run sustainability of the Moldavian leu against the euro, is estimated the equilibrium exchange rate, using the BEER model and are determined the total misalignments of the real exchange rate. The variables used are: the degree of openness, the productivity differential, the real interest rate differential, and the net foreign assets.*

1. Introduction

The assessment of the equilibrium exchange rate has been always an important issue for macroeconomists, due to the fact that the real exchange rate is one of the most important prices, especially for small open economies as Republic of Moldova.

In this context the main goals of this paper is to identify the economic fundamentals, which determine the evolution of the exchange rate on the medium and long run, then applying the Behavioural Equilibrium exchange Rate Model to estimate an equilibrium exchange rate, and to determine the misalignments of the real exchange rate and main factors which determined these misalignments.

2. Literature review

For the Central and Eastern European Countries (CEE) the most used model was the Behavioural Exchange Rate (BEER).

This model was introduced by Clark and MacDonald in 1998 [1]. BEER model try to estimate the equilibrium exchange rate using a wide range of economic fundamentals. The actual exchange rate is considered to be in equilibrium in a behavioural sense when its movements reflect changes in these fundamentals.

As determinants of the exchange rate, for the medium and long run was considered a large number of fundamentals, the most common being: net foreign asset position, productivity differential, and the openness ratio of the country economy.

But, were, also, many studies, which tried to particularize the BEER model for the analyzed economy. For example Egert and Halpern [2] considered as fundamentals, too, the public and external debt, Saayman [5] – the government consumption and the gross reserves, Melecky and Komarek [3] – interest rate differential and foreign direct investment.

A model derived from BEER can be considered the Permanent Equilibrium Exchange Rate (PEER), which differs from BEER in that it decomposes directly the estimated long-term cointegration relationship into transitory and permanent components, with the latter constituting the measure of the equilibrium exchange rate. [2]

2. The Behavioural Equilibrium Exchange Rate approach

The concept of Behavioral Equilibrium Exchange Rate was introduced by Clark and MacDonald in 1998. Authors assumed that the real exchange rate can be decomposed into transitory, medium-run and long-run components. [1, p.10]

$$q_t = \beta_1' Z_{1t} + \beta_2' Z_{2t} + \tau' T_t + \varepsilon_t \qquad (1)$$

where:

q_t *– the real exchange rate*

Z_{1t}, Z_{2t} *- vectors of long-run and medium-run fundamentals*

T_t *– a transitory component*

ε_t *– random disturbance term*

Setting transitory components to zero, the "current equilibrium rate" or medium-run BEER ($\bar{q}_{1t}$) can be defined by:

$$\bar{q}_t = \beta_1' Z_{1t} + \beta_2' Z_{2t} \qquad (2)$$

The long-run BEER (also, known as Permanent Equilibrium Exchange Rate (PEER), is reached when fundamentals are at their long-run value, and can be written as:

$$\bar{q}_{Lt} = \beta_1' \bar{Z}_{1t} + \beta_2' \bar{Z}_{2t} \qquad (3)$$

Consequently, the total misalignment, defined by Clark and MacDonald in 1999 can be computed as the difference between the actual and equilibrium exchange rate, given by the long-run values of the economic fundamentals: [4, p.6]

$$tm_t = q_t - \beta_1' \bar{Z}_{1t} - \beta_2' \bar{Z}_{2t} \qquad (4)$$

5. Empirical results

5.1 Data

In the following study were used quarterly data covering the period from the first thirs quarter of 2000 to the fourth quarter of 2010 (42 observations).

The data were obtained from the International Monetary Fund's International Financial Statistics (IMF) and United Nations Economic Commission Database.

Where appropriate the series were seasonally adjusted using the Tramo Seats procedure and transformed into natural logarithms.

Real exchange rate (leur): was considered an average nominal exchange rate EUR/MDL, deflated by the consumer price indexes (CPI) in both countries (Moldova and Euro Area). A decrease of rer denotes a real appreciation, and an increase a real depreciation, of the home currency.

Productivity differential (lprod): was calculated as the ratio of real GDP over employment in both countries. This variable was used to capture the Balassa-Samuelson effect.

Net foreign assets (lnfa): to compute the variable of the net foreign asset position we used the ratio of the negative of the net foreign assets, calculated based on the methodology proposed by Lane and Milesi-Ferretti (2004) to nominal GDP, both denominated in MDL.

Also, we considered, that the net foreign assets position influences positively the real exchange rate and was calculated it as follows:

$$NFAt=NFA_0+\Delta NFA_t \quad (5)$$

$$\Delta NFAt\approx CA_t+\Delta KA_t \quad (6)$$

where: NFA0 – initial value of the net foreign assets, which was set to zero, CA – current account balance, ΔKA – change in capital account balance

Degree of openness (lopen): to capture the impact of the level of liberalization of external trade we considered as a variable the degree of openness, and calculated it as the domestic ratio of the sum of exports and imports in GDP.

Interest rate differential (lrd): the differential between the Moldavian and Euro Area money market rates (3 months), deflated by Moldavian and Euro Area CPI inflation.

Dummy variables (crisis, crisis2): I used two dummy variables: one for the present international financial crisis: this variable takes the value 1 in 2008Q2-2010Q4 and 0 for other periods of the sample. And the other dummy variable was used for the second quarter of 2002.

5.2 Unit root test

To find the order of integration of the variables we applied two tests: the Augmented Dickey-Fuller Test (ADF test) and Phillips-Perron Test (PP test). The lag length for the test was chosen using automatic selection, based on the Schwarz Info Criterio (SC), with maximum 4 lags, because we have the quarterly data.

With respect to the equation of the performed test, we decided to include a constant and a time trend for variables in levels, and a constant for first differences.

The results of running the ADF tests in level on the series mentioned above, suggested, that the null hypothesis, that a series has a unit root, cannot be rejected at the 5 percent level and that the time series variables are all non-stationary in the level form.

The variables were therefore differenced and the ADF test runs again. The results from the table above indicate that the variables in their first difference are all stationary at the 1 percent significance level.

Table 1: Unit root test results

Variable	ADF test	PP test
leur	34,53%	57,41%
lprod	13.70%	17.54%
lnfa	26,70%	<1%
lrd	<1%	27,92%
lopen	57,54%	49,03%
D(leur)	<1%	<1%
D (lprod)	<1%	<1%
D(lnfa)	<1%	<1%
D(lrd)	<1%	<1%
D(lopen)	<1%	<1%

Source: Author's calculations

5.3 Johansen cointegration method

Given that all variables were integrated of order one, next was performed a cointegration test, to identify the long-run relationship between them.

To estimate the optimal number of lags used in the model, we used the following tests: LR, sequential modified LR test statistic, Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). The test results showed one or three lags and was decided to choose one lag length in the VAR model.

Table 2: Lag length test results

Lag	LR	FPE	AIC	SC	HQ
0	NA	2.87e-08	-3.178241	-2.733856	-3.024839
1	221.5578	4.50e-11	-9.662449	-8.107101*	-9.125543*
2	33.13304	5.00e-11	-9.674444	-7.008133	-8.754034
3	38.35641*	3.35e-11*	-10.37678*	-6.599511	-9.072870

Source: Author's calculations

Table 3: VAR model evaluation and diagnostics

VAR stability condition check	No root lies outside the unit circle VAR satisfies the stability condition		
Autocorrelation LM test	LM1	LM2	LM3
LM-statistics	35.28009	31.66842	32.28778
p-value	(0.0833)	(0.1678)	(0.1499)
	no serial correlations		
Heteroskedasticity test	χ^2(180)=197.8154 (0.1725) no heteroskedasticity		
Jarque-Bera normality test	x^2(10)=13.84735 (0.1801) normally distributed		

Source: Author's calculations

The next step, we performed a series residual tests on VAR and was evaluated the stability of the chosen model. The results presented in the table 3, indicate that the VAR model satisfies all the tests conditions.

To test the presence of the cointegrating relationship between the variables were applied Trace and Maximum-Eigen Value statistics.

According to the trace and critical value statistics, presented in the table 4, was rejected the null hypothesis, of no cointegration, and accepted the alternative hypothesis, of existence of one cointegrating relationship among the variables, at the 5% significance level.

Table 4: VAR cointegration test statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	Maximum-Eigen value
None	0.665168	98.41624 (76.97277)*	40.48264 (34.80587)*
At most 1	0.482005	57.93360 (54.07904)*	24.33822 (28.58808)
At most 2	0.413114	33.59538 (35.19275)	19.71822 (22.29962)
At most 3	0.236775	13.87716 (20.26184)	9.997512 (15.89210)

* denotes rejection of the hypothesis at the 0.05 level
Source: Author's calculations

Table 5: Estimation of cointegrating coefficients

	leur	lnfa	Lopen	lprod	lrd	c
Normalized cointegrating coefficient	1.000000	0.461416	-0.033398	-0.626801	-0.067337	-1.800828
Standard error		0.03256	0.10681	0.07352	0.01796	
t-statistic		[14.1712]*	[0.3126]	[8.5255]*	[3.7492]*	

* denotes rejection of the hypothesis at the 0.05 level
Source: Author's calculations

On the basis of the estimated cointegration vector, the long-run relationship between the variables could be written as follows:

leur = -0.461416* lnfa + 0.033398* lopen + 0.626801* lprod+0.067337* lrd + 1.800828 (7)

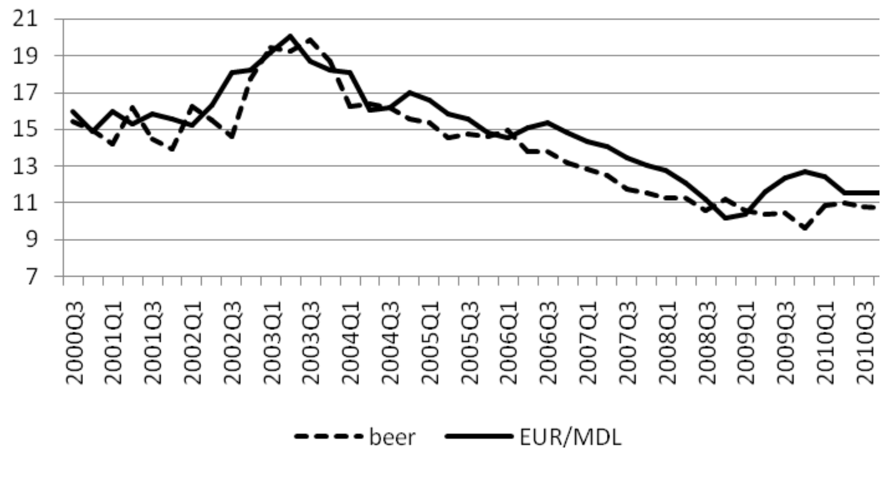
From the equation we can see that mainly all the variables influence positively the real exchange rate, except the net foreign assets. Also, we can observe that the great contribution to the exchange rate evolution have the net foreign assets and productivity differential.

Substituting the values of the fundamental factors in the equation above was obtained the Behavioural Equilibrium Exchange Rate (BEER).

5.4 Exchange rate misalignments

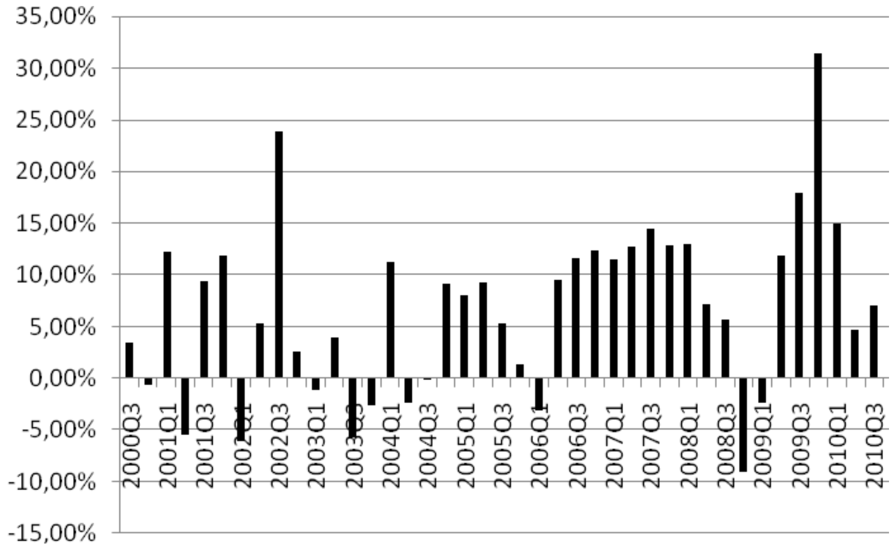
As we can see from the figures below, the level of misalignments for the analyzed period of time was low, as an exception we can mention the year of 2009, than the larger deviation exceeded the 30% level, overall the Moldavian leu being slightly undervalued against the euro.

Figure 1: Evolution of the real exchange rate and the long-run equilibrium exchange rate



Source: Author's calculations

Figure 2: Evolution of the total misalignments of the real exchange rate



Source: Author's calculations

6. Conclusions

The aim of this paper was to assess the long-run sustainability of the Moldavian exchange rate against the euro. For this purpose was estimated the long-run equilibrium exchange rate, applying the BEER model and methodology specific to non-stationary time-series. The main conclusion drawn, after analyzing the total misalignments of the real exchange rate, was that in the medium and long run the EUR/MDL exchange rate was sustainable, but, also was very vulnerable to the shocks from outside, such as international financial crisis from the last years.

7. References

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