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The Estimation of the Equilibrium Real Exchange Rate for Romania

By

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Abstract:

This paper aims to estimate the equilibrium real exchange rate for Romania, respectively the real exchange rate consistent with the macroeconomic balance, which is achieved when the economy is operating at full employment and low inflation (internal balance) and has a current account that is sustainable (external balance). This equilibrium real exchange rate is very important for an economy because deviations of the real exchange rate from its equilibrium value can affect the competitiveness of a country. An overvalued real exchange rate will determine a lack of external competitiveness and deteriorate the country's real activity. An undervalued exchange rate will increase on short term exports and it will lower the current account deficit but, on the long term it will increase the inflationary pressures. The equilibrium real exchange rate is also a very important variable for a country who wishes to join ERM II. In fact the central parity should be chosen to reflect the equilibrium exchange rate. The conclusion is that the real exchange rate had some important deviations from its equilibrium value which were determined by the liberalization of the prices and of the foreign exchange market and by the fluctuations of the nominal exchange rate. These deviations are not likely to put at risk the entry in ERM II.

Keywords: *equilibrium real exchange rate, productivity differential, nominal convergence*

JEL Classification: M41, M42, H83

1. Introduction

This paper aims to provide estimates for the equilibrium real exchange rate in Romania, respectively the real exchange rate consistent with the macroeconomic balance, which is achieved when the economy is operating at full employment and low inflation (internal balance) and a current account that is sustainable (external balance). This equilibrium real exchange rate is very

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important for an economy because deviations of the real exchange rate from its equilibrium value can affect the competitiveness of a country. An overvalued real exchange rate will determine a lack of external competitiveness and deteriorate the country's real activity. An undervalued exchange rate will increase on short term exports and it will lower the current account deficit but, on the long term it will increase the inflationary pressures. The equilibrium real exchange rate is also a very important variable for a country who wishes to join ERM II. In fact the central parity should be chosen to reflect the equilibrium exchange rate. If not, it will be hard for the central bank to limit the fluctuation to +-15% and it could result a delay in adopting the euro.

This paper will use a BEER approach in order to estimate the equilibrium exchange rate. This approach was computed by Clark and MacDonald (1998) and consists in explaining the actual behavior of the exchange rate in terms of relevant economic variables. The variables used in this paper are: the productivity differential between Romania and the Euro area (productivity differential between the two sectors of the economy), total consumption, net foreign assets and the degree of openness.

2. Literature Review

The first attempt to determine a countries equilibrium exchange rate was made by Gustav Cassel (1922) who introduced the purchasing power parity. The PPP theory states that exchange rates tend to equalize relative price levels in different countries. This theory can be seen as a long –term tendency for the exchange rate (the value predicted by the PPP theory is an equilibrium value). However, the convergence to PPP is a slow process. Consensus estimates put the half-life of deviations from PPP at about 4 years for exchange rates among major industrialized countries. The theory is not valid on the short term for various reasons: first, the existence of non-tradable sector (a sector where prices do not equalize because they are not subject of international competition) creates important deviations from the level determine by PPP. Second, exchange rates tend to be higher in rich countries than in poor countries, and relatively fast growing countries experience real exchange rate appreciation. The econometric testing of PPP evolved from linear regressions to unit root and cointegration tests.

Balassa and Samuelsson were the first who showed that the PPP theory is not valid. They separate the economy in 2 sectors: the tradable sector (goods) that is subject to international competition and non-tradable sector (services). The productivity tends to increase more in the tradable sector than in the non-tradable sector. As a result, the wages in the tradable sector increase and, with labor being mobile, wages in the entire economy will rise. Producers of non-tradables will be able to pay the higher wages only if the relative price of non-tradables rises. This will in general lead to an increase in the overall price level in the economy. For a catch-up country the productivity gains are higher so the effect is stronger.

Wiliamson (1994) introduced the concept of fundamental equilibrium exchange rate (FEER) which is the exchange rate consistent with the macroeconomic balance, both internally and externally. Internal balance is the

level of output consistent with full employment (NAIRU) and low inflation. The external balance is the desirable net flow of resources between countries when they are in internal balance. The FEER exchange rate measure is a normative one; it is an equilibrium exchange rate consistent with ideal economic conditions.

Clark and MacDonald (1998) introduced the BEER approach (Behavioral Equilibrium Exchange Rate) which is the most used technique for estimating the equilibrium real exchange rate. Basically, it consists in estimating a reduced-form model, which explains the behavior of the real exchange rate on medium and long term. The model allows calculating the current misalignment and the total misalignment from the equilibrium exchange rate. The variables used for explaining the behavior of the real exchange rate are not the same for each country. Generally speaking, these variables are:
the productivity differential (an increase will result in real appreciation), the degree of openness (positive or negative relation), terms of trade (an increase will result in real appreciation), consumption (positive or negative relation), real interest rate differential (an increase will result in appreciation). The BEER approach was used in the estimation of equilibrium real exchange rates for central and eastern european countries by Halpern and Wyplosz (2001), De Broeck and Slok (2001), Egert (2002).

Stein (1994) introduced the notion of Natural Real Exchange Rate (NATREX). This theory states that the desired capital flows between two countries depends on the difference between investments and savings. The variables used are productivity and savings which influence the capital account. The latter influences the real exchange rate by changes in the current account. The equilibrium is obtained when the domestic capital stock and net foreign assets are set to their equilibrium values.

The econometric techniques used are unit root and cointegration tests which show the long-term behavior of the series. Because of the limited number of observations some authors use panel analysis. (Egert 2004, Coudert and Couharde, 2006).

3. The Model

This paper uses a BEER model in order to estimate equilibrium real exchange rate. The starting point in this model consists in expressing the real exchange rate as a function of the expected value of the real exchange rate at maturity t+k, the real interest rate differential and a time-varying premium-risk: (nominal exchange rate is expressed in units of foreign currency for one unit of local currency so an increase stands for depreciation)

$$q_t = E_t(q_{t+k}) + (r_t - r_t^*) - \Pi_t \quad (1)$$

The time-varying risk premium is a function of relative government debt. Because of the low level for this variable for Romania I considered that the risk premium is 0. Also I tried to implement the real interest rate differential but the results were not statistically significant.

I assume that the unobservable expectation of the exchange rate is determined solely by the long run economic fundamentals Z_{1t}. I denote the long run equilibrium as $\hat{q}$ and assume that $\hat{q}_t = E_t[\beta_1 Z_{1t}] = \beta_1 \overline{Z}_{1t}$

The total misalignment from the equilibrium real exchange rate can be expressed:

$$tm_t = q_t - \beta_1 \overline{Z}_{1t} \quad (2)$$

The long-run economic fundamentals used in this paper are $\hat{q}_t = f(prod, cons, nfa, open)$. The coefficients are found to be statistically significant and correctly signed.

The steps in estimating the equilibrium exchange rate will be described in Section 5.

4. Data Description

The source of data is Eurostat and The National Bank of Romania database. The economies and periods covered are Romania (1998:1-2006:3) and Euro area (1998:1 - 2006:3). The frequency of observations is quarterly and, in the econometric work, all series are seasonally adjusted using TramoSeats.

A first problem is how to construct tradable and non-tradable sectors. I have considered both the suggestions present in the literature and the characteristics of the Romanian economy. The tradable-sector is composed from industry and construction while the non-tradable is residual (total - tradable – agriculture). I didn't include agriculture because trade is distorted by controlled prices.

A very important fact is that when I calculated the productivity differential I have also considered the share of tradables (calculate as the share of the tradable sector in total value added). Also, the productivity is proxied by labor productivity because data on capital stocks are unavailable.

All variables are in constant prices (1998=100).

Description of variables:

- Quarterly observations of value added from the production side GDP estimates (decomposed into tradables and non-tradables)
- CPI rates of inflation with subcomponents enabling a breakdown into traded and non-traded goods and services
- Nominal exchange rates of domestic currency against the euro (quarterly averages)
- Employment (quarterly averages) in traded and non-traded industries.
- Consumption, net foreign assets, openness as a share of GDP.

5. Empirical Results

In order to estimate the equilibrium real exchange rate using a BEER approach I have followed more steps.

First I checked if the series used are stationary, using Augmented Dickey-Fuller and Phillips-Perron tests. The results are in the appendix (table 1.a)

As it can be seen from the table all variables are integrated of order 1.

Next I tried to determine a long-term relation between variables by using cointegration tests. First I estimated a VAR. The lag length was choosing in order to minimize the information criterions. The results are in the appendix (table 2.a)

After examining the results from table 2.a, I have estimated a VAR with 3 lags. The tests performed on the residuals revealed a normal distribution, no autocorrelation and the absence of heteroskedasticity. The results are presented in the appendix (table 6.a)

Next I performed a Johansen cointegration test. The test showed the presence of two cointegrations vectors at both 1% and 5% level. The results are presented in the appendix (table 3.a)

If we normalize the cointegrating vector with respect to RER, we can obtain the following expression (standard errors in ( ), t-statistics in [ ]):

RER= -1.4336*PROD_DIF - 4.8498*CONS - 0.3151*NFA +1.8390*OPENESS - 0.6816

(0.1545)	(0.8637)	(0.029)	(0.1273)
[9.2795]	[5.6158]	[10.6710]	[-14.4494]

All coefficients are statistically significant and correctly signed. An increase in the productivity differential between Romania and the euro area will lead to an appreciation of the real exchange rate, as predicted by the Balassa-Samuleson effect. An increase in the productivity differential will increase the relative price of non-tradables. Given the fact that non-tradable goods and services represent about 65% of the consumption basket, domestic prices will have a superior dynamic to inflation of the euro area. As a consequence the real exchange rate appreciates.

An increase in consumption will lead to real exchange rate appreciation because it is mainly directed towards non-tradable goods.

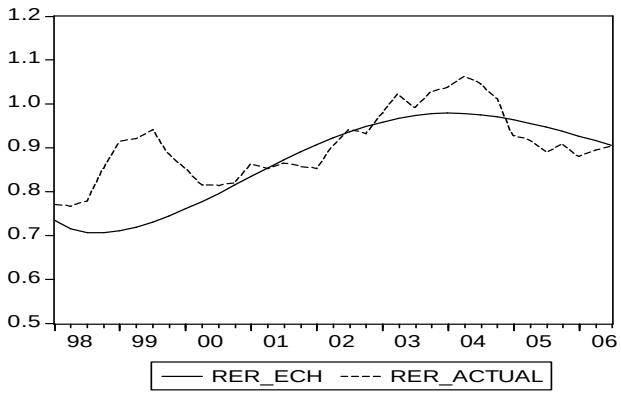
An increase in net foreign assets will lead to real exchange rate appreciation which is characteristic for a transition country. A higher value for this variable will lead to higher yield for domestic savings, higher levels of foreign currency entering the country and as a consequence, real exchange rate appreciation.

An increase in the degree of openness will determine an increased demand for foreign tradable goods, the current account deficit will widen so a depreciation of the real exchange rate will be required.

The next step in the BEER approach requires the estimation of the long run sustainable values for the variables used. In order to do that, I have used a Hodrick-Prescott filter on the extend ARIMA series. (I have extended the series because of the problems of the Hodrick-Prescott filter at the beginning and at the end of the series). The results are in the appendix. (Figures 1.a to 4.a)

In order to determine the equilibrium real exchange rate, I have replaced the values obtained by filtering the series in the cointegrating relationship estimated in step 1. The results were used to construct the next figure:

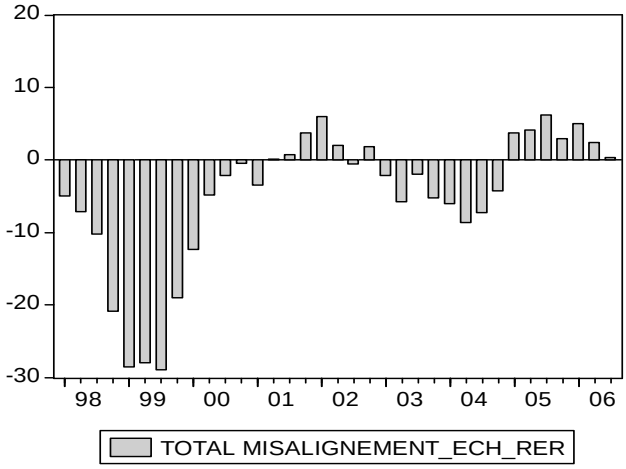
Figure 1: The real exchange rate and the real equilibrium exchange rate



The total misalignment of the real exchange rate from its equilibrium value was obtained by using the next formula: Total misalignment= (Real exchange rate-Equilibrium Real Exchange Rate)/Equilibrium Real Exchange Rate

The results are shown below:

Figure 2: Total misalignment real exchange rate from its equilibrium value



As it can be seen from figure 2, the real exchange rate had some important deviations from its equilibrium value. During 1998:Q1-2001:Q1 the real exchange rate was undervalued from its equilibrium value, with a maximum misalignment of 28,96% in the first quarter of 1999. This misalignment was caused by the rapid depreciation of the nominal exchange rate induced by the liberalization of prices

and of the foreign currency market. Also, the inflations expectations were at a high level which determined the population to keep savings in foreign currency, putting even more pressure on the nominal exchange rate. During 2001:Q2-2003Q4 the real exchange rate was fairly valued while in 2005Q3-2006Q4 it was slightly undervalued. In the last period, 2005Q3 -2006Q4, the real exchange rate was overvalued. This situation was caused by the increase in the productivity differential and the appreciation of the nominal exchange rate caused by the large speculative funds attracted by the interest rate differential. The overvaluation can have the effect of losing external competitiveness inducing a larger current account deficit.

The short term dynamics of the real exchange rate can be obtained by estimating a vector error correction model:

RER = 0.0941*(-1.4336*PROD_DIF(-1) - 4.8498CONS(-1) - 0.3151*NFA(-1) +

(0.0463) (0.1545) (0.8637) (0.029)

[2.0333] [9.2795] [5.6158] [10.6710]

+1.8390*OPENESS - 0.6816) + 0.5178* ΔRER(-1) + 1.5426* ΔCONS(-1)

(0.1273) (0.1818) (0.4028)

[-14.4494] [2.6988] [3.8292]

The adjustment parameter is statistically significant and has a value of 0.0941.

6. Concluding Remarks

This paper has estimated the equilibrium real exchange rate for Romania using a BEER approach. This method is commonly used for transition countries (Halpern and Wyplosz (2001), De Broeck and Slok (2001), Egert (2002)). In the covered period the real exchange rate had some important deviations from its equilibrium value which were determined by the liberalization of the prices and of the foreign exchange market and by the fluctuations of the nominal exchange rate. The nominal exchange rate had a high volatility because of its use by the central bank in order to maintain a low inflation and because of the speculative funds attracted by the interest rate differential. In the last period covered, the real exchange rate seems to be fairly valued which will lead to external competitiveness. The nominal appreciation of the exchange rate in 2007 can cause an overvaluation of the exchange rate putting at risk the external competitiveness and the ability of Romania to join ERM II. If the central parity is not chosen in order to reflect the equilibrium exchange rate, the central bank is likely to face speculative attacks that could result in delaying the introduction of the single currency.

This paper found a negative relation between productivity differential, total consumption, net foreign assets and the real exchange rate which is consistent with the literature. Also, an increase of the degree of openness is likely

to cause a depreciation of the real exchange rate because of the increased demand for tradable goods from abroad.

This paper has found evidence of the Balassa-Samuelson effect in Romania. The coefficient of the productivity differential is statistically significant but the effect does not explain the large inflation differentials between Romania and the euro area. The productivity differential explained on average only 0.5% of the inflation differential in the period covered with a higher impact in 2005 and 2006 (1.17% and 1.31%). The conclusion is that factors different from the productivity differential are responsible for the high inflation differential and that the Balassa-Samuleson effect is not likely to put at risk the Maastricht inflation criterion.

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Appendix

Table 1.a Unit root tests for variables incuded in BEER approach

Series	ADF Test		Phillips-Perron Test		Conclusion
	Level	First difference	Level	First differnce	
LRER	-1.8843	-4.2162	-2.0237	-4.1935	I(1)
	(0.3354)	(0.0023)	(0.2758)	(0.0025)	
LPROD_DIF	-2.8915	-5.193	-1.7621	-5.2575	I(1)
	(0.0578)	(0.0002)	(0.3922)	(0.0001)	
LCONS	-2.1098	-4.4646	-1.9199	-6.3654	I(1)
	(0.2454)	(0.0014)	(0.3196)	(0.000)	
LOPENESS	-2.3525	-4.0148	-2.6571	-5.8834	I(1)
	(0.1629)	(0.0041)	(0.092)	(0.000)	
LNFA	-2.5709	-5.1184	-2.4083	-9.892	I(1)
	(0.1087)	(0.0002)	(0.147)	(0.000)	

Table 2.a Choosing the lag length in VAR

Lag	LR	AIC	SC	HQ
0	NA	-10.82199	-10.59297	-10.74607
1	154.0059	-15.18279	-13.80866*	-14.72731
2	33.10951	-15.19693	-12.6777	-14.36188
3	58.40837*	-17.28496*	-13.62062	-16.07033*

Table3.a Cointegration test for BEER Model

Sample(adjusted): 1998:4 2006:3
Included observations: 32 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LCURS_REAL L_DIF_PROD LCONSUM LNFA LOPENESS
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value

None **	0.916541	139.6949	68.52	76.07
At most 1 **	0.648638	60.22592	47.21	54.46
At most 2	0.347614	26.75592	29.68	35.65
At most 3	0.223734	13.08811	15.41	20.04
At most 4 *	0.144221	4.983779	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.916541	79.46893	33.46	38.77
At most 1 **	0.648638	33.47001	27.07	32.24
At most 2	0.347614	13.66780	20.97	25.52
At most 3	0.223734	8.104335	14.07	18.63
At most 4 *	0.144221	4.983779	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level

Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Tabel 4.a VEC-VEER Model

Vector Error Correction Estimates

Sample(adjusted): 1998:4 2006:3
Included observations: 32 after adjusting endpoints

Cointegrating Eq:	CointEq1
LCURS_REAL(-1)	1.000000
L_DIF_PROD(-1)	1.433621 (0.15449) [9.27945]
LCONSUM(-1)	4.849883 (0.86362) [5.61578]
LNFA(-1)	0.315061 (0.02952) [10.6710]
LOPENESS(-1)	-1.839020 (0.12727) [-14.4494]
C	0.681568

***Table 5.a* : Residual tests on VAR**

	t-statistic	Probability
LM autocorrelation test		
LM(1)	21.83	(0.6455)
LM(2)	12.97	(0.1635)
LM(3)	16.81	(0.8804)
LM(4)	9.32	(0.4078)
Jarque-Berra Normality test	92.27	(0.8078)
White`s heteroskedasticity test	463.17	(0.3237)

***Table 6.a* : Checking VAR stability**

Roots of Characteristic Polynomial
Endogenous variables: LCURS_REAL L_DIF_PROD LCONSUM LNFA LOPENESS
Exogenous variables: C
Lag specification: 1 3

Root	Modulus
0.905770 - 0.181308i	0.923738
0.905770 + 0.181308i	0.923738
-0.852741	0.852741
0.799589 + 0.244422i	0.836113
0.799589 - 0.244422i	0.836113
0.038655 + 0.822617i	0.823525
0.038655 - 0.822617i	0.823525
0.641456 + 0.478957i	0.800541
0.641456 - 0.478957i	0.800541
0.450079 + 0.650484i	0.791013
0.450079 - 0.650484i	0.791013
`-0.544867 + 0.567723i	0.786886
-0.544867 - 0.567723i	0.786886
-0.364578 - 0.157192i	0.397022
-0.364578 + 0.157192i	0.397022

No root lies outside the unit circle.
VAR satisfies the stability condition.

Figure 1.a **: Equilibrium values for total consumption -Hodrick-Prescott filter Prescott filter**

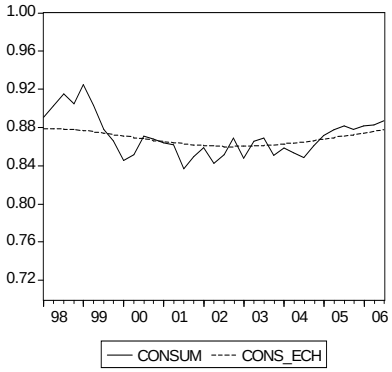

Figure 2.a **: Equilibrium value for productivity differential - Hodrick-**

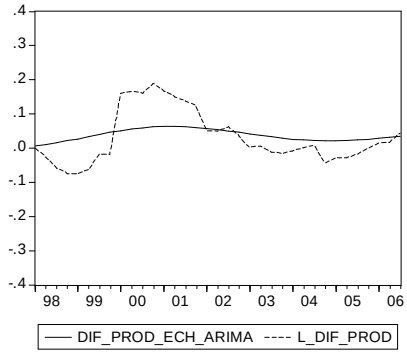

Figure 3.a **: Equlilibrium value for net foreign assets- Hodrick-Prescott filter**

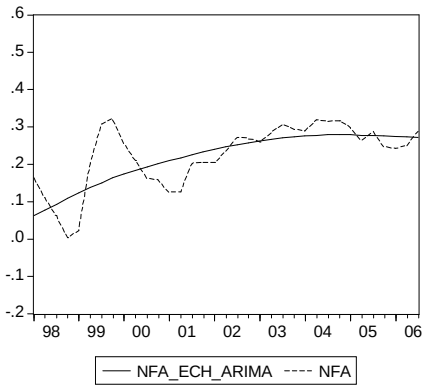

Figure 4.a **: Equilibrium value for openness- Hodrick-Prescott filter**