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Estimating the exchange rate in the context of Romania's integration in the Eurozone

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Abstract. *In this article I want to elaborate a case study on for estimating the equilibrium exchange rate in the context of Romania's accession to the Eurozone. This paper reveals an econometric model between real exchange rate and its determining factors based on the methodology BEER.*
I started this study because currently the challenge for Romania is joining ERM II and hence the Economic and Monetary Union. Given the exchange rate volatility and the implications it may have on the Romanian economy, it is important to determine whether or not there were internal devaluations.

Keywords: currency, ERM II, optimum currency area, exchange rate undervalued/overvalued, the trade openness.

JEL Classification: C15, E37, F31, O11.

1. Research Methodology

At the core of the Economic and Monetary Union is the optimum currency area theory, first formulated by Robert Mundell in an article published in 1961 "Theory of Optimum Currency Areas". Subsequently, this theory was developed by economists: McKinnon (1963) and Keenen (1969). Thus, an optimum currency area is a geographic region with a single currency, where the asymmetric shocks are absorbed without using the exchange rate or monetary policy instrument. OCA theory assumed completing development of four main phases. Each of these had a significant contribution.

The first is the pioneering phase, which took place between 1960-1970. The main merit of this phase was to highlight the properties of an optimum currency area, properties that are under discussion today. The second phase is the reconciliation that took place during the ’70. This phase meant "significant progress" in terms of properties. They thus began to be analyzed and compared against each other to determine the importance of each, missing altogether empirical arguments. So there were some problems, regarding the theory conclusively that were later resolved, which led to a reassessment of OCA‘s costs and benefits. This is why this phase is called the revaluation phase. The last phase - the empirical one, has resumed and analyzed all OCA’s properties.

In the next part I will present in detail the need to estimate the equilibrium exchange rate for Romania. Starting from the idea that the undervaluation or overvaluation of the exchange rate is a matter of economic interest, I wish to draw attention to problems that may occur as a result of exchange rate estimation in the context of Romania's integration in the Euro zone. It is a delicate situation, because of this step depends on the economic welfare of our country. An overvalued exchange rate implies that the currency of the country is valued for the fundamentals of the economic situation at the time. This means that exports will be more expensive, while imports will be cheaper. So, an overvalued exchange rate leads to a decrease in domestic demand and encourage spending on imports. Thus, the country would lose competitiveness abroad, which would lead to a weakening of economic growth. Overall, from the experience of other countries, we can say that maintaining an overvalued exchange rate has a negative effect on economic growth in the medium and long term. This reduces efficiency and leads to further trade controls.

Also undervaluation of the exchange rate would cause inflationary pressures in the economy and a misallocation of capital, which would stimulate companies to produce competitive equilibrium conditions. According to Rodrik (2003) and Bhala (2008), an undervalued exchange rate can be used as an instrument of industrial policy to stimulate the commercial sector thus economic growth.

Cottani, Cavallo and Khan (1990) have investigated the effects of real exchange rate, it’s misalignment and variability on economic performance for 24 developing countries from 1960 to 1983. They found that misalignment of the exchange rate was strongly related to low growth of GDP per capita. Moreover, the misalignment has been also related to low productivity. GDP/inhabitant, which reveals the performance of economic activity, the

most important indicator of real convergence in Romania, had a value of 54% (2015), considered a sustainable one.

Broadly it is desirable that the value of the real exchange rate to be aligned with its equilibrium value, because it represents an important part of the country's macroeconomic scoreboard. Persistence misalignment of real exchange rates can cause a misallocation of resources between tradable and non-tradable sectors, as well as a negative impact on employment. Also, misalignment of the exchange rate may lead to inflationary pressures, including the generation of speculative attacks or it may prevent the development of financial markets, according to Domec and Shabsigh (1999).

Ishiyama (1975) argues that a state wishing to become a member of the Euro zone must determine at an early stage, both the benefits and costs of integration, so that "the benefits are greater than the costs".

To join the Euro zone, Romania must attend first to the Exchange Rate Mechanism (ERM II) on a minimum of two years. In fact, ERM II is a kind of "corridor" in which states must maintain a fixed exchange rate within a set, before adopting the euro. Fluctuation band for this interval is ±15%. In ERM II, if a state does not comply with the fluctuation range once established, the period will be extended for another two years, and once you're there it’s not reversible. It is therefore important that the state fulfills certain conditions regarding macroeconomic stability, before joining the ERM II. Since the decision to enter the ERM II belongs to every state, there is not a deadline. Therefore, the country concerned must ensure that the national economy meets the criteria of nominal and real convergence. It is important for the country wishing to adopt the single currency to meet the five nominal convergence criteria (price stability, interest rates on long-term, exchange rate, public debt and budget deficit) of the Maastricht Treaty, but also the real convergence to avoid a financial crisis. In terms of real convergence, there are not clearly defined a number of objectives, but every country must consider indicators that show its economic development, such as: GDP per capita, trade openness, labor productivity etc.

In fact, real and nominal convergence criteria are an analysis of the economic performance of a country within the context of EMU. Based on their achievement the optimal integration time is determined. Although Romania fulfills all the nominal convergence criteria, according to the latest Convergence Report of the European Central Bank in June 2014, it is not yet ready to join the EMU. For adopting the single currency, Romania should take into account harmonizing the legal framework with the Euro zone standards and joining ERM II.

In terms of asymmetric shocks, which can be easily transmitted from EZ to our country, Romania has a limited capacity to mitigate and to prevent them, because it has a limited capacity for adjustments in terms of the economy.

To understand the analysis conducted in this paper, I will present the models used to estimate the equilibrium exchange rate and their importance for countries wishing to become members of the Euro zone.

In literature there are several methods for estimating equilibrium exchange rate, namely:
- Purchasing Power Parity.
- The Balassa-Samuelson model.
- Behavioral Equilibrium Exchange Rate – BEER.

The theory of purchasing power parity (Gustav Cassel, 1918) captures internal and external price developments. This is the simplest method, relying on the absence of shocks in a national economy. Whereas empirical studies of this method have shown deviations from economic reality, new models were created that counteracted the theory of purchasing power parity. Thus were laid the foundations of the Balassa-Samuelson model by economists Bela Balassa and Paul Samuelson (1964). As a reaction against the theory of purchasing power parity, Balassa-Samuelson model suggests a separation of tradable and non-tradable goods, to understand the existence of price differences on different markets. Thus, the authors argue that it is normal to have differences of prices in the same currency in different markets. The argument is that there are discrepancies between the productivity differential between developing countries and developed ones because labor in developed countries is more productive than in the others.

For further research, I will turn my attention to the model examined in this paper - BEER. Theorists of this model, Clark and MacDonald (1998) and MacDonald (2000), say that is best to choose the determinants of the exchange rate and to estimate the equations of the real exchange rate and the chosen variables. Estimating equilibrium exchange rate using the BEER methodology involves several steps:
- Choosing relevant explanatory variables for Romania, that have an influence on the exchange rate.
- Using the Johansen method to determine the number of co integrations between the real effective exchange rate and other variables.
- Establishing the equilibrium values of the explanatory variables by using the Hodrick-Prescott filter.
- Estimating the equilibrium exchange rate by substituting equilibrium values of the determinants estimated in the co integration relationship, in the second stage.
- Estimating the real exchange rate deviation from its equilibrium rate.

Based on this approach I developed an econometric model to estimate the equilibrium exchange rate for Romania.

2. Empirical Analysis – Estimating the behavioral equilibrium exchange rate in the context of Romania's accession to the Euro zone

BEER approach tries to find a statistically significant relationship between certain economic variables and the real exchange rate. In addition, this method allows the analysis to be adapted to the specific country in question, because the Johansen co-integration methodology implies that the chosen variables to be non-stationary. The chosen variables in the model are: trade openness, foreign direct investment, savings rate, government debt, budget deficit, capital account.

In designing the econometric model, I used quarterly data from 2000, first quarter to 2015, the third quarter. In choosing the set of variables determining the exchange rate, I have taken into account the studies carried out in other countries, which have a similar structure to that of our country, like Hungary and Czech Republic.

Initially, to apply the Johansen methodology, which sets long-term equilibrium relationship between deterministic variables and the exchange rate, I had to determine if the data is stationary. The Johansen co-integration test involves using a set of variables that are stationary in the same grade. So I applied Dickey-Fuller Augmented test (ADF), yielding the following results:

Table 1. *Test results ADF*

	Cs	Ccurent	Datguv	Defbug	ISD	OPEN	SAV
Test statistic (Dickey-Fuller)	-1,67	-1,39	-0,86	-1,23	-1,63	-2,04	-0,94
Probability (Prob*)	0,44	0,57	0,79	0,65	0,45	0,26	0,76
Critical values (5%)	-2,9	-2,91	-2,91	-2,91	-2,91	-2,9	-2,91
1st difference	0,0000	0,0054	0,0382	0,0000	0,0000	0,0000	0,0000

Source: Author's calculations in Eviews 8.0.

Given that the value of t-statistic from the table is greater than the reference value for a significance threshold of 95% and the probability for each exceeds 10%, it follows that the chosen variables are non-stationary. Applying the first difference for the individual variables, one can say with 95% confidence level that the selected data series become stationary. Thus, t-test probability for each variable becomes less than the 5% level relevance (Prob. = 0.0000), which means that the risk of the estimator to be null is less than 5%, meaning that the confidence in the estimator is greater than 95%.

Next I used a Vector Autoregressive (VAR) methodology to determine the optimal number of lags.

Figure 1. *Determination of the optimal number of lags*

VAR Lag Order Selection Criteria
Endogenous variables: CS CCURENT DATGUV DEFBUG ISD OPEN SAV
Exogenous variables: C
Date: 05/16/16 Time: 05:25
Sample: 2000Q1 2015Q3
Included observations: 59

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1234.307	NA	4.44e+09	42.07822	42.32471	42.17444
1	-935.1068	517.2622	930487.5	33.59684	35.56874*	34.36659
2	-835.9147	147.9475	181694.0	31.89541	35.59273	33.33869*
3	-775.6102	75.63616	148962.4	31.51221	36.93493	33.62902
4	-704.8095	72.00070*	104786.8*	30.77320*	37.92134	33.56355

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Author's calculations in Eviews 8.0.

Based on the test carried out while taking into account the Akaike criterion, the optimal number of lags is 4. Because the data series are integrated of first order, the Johansen test can be applied to find the long-term equation between the real exchange rate and its determinants. Taking into account the number of lags I applied the Johansen co-integration methodology.

Figure 2. *Johansen co-integration test*

Date: 05/16/16 Time: 05:43
Sample (adjusted): 2001Q2 2015Q3
Included observations: 58 after adjustments
Trend assumption: Linear deterministic trend
Series: CS CCURENT DATGUV DEFBUG ISD OPEN SAV
Lags interval (in first differences): 1 to 4
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.809504	280.4475	125.6154	0.0000
At most 1 *	0.669321	184.2764	95.75366	0.0000
At most 2 *	0.581264	120.0933	69.81889	0.0000
At most 3 *	0.466949	69.60337	47.85613	0.0001
At most 4 *	0.321795	33.11335	29.79707	0.0200
At most 5	0.166566	10.59165	15.49471	0.2379
At most 6	0.000414	0.024025	3.841466	0.8767

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.809504	96.17107	46.23142	0.0000
At most 1 *	0.669321	64.18317	40.07757	0.0000
At most 2 *	0.581264	50.48990	33.87687	0.0002
At most 3 *	0.466949	36.49002	27.58434	0.0028
At most 4 *	0.321795	22.52170	21.13162	0.0317
At most 5	0.166566	10.56763	14.26460	0.1773
At most 6	0.000414	0.024025	3.841466	0.8767

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's calculations in Eviews 8.0.

Because the variables are stationary of first-order, we can determine whether there is a co-integration relationship between data series. So, according to calculations, the test shows 5 co-integrations between the exchange rate and the deterministic variables. In other words, between the deterministic variables and the exchange rate are 5 long-term equilibrium relationships, according to analysis.

To check the Johansen co-integration test, I applied the VEC model (Vector Error Corection), with which I determined the coefficients of the co-integration equation.

Figure 3. *Estimating coefficients based on the VEC methodology*

Error Correction:	D(CS)	D(CCURENT...	D(DATGUV)	D(DEFBUG)	D(ISD)	D(OPEN)	D(SAV)
CointEq1	-0.243442	-0.077792	0.064873	0.178303	-0.146572	-0.138038	0.143326
	(0.07894)	(0.06433)	(0.03295)	(0.08030)	(0.06301)	(0.06618)	(0.08606)
	[-3.08407]	[-1.20931]	[1.96902]	[2.22048]	[-2.32632]	[-2.08587]	[1.66537]
CointEq2	-0.964901	-1.277523	0.386306	1.216350	-1.125931	-0.264396	-0.504616
	(0.50297)	(0.40989)	(0.20994)	(0.51166)	(0.40147)	(0.42168)	(0.54838)
	[-1.91840]	[-3.11674]	[1.84012]	[2.37726]	[-2.80452]	[-0.62700]	[-0.92019]
CointEq3	1.314999	0.987898	-0.213871	-0.738051	0.702041	0.126310	0.203256
	(0.39713)	(0.32364)	(0.16576)	(0.40399)	(0.31699)	(0.33295)	(0.43299)
	[3.31124]	[3.05248]	[-1.29025]	[-1.82689]	[2.21472]	[0.37937]	[0.46943]
CointEq4	1.536537	0.573658	-1.229297	-1.974992	2.565254	0.796743	1.229718
	(1.02325)	(0.83389)	(0.42710)	(1.04093)	(0.81676)	(0.85787)	(1.11564)
	[1.50162]	[0.68793]	[-2.87827]	[-1.89733]	[3.14078]	[0.92874]	[1.10225]
CointEq5	2.673019	0.100582	-0.027646	-0.569951	-0.107727	-0.259361	-0.686164
	(0.63100)	(0.51422)	(0.26337)	(0.64190)	(0.50366)	(0.52901)	(0.68797)
	[4.23619]	[0.19560]	[-0.10497]	[-0.88792]	[-0.21389]	[-0.49027]	[-0.99738]
R-squared	0.765278	0.900103	0.798484	0.882596	0.778021	0.748847	0.982771
Adj. R-squared	0.442535	0.762744	0.521400	0.721165	0.472799	0.403512	0.959081
Sum sq. resids	130.5320	86.68962	22.74061	135.0814	83.16423	91.74809	155.1664
S.E. equation	2.332131	1.900544	0.973409	2.372423	1.861498	1.955208	2.542689
F-statistic	2.371168	6.552921	2.881738	5.467325	2.549035	2.168467	41.48519
Log likelihood	-105.8225	-93.95328	-55.14600	-106.8160	-92.74929	-95.59794	-110.8360
Akaike AIC	4.821466	4.412182	3.074000	4.855726	4.370665	4.468895	4.994346
Schwarz SC	6.029312	5.620028	4.281846	6.063571	5.578511	5.676740	6.202192
Mean dependent	0.336552	0.075862	0.232759	0.091379	0.005172	0.044167	0.419498
S.D. dependent	3.123518	3.901835	1.407048	4.492812	2.563743	2.531583	12.56994

Note: In the figure we can see the estimated coefficients and in the parenthesis are given the standard errors.
Source: Author's calculations in Eviews 8.0.

The results in the table indicate that the most significant coefficients to determine the exchange rate are the current account balance, government debt, public deficit, foreign direct investment, the trade openness and savings rate. It can also be seen that the R-squared value of approx. 76% shows that the model is closer to economic reality.

According to the Johansen co-integration test, the equilibrium equation below, is consistent with economic reality, the coefficients being statistically significant.

CS=-8.6486*CCURENT+6.5428*DATGUV+16.2734*DEFBUG+4.3910*ISD-6.7368*OPEN-3.2536*SAV+492.1320.

The co-integration relationship states that an increase of 1 percent in the current account leads to a depreciation of the exchange rate by 8.64 pp. Furthermore, a current account deficit implies a higher external debt, which can be supported by foreign investors. So this will generate a depreciation of the national currency.

Also, an increase of 1 percent of government debt leads to an appreciation of the exchange rate by 6.54 percentage points. At the same time, a higher level of public debt could result to a depreciation of the real exchange rate. Regarding the budget deficit, it can generate either an appreciation or a depreciation of the exchange rate. In this case it depends heavily on the direction of public expenditure, if they are higher in the tradable

and non-tradable. Thus, an increase in the budget deficit by 1 pp, leads to an appreciation by 16.27% of the exchange rate.

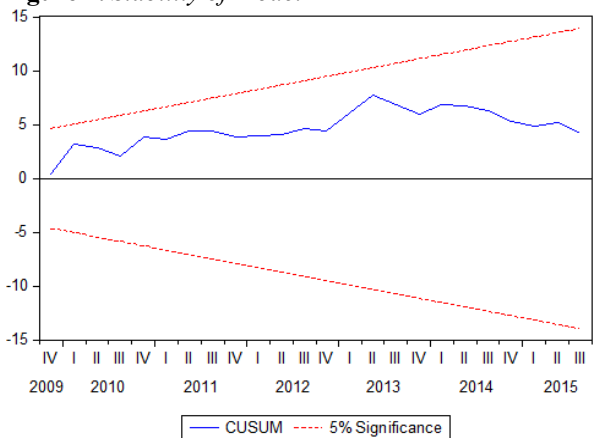
In addition, an increase in foreign direct investment has the effect of appreciating the exchange rate. According to the co-integration equation, an increase of 1 percent of FDI leads to an appreciation by 4.39 pp of the exchange rate.

Moreover, a 1 pp increase of the trade openness variable leads to a depreciation of the real effective exchange rate by about 6.73 pp. So between the real exchange rate and the trade openness is a negative relationship. This is true because, with the capital account liberalization in Romania, imports rose more than exports, putting pressure on the current account. Also, a 1 percent increase in the savings rate causes a depreciation of the exchange rate by 3.25 percentage points.

The study found that the most significant variables determining the exchange rate are the current account, the trade openness, foreign direct investment and savings rate.

To verify the accuracy of the econometric model I tested the stability, validity, homoscedasticity, autocorrelation and normal distribution of errors.

Figure 4. *Stability of Model*



Source: Author's calculations in Eviews 8.0.

To verify that the model satisfies the condition of stability I applied the Cusum test. Under this test, the models cannot be valid unless they take into account any changes that may occur in the period under review. One of the most used econometric models stability tests is Cusum. Thus, it can be seen that the trend falls within the range (-5, + 5), which means that the hypothesis of stability of the model can be accepted, taking into account the structural changes occurring during the period selected.

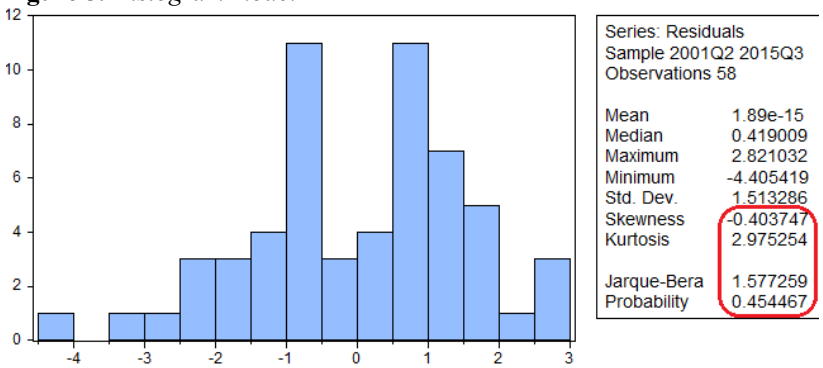
Figure 5. *Heteroscedasticity model*

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.024853	Prob. F(35,22)	0.4865
Obs*R-squared	35.95052	Prob. Chi-Square(35)	0.4238
Scaled explained SS	6.079455	Prob. Chi-Square(35)	1.0000

Source: Author's calculations in Eviews 8.0.

Because the Chi-Square probability of 42.38% is greater than the materiality threshold of 5%, I can say that the model complies with this condition, it is homoscedastic.

Figure 5. *Histogram model*

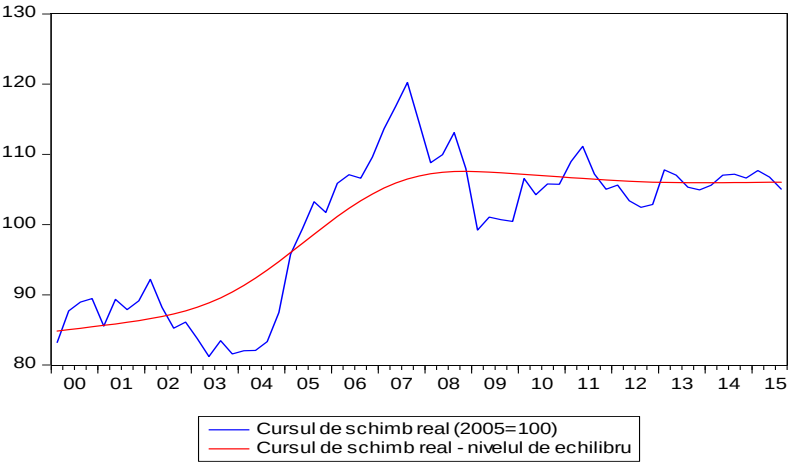


Source: Author's calculations in Eviews 8.0.

Given the histogram of the model developed, it can be seen that the probability (45.44%) is higher than the materiality threshold of 5%, which confirms my hypothesis that the errors are normally distributed. Moreover, we can see that the two criteria are met and Skewness and Kurtosis that appropriate values, namely: Skewness should be as close to 0 and Kurtosis closer to 3.

Next, to determine the equilibrium value of the exchange rate I calculated the sustainable values of the deterministic variables. Thus, I seasonally adjusted the time series to determine the cyclical and the trend components using the Hodrick-Prescott filter. I chose as equilibrium value the trend component and the cyclical component as the deviation of the exchange rate. The chart below reflects the evolution of the real exchange rate to its equilibrium level (trend component, obtained by deseasonalizing data sets and applying Hodrick-Prescott filter).

Figure 6. *The real exchange rate and its equilibrium value*



Source: Author's calculations in Eviews 8.0.

Thus we can see that in 2002-2004, the second quarter, the exchange rate was undervalued compared to its equilibrium level. Later, during 2004QII-2009, the exchange rate was overvalued. As a result, the time that we faced with undervalued exchange rate has put pressure on prices in the economy.

3. Conclusions

By developing the present article I considered evaluating the determinants of the real exchange rate for Romania's accession to ERM II, respectively the Euro zone. Doing so, I studied several models for estimating the equilibrium exchange rate, especially the BEER methodology that I use to conduct the case study. Setting the central parity when joining the ERM II requires estimating the equilibrium exchange rate. It is therefore appropriate that the central parity to be established at the exchange rate market to avoid any fluctuations on the currency.

It is therefore recommended to conduct periodic surveys to determine a fair level of the exchange rate for a prepared accession of Romania in the Economic and Monetary Union.

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