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REAL EFFECTIVE EXCHANGE RATE DETERMINATION IN INDONESIA: A BEHAVIORAL EQUILIBRIUM EXCHANGE RATE APPROACH

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Abstract

The aim of this paper is to analyze the determination of real effective exchange rate in Indonesia for the period 1994.1-2004.6 using behavioral approach. The sets of fundamental variables consisting of net foreign asset, term of trade, ratio total trade to GDP, private and government consumption were used to estimate for resulting estimation of behavioral real effective exchange rate.

The data was used in this study using time series monthly data from 1994.1 – 2004.6. The source of data were taken from International Financial Statistic and Central Bank of Indonesia. The method of analysis is multivariate cointegration methods of Johansen to determine the long run relationship real effective exchange rate. Exchange rate misalignment was also used in this study by plotting the series between actual real effective exchange rate and the behavioral equilibrium exchange rate.

The results of this study showed that from the estimation result of behavioral equilibrium exchange rate, some variables of the sets fundamental variables such as net foreign asset, term of trade and ratio total trade to GDP were correctly signed, plausible magnitude and statistically significant. But, government and private consumption were not statistically significant and incorrectly signed. From the plotted result between actual and equilibrium estimation, it represents that for the period post-1997, the currency has been undervalued. The close alignment between actual and equilibrium was occurred in 1998 and 1999. But at the end of the sample, the currency looked overvalued.

Keywords: *Real effective exchange rate, Behavioral equilibrium approach, Cointegration*

INTRODUCTION

Exchange rate is one of factors that has the important role in the open economy. In monetary policy, the main purpose of exchange rate policy is achieving the stability of price especially stability of imports goods price and providing continuity balance of trade. Stability of exchange rate was needed to aim that goal. Because of its strong influence on imports price, the exchange rate is one of the most important prices in the economy. It is also a very sensitive price, responding rapidly to any changes or even anticipated changes in the economy. That is why exchange rate varies on a daily and even an hourly basis (Kreinin, 2003:227).

Since adopting floating exchange rate system, after crises in 1997, Indonesia exchange rate value of Rupiah-Dollar has undergone large cycles from US 4650 Rp to above US 10375Rp in last January 1998. The decline of exchange rate value became interest to a central bank whether these value cycles are consistent with the funda-

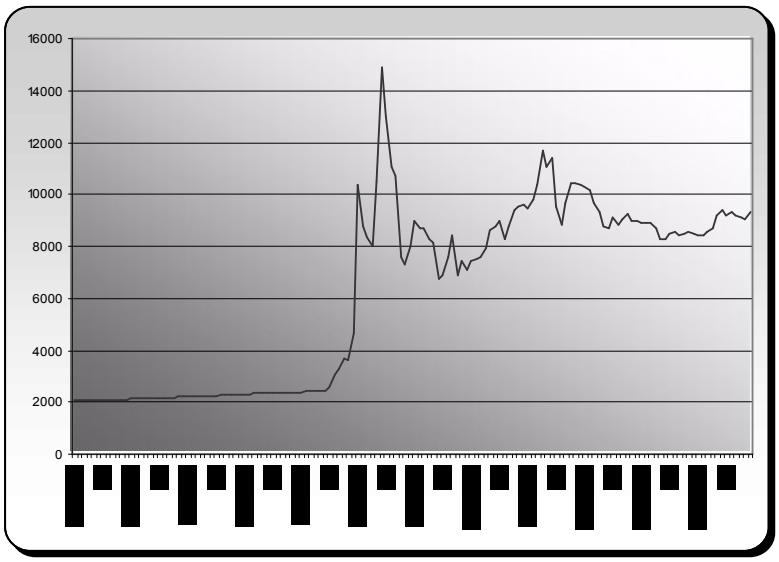
mental equilibrium or whether it is a disequilibrium phenomena. At that period, the movement of exchange rate raised concern about the risks that may pose for the world economy.

Disequilibrium phenomenon in the foreign exchange market requires a measure of the equilibrium exchange rate as the benchmark against which the actual development of the exchange rate is gauged. Although it is widely accepted that providing a precise estimate of the equilibrium level of exchange rate and thus over or undervaluation of a currency is far from straightforward, a number of empirical models based on economic fundamentals have shown that they can track the evolution of the actual exchange rate rather well.

There are many concepts of exchange rate equilibrium in the literature. MacDonald (2002) estimated a time varying behavioral equilibrium exchange rate (BEER). Brook and Hargreaves (2001) estimated an equilibrium that varies over time but it is never the less unconditional on other financial or policy variable. Stephens (2004) estimated a time-varying BEER using only Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP) as determining forces.

This paper examines the role of economic fundamental in explaining the behavioral of Indonesia real effective exchange rate. The analysis in this paper focuses on the behavioral equilibrium exchange rate (BEER) based on a reduced form specification which links the effective exchange rate of Rupiah to a set of economic fundamental. BEER used in this paper refers to McDonald (2004) of BEER approach to produce long run equilibrium exchange rate. The advantage of using BEER-based estimates equilibrium of exchange rate is that in terms of their tractability and transparency. This approach can be used to produce an assessment of the Rupiah-Dollar in terms of periods of misalignment.

Figure 1: Indonesia Nominal Exchange Rate Movement



Source: Central Bank of Indonesia

This paper is organized as follows. The next section presents an overview of fundamental-based models of exchange rate determination especially the BEER-based approach to assessing equilibrium exchange rate. This section also presents some related empirical literature. Section III presents the econometric methodology and describes the data and the choice of variables. Section IV analyzes the empirical results. And the final section summarizes the main conclusions.

THEORETICAL BACKGROUND

BEER Approach to Modeling Determinants of the Exchange Rate

Many studies on exchange rate, starting discuss about Purchasing Power Parity (PPP) doctrine which states that exchange rate is determined by the relative of domestic and foreign prices, thereby suggesting that the equilibrium real exchange rate is constant. The literature explains that the real exchange rate is found to be non-stationary or in studies that using a very long sample, its adjustment speed to the equilibrium path by relative prices is very slow, so the deviation from its equilibrium cannot explained the determinants of exchange rate. Since the evidence failure of purchasing power parity hypothesis, the BEER approach make surely as a useful to construct for producing an equilibrium exchange rate relationship and explaining the determinants of real exchange rate.

The approach that has chosen in this paper to generate BEER approach refers to the uncovered interest parity (UIP) condition. The theory of UIP is the capital market analogue to PPP. It states that if domestic interest rate is higher than similar foreign interest rate, then investor must be expecting the domestic exchange rate to depreciate. UIP can be expressed algebraically as follows.

$$E_t(\Delta s_{t+k}) = -(i_t - i_t^*) + u \quad \text{..... (1)}$$

Where,

s_t = log of foreign currency price of a unit of home currency

E_t = an expectation at time t

$i*$ = foreign interest rate

i_t = domestic interest rate

Δ = the first difference operator

u = the risk premium associated with holding home currency assets

Equation (1) can be converted into a relationship between real variables by adding the expected inflation differential $E_t(\Delta p_{t+k} - \Delta p_{t+k}^*)$ and rearranging as follows.

$$q_t = E_t(q_{t+k}) + (r_t - r_t^*) + e_t \quad \text{..... (2)}$$

Where,

$r_t = i_t - E_t(\Delta p_{t+k})$ = the home ex ante real interest rate

$q_t = s_t + p_t - p_t^*$ = the ex ante real exchange rate

e_t = a disturbance term

Equation (2) describes the current equilibrium exchange rate as determined by two components, the expectation of the real exchange rate in period $t+k$ and the real interest differential with maturity $t+k$.

If assume that the unobservable expectation of exchange rate $E_t(q_{t+K})$ presents the influence of fundamentals exclusive of interest rates on the equilibrium exchange rate and denotes with $\overline{q}_t$. The current equilibrium rate is defined as $\dot{q}_t$. Equation (2) can be rewritten.

$$\dot{q}_t = \overline{q}_t + (r_t - r_t^*) \quad \text{..... (3)}$$

The factors of fundamental variables enter into $\overline{q}_t$ is given as this function.

$\overline{q}_t = f(nfa, ltot, ltotta, lpcon, lfcon)$

The following set of fundamental variables were analyzed in this study.

1. *Net Foreign Assets* (nfa)
   nfa is the ratio of net foreign asset to GDP. The inclusion NFA as determinant of the real exchange rate follows portfolio-balance considerations. This variable was expected positively related to real exchange rate.
2. *Term of Trade* (tot)
   The real exchange rate can be affected by commodity price through the impact on term of trade. Term of trade is defined as the ratio of export price to import price. It is expected positively related to real exchange rate.
3. *totta*
   totta represents the ratio of total trade to GDP. totta measures degree of openness and it is expected to be negatively to real exchange rate. An increase of this variable caused the depreciation of currency. An increase of openness was represented by upward movement of external balance schedules which described depreciation of exchange rate.
4. *lpcon* and *lfcon*
   lpcon and lfcon represent private and government consumption as percentage to GDP. These variables were expected to be positively to real exchange rate.

Empirical Literature

McDonald (2002) measured equilibrium of real effective exchange rate by BEER approach for New Zealand case. Fundamental variable used are differential of productivity, real interest rate, the term of trade, a gap term and net foreign asset as proportion of GDP. Using a method of Johansen, a gap term and net foreign asset were weakly exogenous and excluded from the long run relationship. The result is all of variables have correct sign and statistically significant. The coefficient estimates in the relationship then were used to construct a variety of current and total misalignment. The estimation result shows that New Zealand Dollar has been sharply undervalued in the period post 1999.

Iimi (2006) applied BEER approach to estimate the equilibrium of real effective exchange rate in Botswana for the period 1985-2004. This case related with the successive devaluation of currency in Botswana and recent move from fixed to crawling peg exchange rate regime. The empirical result shows that Botswana seem to have been undervalued in the late 1980s and overvalued by 5 to 10 percent in recent years, through the misalignment in the 1990s.

Fernandez, Osbat and Schnatz (2001) analyze the medium term determinants of the euro effective exchange rate from 1975 to 1998 and derive a Behavioral Equilibrium Exchange Rate (BEER) and a Permanent Equilibrium Exchange Rate (PEER). The result indicates that differential in real interest rate and productivity and the relative fiscal stance and the real price of oil have a significant influence on the euro effective exchange rate. All four models were used unambiguously to the undervaluation of the euro in 2000.

McDonald (2004) identified a long run equilibrium exchange rate for the real effective exchange rate of Singapore. Using the relationship between small set of fundamental variables, BEER was estimated and it showed that on average, there was an undervaluation of the currency in the post-1998 period. The currency was close to its equilibrium in final sample period 2003Q2, as Permanent Equilibrium Exchange Rate (PEER) estimation.

METHOD OF ANALYSIS

Definition variables and Data source

This study used monthly time series data that collected from International Financial Statistic and Central Bank report. The

data that identified were real effective exchange rate (*lreer*) CPI based 2000=100 (BIS), ratio of net foreign asset to GDP (*nfa*), term of trade (*tot*), ratio total trade to GDP (*ltotta*), private consumption (*lpcon*) and government consumption (*lfcon*).

Specification Model

The tool of analysis were used is Johansen method and Vector Error Correction Model (VECM) to examine long run cointegration between variables and dynamic effect within variables in short run. The cointegration analysis is based on a maximum likelihood approach proposed by Johansen (1995).

$$z_t = A_1 z_{t-1} + \ldots + A_p z_{t-p} + u_t \; u_t \sim IN(0, \Sigma) \quad \ldots\ldots\ldots\ldots (4)$$

The system utilized for cointegration can be represented by a VECM for the long run endogenous variables that can be formulated as follow.

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{s-1} \Gamma_i \Delta Z_{t-1} + \quad + \; D_t + \; _t$$

t = 1, …, T..... (5)

Where $Z_t = (z_1, z_2, \ldots z_n)'$ is now, a 6x1 vector of the endogenous variables that is *reer*, *nfa*, *tot*, *totta*, *lpcon* and *lfcon*. $\Pi = \sum_{i=1}^{s} \Pi_i - I, \Gamma_i = -\sum_{j=i+1}^{s} \Pi_j$, μ is a constant term, D_t are dummy97 and ε_t is an independent identically distributed error term. Π_{6x6} is the long run coefficient matrix, which can be decomposed into r distinct cointegrating vectors of $'_{rx6}$ and an adjustment (feedback) matrix $_{6xr}(\Pi = \; ')$. In this respect, testing for cointegration is investigating the number of r linearly independent coloumns in Π. The elements of α indicate the speed of adjustment of a particular variable when there is a disturbance in the equilibrium relation, while the elements of β indicate the long run responses of the variables in the equilibrium relationship. The procedure was applied as follows. 1) unit root test using ADF test, 2) the system test of congruency, 3) Johansen cointegration test, and 4) the misalignment of real exchange rate.

EMPRICAL RESULT

Stationarity tests

The first step in the cointegration analysis is to investigate the individual characteristic of the series used in the model by utilizing the augmented Dickey Fuller test for a sample monthly period 1994.1 – 2004.6. The plots of these series in levels exhibited in figure, may give some idea about stationary and non-stationary.

Figure 2: Graphs in Level

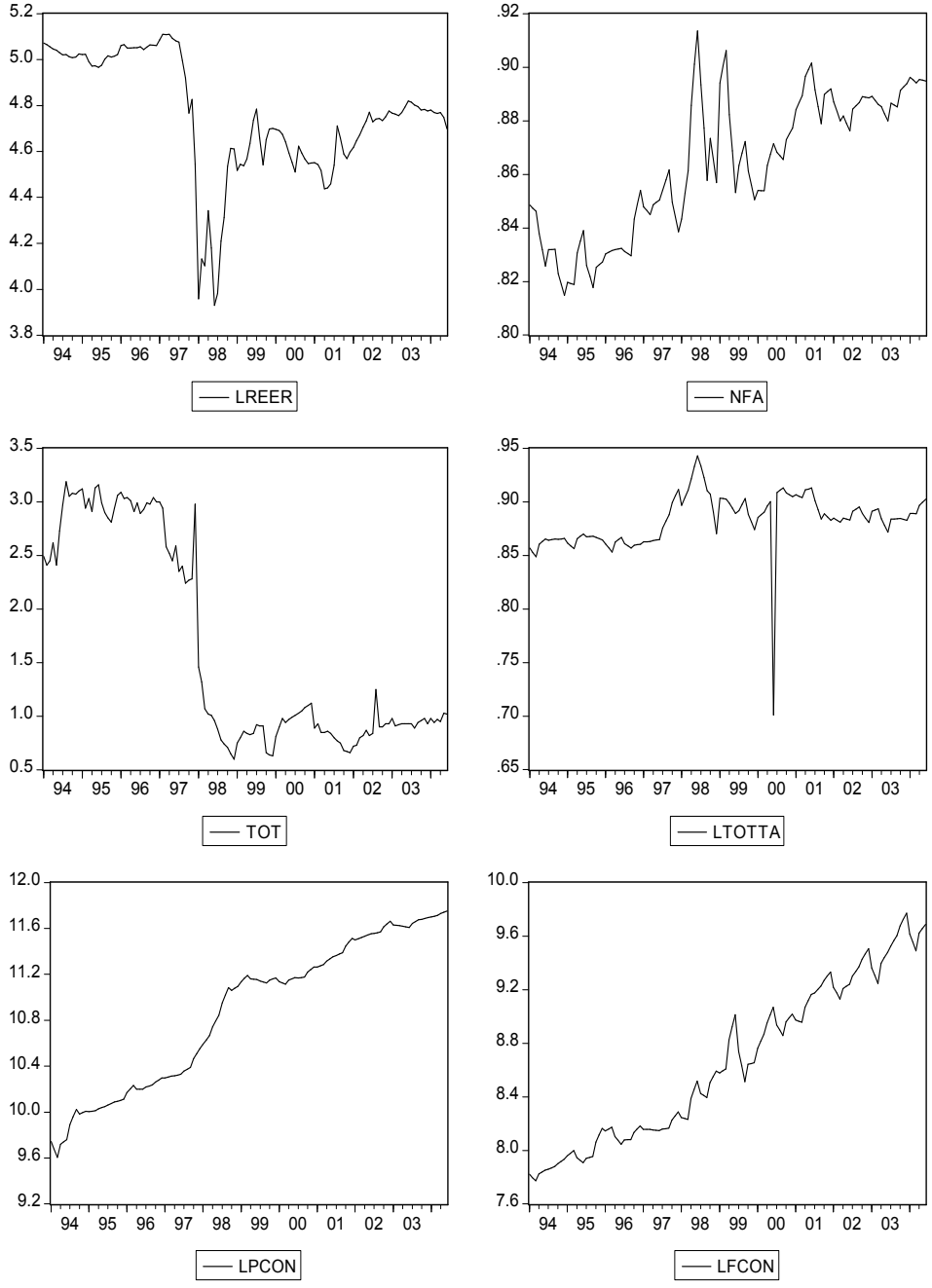


Table 1: Augmented Dickey Fuller Unit Root Test

Variable	Lag	Statistic Test (*Level*)		
		T_t	Tμ	T
Real Effective Exchange Rate (LREER)	0	-2.0244	-2.0238	-0.4959
Net Foreign Asset (nfa)	1	-4.6546***	-1.3476	0.7162
Term of trade (tot)	1	-1.3729	-0.9194	-1.2099
Total Trade/GDP (ltotta)	1	-4.9843***	-4.4808***	0.3357
Private Consumption (lpcon)	4	-1.7804	-1.4142	2.6914
Government Consumption (lfcon)	10	-1.9363	1.0409	4.8349

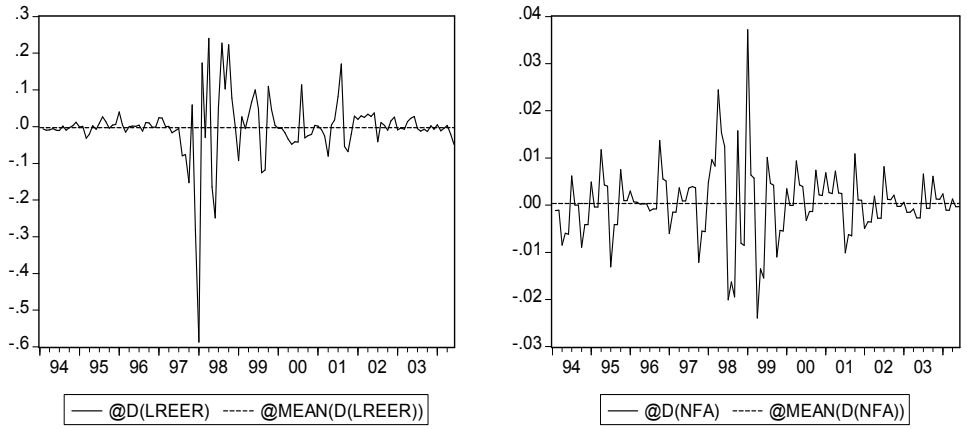
Note: ***, **, * significance at α =1%, 5% and 10%

Based on Figure 2, most of variables are not stationer in level. Some of variables that are net foreign asset (*nfa*) and ratio total trade to GDP (*ltotta*) have stationary at level. The Figures show that there is a positive trend in variable private and government consumption. This plot can be considered with formal conclusion about the integration properties of the series can be arrived at using the unit root test at Table 1 using Schwarz Information Criterion for considered lag length and used maximum at twelfth lag (Hayashi, in E-views: 2001).

The result test shows that almost variables are not stationer at level based on confidence level α = 5 percent except net foreign asset (*nfa*) and ratio total trade to GDP (*ltotta*) that are significance at α = 1 percent.

The plot data in first difference were exhibited Figures 3. The plot of first difference indicate that all of variables are stationer at I(1). This plot also can be represented from order of integration test using ADF test as follow. The result shows that all variables reject null non stationary hypothesis. It indicates that all variables have stationer in the same integration at I(1).

Figure 3: Graphs in First Difference



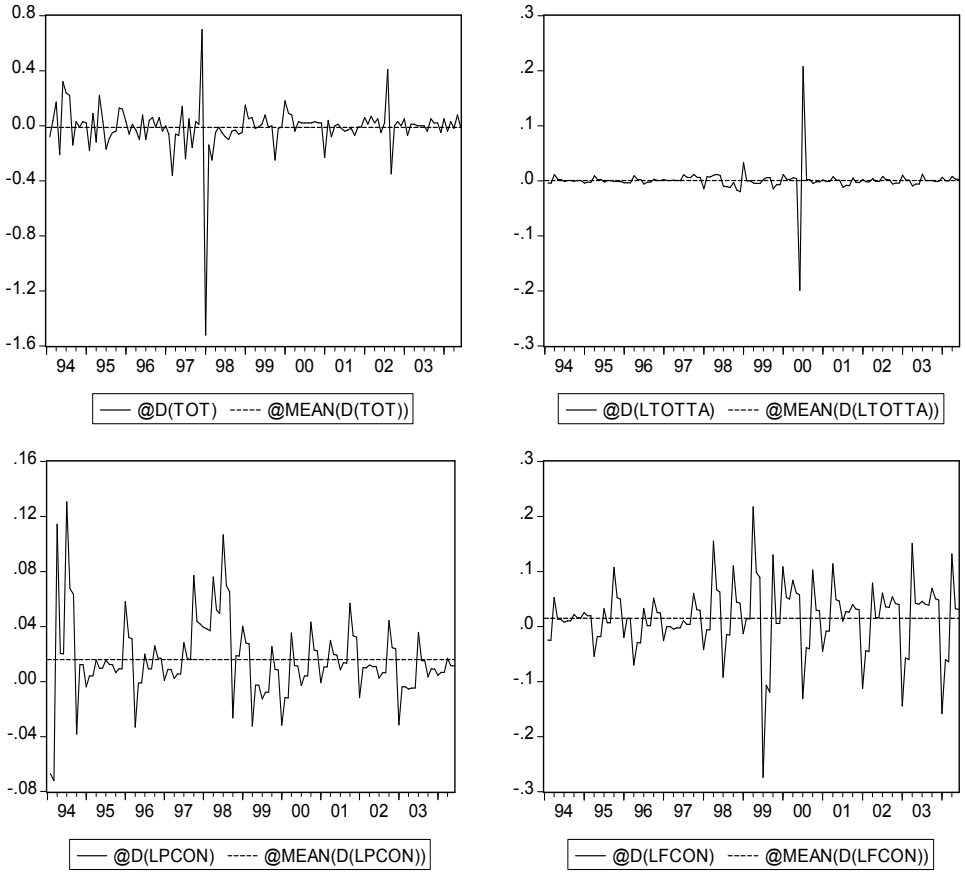


Table 2: Order of Integration Test using ADF

Variable	Lag	Statistic Test (*Level*)		
		T_t	T	T
Real Effective Exchange Rate (LREER)	0	-9.4779***	-9.5045***	-9.5334***
Net Foreign Asset (nfa)	2	-8.6133***	-8.6505***	-8.6337***
Term of trade (tot)	0	-13.9787***	-14.0327***	-14.0215***
Total Trade/GDP (ltotta)	2	-10.0847***	-10.1247***	-10.1528***
Private Consumption (lpcon)	3	-4.3908***	-4.2531***	-3.1040***
Government Consumption (lfcon)	8	-10.2863***	-5.7521***	-1.6003***

Notes: ***, **, * significance at α =1%, 5% and 10%

The system tests of Congruency

The essential step to develop a structural model of a system is to achieve a congruent representation of the data. In this regard, congruency requires a correctly specified lag-structure for the system of which the residuals are well behaved and the parameter constancy is satisfied. In determining the lag structure of the VAR system, Likelihood Ratio test is utilized. The outcome is supported by LR test shows that the lag length decision is made in favor of VAR (7) in this study.

Johansen Cointegration test

This study used Johansen cointegration method to determine the existence of cointegration or long run relationship and to produce estimation of behavioral equilibrium exchange rate. The test for existence of cointegration among the variables that contained in vectors z_t that is reer, nfa, tot, totta, lfcon and lpcon using maximum eigenvalue test. It tests the null hypothesis that there are at most r distinct cointegrating vector using maximum eigenvalue test. Table 3 exhibits the cointegration test, this system includes impulse dummy at 1997 to capture the outlier effect of economic crises at 1997.

These result indicates with utilized Pantula principle that the presence of rank = 1 cointegrating vectors in the system and utilized model 3 since the maximal eigenvalue do not reject the null hypothesis the first at r = 0, it means that there is one cointegrating vectors (r = 1). Model 3 represents that there is linear trend in level data and cointegrating equation has only intercept.

Table 3: Johansen Cointegration Test

Null	Alternative	Model2	Model3	Model4
r = 0	r = 1	55.7095***	54.2247***	73.6155***
r <= 1	r = 2	38.5305**	31.7099	37.9565**
r <= 2	r = 3	26.9930	26.5522	31.3511
r <= 3	r = 4	15.7386	15.7159	18.5004
r <= 4	r = 5	12.9619	8.9057	10.0008
r <= 5	r = 6	8.7294	0.0998	7.8582

Notes: ***, **, * significance at α =1%, 5% and 10%

Table 4: Normalized Cointegration Relationship

β (long run coefficient)						
Lreer	nfa	tot	Ltotta	lpcon	lfcon	C
1.0000	-5.9867	-0.3157	8.2277	-0.2579	0.1464	-4.7973
	(1.8963)	(0.0565)	(1.5415)	(0.2208)	(0.1641)	

α (adjustment coefficient)					
D(Lreer)	D(nfa)	D(tot)	D(Ltotta)	D(lpcon)	D(lfcon)
-0.1488	-0.0211	0.8435	-0.1036	-0.0416	0.1499
(0.1472)	(0.0120)	(0.3179)	(0.0477)	(0.0286)	(0.1125)

Note: ( ) indicate standard error value

The vectors are identified jointly and normalized in Table 4. These one cointegrating vectors and their adjustment coefficients are computed by standardizing the first one with respect to real effective exchange rate (*lreer*). The long run relationship can be rewritten as follows.

$$Lreer = 4{,}7973 + 5{,}9867\, nfa +$$
$$(3{,}1570) \quad (5{,}5905)$$
$$0{,}3157\, tot - 8{,}2277\, ltotta +$$
$$(-5{,}3373)$$
$$0{,}2579\, ipcon - 0{,}1464\, lfcon$$
$$(1{,}1685) \qquad (-0{,}8920)$$

In the long run, the real effective exchange rate was determined significantly by the net foreign asset, term of trade and ratio total trade to GDP. The coefficients of those variables are correctly signed, of plausible magnitude and statistically significant. Private and government consumption are insignificant and not correctly signed, it is not consistent with theory. From Table 4, it looks that term of trade has the biggest value speed of adjustment. It means that this variable has the fastest adjustment process to restore to the long run equilibrium among the other variables.

Diagnostic test consists of serial correlation, heterocedasticity, normality and stability of parameter. The result of tests were exhibited at Table 5.

According to diagnostic test, in general, the system has no serial correlation, heterocedasticity, but not normality. Equation real effective exchange rate and private consumption has serial correlation, heterocedasticity and not normality. Net foreign asset and government consumption equation has normality but not serial correlation and heterocedasticity. Term of trade has no heterocedasticity. Ratio total trade to GDP has no serial correlation and heterocedasticity but not normality.

Exchange Rate Misalignment

Estimation result of behavioral equilibrium exchange rate can be plotted with actual real effective exchange rate to show further alignment the behavioral of exchange rate. Figure 4 represents the plotted result between estimation behavioral exchange rate and against with the actual value.

Table 5: Diagnostic Tests

Statistic	Lreer	nfa	tot	ltotta	lpcon	lfcon
LM - test	77,0527*	67,7573*	69,7886*	0,7917	78,1124*	81,1109*
Normality (Jarque Bera)	29,8684*	2,5069	19,1201*	32065,09*	31,8677*	4,6175
White Heteroscedasticity	63,0494*	36,9777*	51,5109	11,5271	69,4817*	31,6264*
***Multivariate test*:**						
LM-test $\chi^2(25) = 22.6293$						
Normality (Joint-Jarque Bera df=10) = 2300.081*						
White Heteroscedasticity/joint test $^2(1095) = 1117.995$						

Notes: *)**)***) significance at α = 1%, 5%, dan 10%

Figure 4: Exchange Rate Misalignment

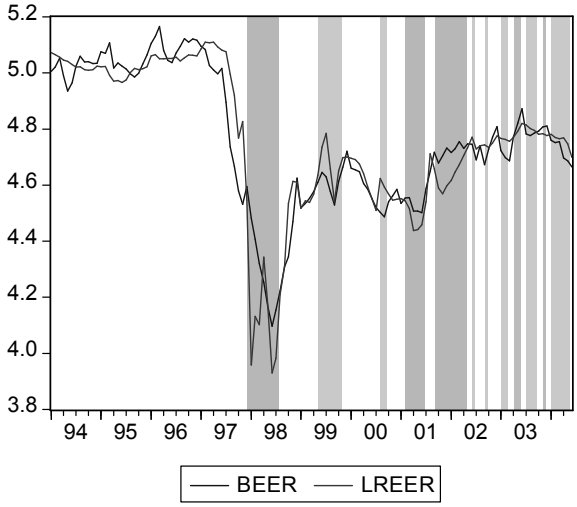


Figure 4 shows that the volatility of behavioral equilibrium exchange rate (BEER) is similar with the actual real effective exchange rate movement. For the period post-1997, after adopt floating exchange rate system, the Indonesian currency has been undervalued, it is showed with grey light shading. But the end of sample, there is overvalued of actual real exchange rate with it is showed by blue light shading. The close alignment between actual and equilibrium were showed for the period 1998 to 1999 and in period 2000.

CONCLUSION

This paper estimated the equilibrium real exchange rate using behavioral approach. Using Johansen cointegration approach to determine the long run relationship the behavioral exchange rate, the result showed that some of variables such as net foreign asset, term of trade and ratio total trade to GDP were correctly signed, plausible magnitude and statistically significant. But, government and private consumption were not statistically significant and incorrectly signed. From the plotted result between actual and equilibrium estimation, it represents that for the period post-1997, the currency has been undervalued. The close alignment between actual and equilibrium was happened in 1998 and 1999. But at the end of the sample, the currency has been overvalued.

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