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Real Exchange Rate Misalignment and Currency Crisis

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ABSTRACT

This paper aims to calculate the real exchange rate misalignment (RERM) of the Indonesian rupiah and to examine whether the misalignment contributes to explaining the exchange rate crisis, by employing a dynamic regime switching model and behavioural equilibrium exchange rate (BEER) approach. This paper found the following. First, net foreign assets and the relative sectoral productivity differential significantly influenced the equilibrium exchange rate, indicating that external and internal balance determine the behaviour of the rupiah in the long run. Second, the BEER approach can properly predict the misalignment of the rupiah, especially in explaining the overvaluation periods of the rupiah before the Asian financial crisis. The regime switching model also performed well in classifying the stable and crisis episodes of the rupiah. Third, from both models, it was found that in 17 crisis episodes, 10 were preceded by high RERM.

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JEL classification: F30, F31, F41

INTRODUCTION

The study of real exchange rate misalignment (RERM) has evolved since the financial crisis hit Asia in 1997. In addition to understanding how the real exchange rate behaves, various studies after the 1997 Asian crisis were also aimed at finding out how RERM impacts the economy. Initially, empirical research on exchange rates used the Purchasing Power Parity (PPP) doctrine approach, where under the assumption of free trade, the exchange rate between countries is equal to the ratio of two countries' price level. Newer approaches then develop such as the fundamental equilibrium exchange rate (FEER) and Behavioral equilibrium exchange rate (BEER) that are used to analyze exchange rate behavior. Specifically, the BEER approach focuses on the short run of the dynamic behavior of the exchange rate and the deviation of the actual exchange rate level from its long-term value by using macroeconomic variables as its determinant (Aliyu, 2009).

Most studies of RERM are related to macroeconomic performance. Extensive research shows that RERM impacts economic growth (Akram & Rath, 2017; Ribeiro, McCombie, & Lima, 2019; Wong, 2019). In several other studies, it shows how RERM influences export competitiveness and private investment (Jongwanich, 2009; Nouira & Sekkat, 2015; Razmi, Rapetti, & Skott, 2012; Sekkat, 2016; Sekkat & Varoudakis, 2000).

In the currency crisis context, the development of research on RERM shows how RERM can predict currency crises in various countries (Holtemöller & Mallick, 2013; Jongwanich, 2008; Kemme & Roy, 2006; Stein & Paladino, 1999). So far, the relationship between the RERM and the episode of the exchange rate crisis in Indonesia has not been widely discussed and even tends to be difficult to find. In the context of the early warning system, knowing about the relationship between RERM and currency crisis episodes is

very important to anticipate the occurrence of a financial crisis, especially in the case of Indonesia. Therefore, this paper aims to fill the gap.

Theoretically, the relationship between exchange rate misalignment and exchange rate crisis model is formulated in the second-generation crisis models, which is a further development of the first-generation model. The first-generation model sees the currency crisis as a consequence of an inconsistent macroeconomic policy stance (Agenor, Bhandari, & Flood, 1992; Feridun, 2009; Ford, Santoso, & Horsewood, 2007; Heriqbaldi, Ismail, Kaluge, & Santoso, 2014; Krugman, 1979; Sachs, Tornell, & Velasco, 1996). The second-generation model asserts that speculative attacks can grow into a crisis, even in cases where monetary and fiscal policy stance are consistent with the exchange rate regime (Heriqbaldi et al., 2014). This model argues further that the temptation for the government to leave the exchange rate regime may create negative expectations in the market. In this sense, a minor change in macroeconomic policy may potentially end with the collapse of the fixed exchange rate regime. Such conditions, then, reinforce agent expectations, which in turn creating multiple equilibria in the economy. Hence, if there is a trend of overvaluation of the exchange rate, this may create a negative expectation from the agents' perspective, which can trigger speculative attacks and end up in a currency crisis.

Despite theoretical and policy discussion has put RERM as one of the important issues, there is less attention has been paid to the study of the relationship of RERM and currency crisis, especially in the context of the Indonesian economy. One of the questions raised for example whether overvaluation prelude to a currency crisis. Within the above framework of exchange rate crisis model, RERM may affect the formation of expectations

of economic agents and can lead to downward pressure on the currency, which in turn cause exchange rate crisis when the speculative attack is successful.

This paper aims to calculate the RERM in the Indonesian rupiah and examine whether the misalignment contributes to explain the exchange rate crisis. This paper differs from earlier researches in two points. First, this paper identifies currency crisis episodes by employing the regime switching model. Second, this paper relies on the BEER approach in estimating the RERM.

The rest of the paper is organized as follow. Section 2 explains briefly the relevant literature on currency crisis, regime switching and BEER as approaches in this paper. Section 3 presents the theoretical framework as the foundation for the model and analysis. Model and data are mentioned in Section 4, followed by empirical findings and discussion in Section 5. Section 6 concludes the paper.

A BRIEF REVIEW OF LITERATURE

The Literature on the currency crisis

Theoretically, the views on the currency crisis are divided into three groups, namely the first, second and third-generation crisis models. The first-generation crisis model sees that the poor fundamental or inconsistent macroeconomic policies are the main sources of speculative attacks which ultimately result in exchange rate crises (Chui, 2003).

The second view of the causes of the exchange rate crisis refers to the second-generation crisis model. According to this model, speculative attacks can occur even in circumstances where fundamental factors (internal and external balance) are in good condition. This model states that if there are circumstances in which an overvalued exchange rate occurs, it will encourage the emergence of corrective expectations of economic actors in the market. If speculative attacks are carried out, it will encourage an

exchange rate crisis. This is what became known as the self-fulfilling attack. If the market attacks, a currency crisis will occur, otherwise if there is no attack, the crisis will not occur. This then has implications for the emergence of the phenomenon of multiple equilibria.

The crisis as in this second-generation model, among them, occurred during the 1997 Asian crisis. High economic growth, a relatively low unemployment rate, and a trade balance surplus were conditions in countries such as Thailand, Indonesia, Malaysia, South Korea before the crisis. However, in 1997 there was a crisis with a very rapid spread in Asian countries (Ford et al., 2007).

In the third-generation crisis model, the emergence of the exchange rate crisis was associated with the events of the banking crisis caused by the practice of moral hazard and the poor supervision of the banking system. A large amount of capital inflow in a country has encouraged excessive lending to the private investment sector whose value tends to be overvalued. This then creates bad loans (Reinhart, Goldstein, & Kaminsky, 2000). These bad loans then lead to a drastic decline in the value of assets that causes panic in the market resulting in speculative attacks that end in sudden capital outflows and reduced foreign exchange reserves and depreciation pressures.

As a consequence of various research objectives regarding the exchange rate crisis, there were differences in the use of research approaches and models (see: Cerra & Saxena, 2002; Ford et al., 2007; Frankel & Rose, 1996; Hernández & Montiel, 2003; Kaminsky, Lizondo, & Reinhart, 1998; Kumah, 2011; Liu, 2009). In research using a binary approach, some researchers used the PROBIT and LOGIT models to answer research questions about the probability of crises (see: Cipollini & Kapetanios, 2009; Moreno, 1999). In other studies, studies were directed at the formation of indicators for

an early warning system, by using arbitrary thresholds for crisis indicators (see: Abiad, 2003; Arias & Erlandsson, 2004). In studies of other crisis determinants, structural approaches are used such as Vector Auto Regression (VAR), Vector Error Correction Model (VECM), and regime switching approaches (see: Feridun, 2009; Sachs et al., 1996).

The development of research approaches and models shows that the emergence of second-generation model has changed how studies of crises are carried out. The characteristics of multiple equilibria (regime switching) and self-fulfilling attacks cause linear structural models such as VAR and VECM cannot accommodate changes in equilibrium. Therefore, Kaminsky (2003) states that in order to understand the exchange rate crisis that has elements of multiple equilibria, a switching regime approach is needed.

For these reasons, research on the exchange rate crisis in a situation where there is an element of self-fulfilling attack in the exchange rate crisis will be more valid through the application of approaches that accommodate multiple equilibria in the economy. One of the frontier approaches that can be used to accommodate multiple equilibria is the Markov Regime-Switching (MRS).

The Literature on Behavioral Equilibrium Exchange Rate (BEER)

The inability of “traditional" model such as PPP, monetary models, and uncovered interest parity in explaining the behaviour of the exchange rate has led to the development of new approaches (PPP failure in explaining empirically the behaviour of the exchange rate is documented in Breuer (1994)). The new approach is including the Fundamental Equilibrium Exchange Rate (FEER) and Behavioural Equilibrium Exchange Rate (BEER).

FEER which is advocated by Williamson (1994), can be defined as the level of an exchange rate that is consistent with simultaneous internal and external balance in the medium term (Lòpez-Villavicencio, Mazier, & Saadaoui, 2012). The Internal balance refers to the condition where the level of output which is consistent with the state of full employment and low inflation. While the external balance refers to the situation where there is a current account balance that is not only sustainable but also at the right level when the economy is at its internal balance.

Several studies in the past few years that utilized FEER in the way of identifying the existence of RERM are Jeong, Mazier, & Saadaoui, 2010; Lòpez-Villavicencio et al., 2012; Saadaoui, Mazier, & Aflouk, 2013; You & Sarantis, 2012. This balance principle of FEER approach is then used by other approaches such as the Natural Real Exchange Rate (NATREX) (JL Stein, 1993) and the Debt Adjusted Real Exchange Rate (DARER) (Fabella, 1996).

The FEER approach tends to be normative, especially when identifying the medium term of current account equilibrium. It is operationally difficult to determine the equilibrium level because there is no reference to ideal conditions in the current account. Therefore, the BEER approach modifies the FEER by focusing on the actual value rather than the medium-term equilibrium. This means that the macroeconomic balance assumption in FEER is no longer used by the BEER approach.

BEER which popularized by Clark & MacDonald (1999) is an empirical approach to estimating equilibrium exchange rate based on an econometric long-term relationship between real exchange rate and fundamental factors that influence it. In the process of identifying the fundamental factors, some studies refer to the stock-flow models developed by Alberola, Lopez, Ubide, & Cervero (1999) and Alberola (2003).

This approach typically uses a two-stage procedure for obtaining the estimation RERM. In the first stage, the long-run relationship between real exchange rate and fundamentals is estimated. The result of this estimation is the equilibrium exchange rate which is obtained by imposing the values of all explanatory variables in the long-term equation. In the second stage, RERM can be obtained by calculating the difference between the actual and fitted values of real exchange rate variable. Based on the purpose of this study, the BEER approach is best suited to calculate the degree of misalignment of Indonesian Rupiah to US Dollar.

Several studies which utilized BEER approach, combining Balance of Payment (BoP) approach (Frenkel & Mussa, 1985) and Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964) to see empirically exchange rate behaviour. While the BoP approach considers that the accumulated current account balances can explain the behaviour of the real exchange rate, Balassa-Samuelson hypothesis considers that the differences in productivity growth between countries and between sectors in the country are major determinants of the behaviour of the real exchange rate in the long run. Some studies on RERM using BEER approach that can be mentioned are Cheung, Chinn, Pascual, & Zhang (2019); Wong (2019); Adu, Litsios, & Baimbridge (2019); Allegret & Sallenave (2014); Baak (2012); Couharde & Sallenave (2013); Coulibaly & Gnimassoun (2013); Holtemöller & Mallick (2013); Schröder (2013); Terra & Valladares (2010). In the Indonesian context, several studies show that BEER estimations are quite robust based on statistical criteria used by several researchers (Bénassy-Quéré, Béreau, & Mignon, 2009; Lòpez-Villavicencio et al., 2012). Therefore, BEER was used as a model in this study.

One research gap in the study of RERM misalignment in the context of Indonesia is the question of whether the misalignment tends to precede the exchange rate crisis. Within the framework of the theory of exchange rate crisis, RERM misalignment can affect the formation of expectations of economic agents. Theoretically, the tendency of the real exchange rate overvaluation can lead to downward pressure on the currency, which then can be ended with the exchange rate crisis when the speculative attack is successful. Therefore, this gap motivates this paper to study the relationship between RERM and exchange rate crisis in the Indonesian context.

RESEARCH METHOD & DATA

VECM Methodology

Methodologically, this paper uses two stages of estimation, namely VECM model and regime switching model. Regime switching model is used to determine the exchange rate crisis episodes experienced by Indonesia during the observation period, while VECM model is used to estimate the equilibrium real exchange rate. Through VECM models, the relationship between the real exchange rate and its fundamentals will be identified. The estimation results from those two models are used to answer the question of whether the exchange rate crisis in Indonesia is always preceded by RERM.

Prior to the VECM model estimation, there are econometric procedures that should be employed. First is to apply standard unit root tests on all series to determine the integration order of each series. If all series is on the same order, then the second step is to test the existence of cointegration relationships among all series by using multivariate Johansen cointegration techniques.

In the third step, the estimation of the VECM models performed to obtain short-term relationships and long-term of the entire series. The VECM estimation results are

used to calculate the equilibrium real exchange rate by obtaining the fitted value. The difference between the actual value and the fitted value is the RERM, where a positive value shows overvalued condition and a negative value refers to undervalued circumstances. The difference between actual and fitted values is called RERM. This misalignment can be divided into two groups, namely the short-run and long-run RERM based on Clark & MacDonald (1999).

Markov Switching Autoregressive Methodology

The most common procedure for determining the dating of crisis episodes is to use changes in exchange rates, reserves, and interest rates, determine the weights for these three variables, and combine it into an exchange market pressure index. The next step usually determines the time span and then identifies the crisis episode based on whether the index exceeds the threshold. This approach has several disadvantages (Abiad, 2003). First, the choice of the threshold level for identifying crisis episodes is arbitrary. For example, some literature uses 1.5 x σ (Aziz, J., Caramazza, F., and Salgado, 2000), while other literature uses 2.5 x σ (Edison, 2003) and 3 x σ (Kaminsky et al., 1998). This difference in threshold has consequences for differences in crisis dates. Second, the results of calculating the threshold using a specific time sample indicate that future data affects the identification of past crisis times. Edison (2003) identified the loss of several crisis episodes due to the calculation of the threshold that accommodated events such as the Asian crisis. Third, ad hoc adjustments to this binary crisis variable can cause artificial serial correlation. Fourth, the continues variable transformation into binary variables causes information lost, especially those related to the dependent variable dynamics.

Therefore, this paper uses a regime switching model (RS Model) which has several advantages. First, the RS model does not require a priori dating of crisis episodes.

The RS model identifies endogenous crisis episodes that are estimated simultaneously with the crisis forecast probabilities within the maximum-likelihood framework. Second, information loss does not occur because it does not transform dependent variables into binary variables.

Markov Switching Autoregressive model (MS-AR) was first developed by (Hamilton, 1989). Hamilton (1989) using a two-state mean switch models of order four to classify the US economy business cycle into recessionary state and growth state.

$$y_t = \mu(s_t) + \left[\sum_{i=1}^{4} \alpha_i \left(y_{t-i} - \mu(s_{t-i})\right)\right] + u_t, \quad (1)$$
$$u_t | s_t \sim NID(0, \sigma^2) \; and \; s_t = 1,2$$

Based on Equation (1), the two regimes are distinguished in terms of the mean parameter, μ. Krozlig (1997) classifies this as Markov Switching Mean Autoregressive Model [MSM (2) – AR (4)]. As the data generating process is determined in the form of the autoregressive model, the next step of MS methodology is identifying the regime generating process. Under this regime generating process, the unobserved state, s_t is assumed to be following the first-order Markov-process. It means that the current regime, s_t depends only on the regime of one period before, s_{t-1}. The transition probability is shown below.

$$P\{s_t = j | s_{t-1} = i, s_{t-2} = k, \ldots\} = P\{s_t = j | s_{t-1} = i\} = p_{ij}, \quad (2)$$
$$\sum_{j=1}^{M} p_{ij} = 1 \quad \forall \, i, j \in \{1, \ldots, M\}$$

where p_{ij} is the probability of being in regime *j* in period *t* if regime *i* occurs in period *t-1*. *Markovian transition matrix P** can be summarized as follow.

$$P^* = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1M} \\ p_{21} & p_{22} & \cdots & p_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ p_{M1} & p_{M2} & \cdots & p_{MM} \end{bmatrix}, \quad (3)$$

Univariate Model of Exchange Rate

Below is the univariate exchange rate model.

$$q_t = \alpha_0(s_t) + \sum_{i=1}^{p_0} \alpha_i \, q_{t-i} + \varepsilon_t, \quad (4)$$
$$\varepsilon_t \sim IID\left(0, \sigma^2(s_t)\right)$$

Based on Markov Switching model classification (Krolzig, 1997), the above model falls into Markov Switching-Intercept Autoregressive-Heteroscedastic (MSIAH) specification. This model used to identify the currency crisis episodes, and the episodes divided into two groups which are tranquillity and volatile states. The volatile state represents crisis episodes. The autoregressive model was employed as a data generating process to accommodate the inertia factor, while the heteroscedastic specification was used to allow the disturbances to be different in each state.

Data

The empirical analysis of the real exchange rate of the Indonesian rupiah makes use of quarterly data spanning from the first quarter of 1980 to the fourth quarter of 2012. All data compiled from International Financial Statistic and Central Bureau of Statistic Indonesia. There are three variables considered in the estimation, the real exchange rate (q), the net foreign assets in ratio to GDP (f), and the relative sectoral productivity differential (a). RER was calculated in two stages. First, the natural logarithm of the average exchange rate (rupiah/US dollar) was calculated, and then multiplied by the ratio

of US CPI/Indonesia CPI. The net foreign asset of the Central Bank of Indonesia was calculated by the difference the foreign assets and the liabilities to non-residents. This series is expressed as a share of GDP. For relative sectoral productivity, this paper uses average labour productivity as a proxy by employing the ratio of GDP to total employment.

Unit root test was conducted to all series by ADF test. Table 1 presents the results of the unit root test, which indicates that at 5% critical value, all series are non-stationary at level, except for q.

Table 1. Unit Root Test

	Levels		First Differences	
	Adj. t-stat	Prob.	Adj. t-stat	Prob.
Q	-3.173	0.0017	-6.632	0.0000
F	0.318	0.9986	-3.674	0.0276
A	0.382	0.9815	-3.076	0.0310

Table 2 reports the results of the Johansen cointegration test. The results from the maximum eigenvalue test as well as the trace test show that there is at least one cointegrating relationship in the chosen set of variables.

Table 2. Johansen cointegration test

Rank	Eigenvalue	Trace test		Maximum eigenvalue test	
		λ_{trace}	*p-value*	λ_{max}	*p-value*
r = 0	0.179	30.29	0.04**	25.04	0.01**
r ≤ 1	0.004	5.25	0.78	5.02	0.74
r ≤ 2	0.002	0.22	0.63	0.23	0.64

The superscript (**) signify the rejection of the null hypothesis at 5% critical value

RESULTS

Estimation of the Equilibrium Exchange Rates and Misalignments

Long run and short run estimation

Since λ_{trace} and λ_{max} statistics indicate the presences of one cointegrating vector among variables, the short run and the long run equation can be estimated. The estimation results are the following:

Table 3. Estimation of the long run and short run coefficients

	Long run			Short run	
	Coef.	*t*-stat.		Coef.	*t*-stat.
f	-99.293	-5.76	ect_{t-1}	-0.001	-4.27
a	0.000001	2.14	Δq_{t-1}	0.272	2.89
c	94.147		Δq_{t-2}	-0.103	-1.19
			Δf_{t-1}	0.160	2.98
			Δf_{t-2}	0.017	0.34
			Δa_{t-1}	6.6E-08	0.87
			Δa_{t-2}	-8.57E-08	-1.12
			c	-0.072	-3.89

In the long run equation, the t-statistics shows that all of the estimates are significantly different from zero at the 5% significance level. While the estimated coefficient values for labour productivity (a) has a positive sign as predicted by the theory, but the sign of net foreign assets (f) shows a negative relationship between NFA and real exchange rate. This negative relationship is consistent with previous findings (Alberola & Navia, 2008; Alper & Civcir, 2012).

It also reported that the adjustment coefficient or the coefficient of the error correction term is estimated to be -0.001 and that its t-statistic is -4.27, indicating that it is significant at the 1% significance level. This result also confirms the existence of one cointegrating vector as was indicated by the Johansen cointegration test.

Measuring Misalignment

The behavioural equilibrium exchange rate (BEER) or the long run relationship between real exchange rate, net foreign asset and productivity effect is illustrated in figure 1 along with the actual exchange rate (RER). The BEER is calculated by estimated values of long-run equation. The current misalignments are computed by taking the difference between the BEER and the RER after estimated using Hodrick-Prescott filter (similar methodology was applied by Baffes, O'Connell, & Elbadawi (1999); Clark & MacDonald (1999); Iossifov & Loukoianova (2007); Yehoue & Dufrénot (2005)). This current misalignment is illustrated in figure 1 and 2.

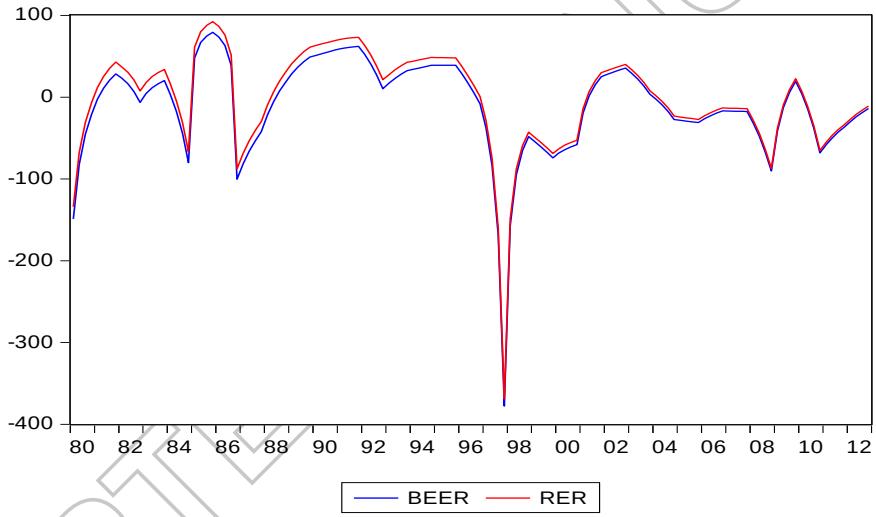

Figure 1. Long run BEER and Actual RER

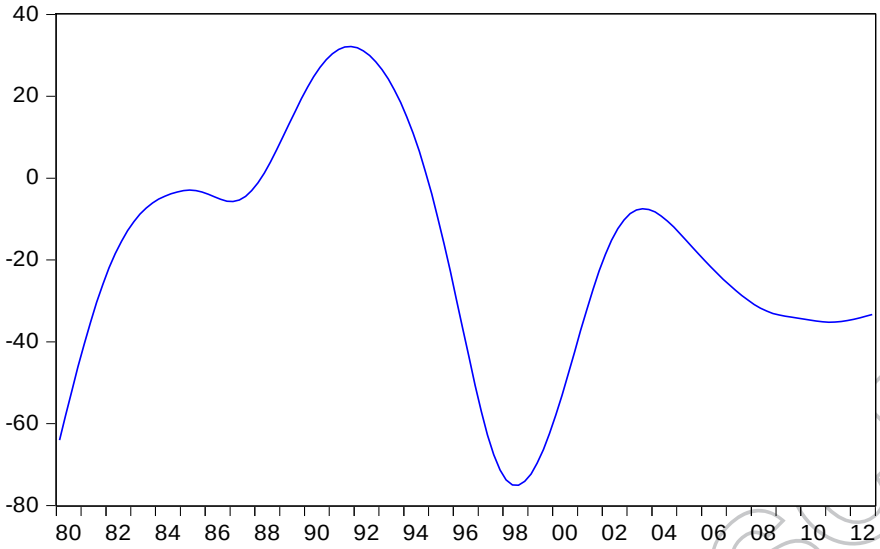

Figure 2. Degree of misalignment

Estimation of Exchange Rate Crisis Episodes

Diagnostic test

The diagnostic test is presented in Table 4. Heteroscedasticity test using ARCH method shows that the test could not reject the null hypothesis, which was the homoscedastic residual. The regime-switching model was sufficient to capture the ARCH process, as was evidenced by the ARCH test and the Ljung-Box Q-test for serial correlation in the standardized residuals. Hence, it can be said that there is no evidence of heteroscedasticity in the residuals. The portmanteau test confirms that it could not reject the null hypothesis, which means that there was no autocorrelation based on an 11-lag test.

In the context of the normal distribution, the residual was tested using the normality test developed by Doornik & Hansen (2008). The test showed that it could not reject the null hypothesis (normal distribution), which means that the residual derived from the estimation has a normal distribution.

Table 4. Diagnostic test for regime switching model

Criteria	
No. of observations	128
No of parameters	11
AIC criterion	-1.28030205
Log-likelihood	92.9393311
Linearity LR-test [$Chi^2(17)$]	110.93 [0.0000]**
Normality test [$Chi^2(2)$]	2.5318 [0.2820]
ARCH 1-1 test: F(1,115)	1.3790 [0.2427]
Portmanteau(12): Chi^2(11)	9.0031 [0.6216]

Regime Characterization

The diagnostic test also covers the test for the robustness of the regime-switching model. The LR test was conducted to compare the linear model against the regime-switching model. The null hypothesis of the test was that the appropriate model was the linear specification, while the alternative hypothesis was that the regime-switching model was more representative. The chi-square value shows that it rejects the null hypothesis and it is concluded that the regime-switching specification fitted the data better than the linear specification.

The regime-switching estimates show that period can be divided into two regimes, stable and volatile, as indicated in Figure 3 by the blue bar and the unshaded regions. Through smoothed probabilities method, it can be observed that the volatile state has limited occurrence; as indicated by the blue bars, these periods are concentrated in the middle parts of the sample period, in the mid of 1980, the mid of 1997 and during 1998, early 1999, and early 2001. The volatile states in 1997 coincide with the Asian financial crisis, while the high pressures during 2001 correspond to the Latin America debt crisis. Periods of stable state (indicated by the unshaded regions) dominate the picture, which

means that stable states tend to have a longer duration than volatile states. Furthermore, the estimation result of the endogenous regime by employing the Markov switching model shows that the model can predict accurately the volatile and stable periods, especially during the late 1990s financial crisis periods.

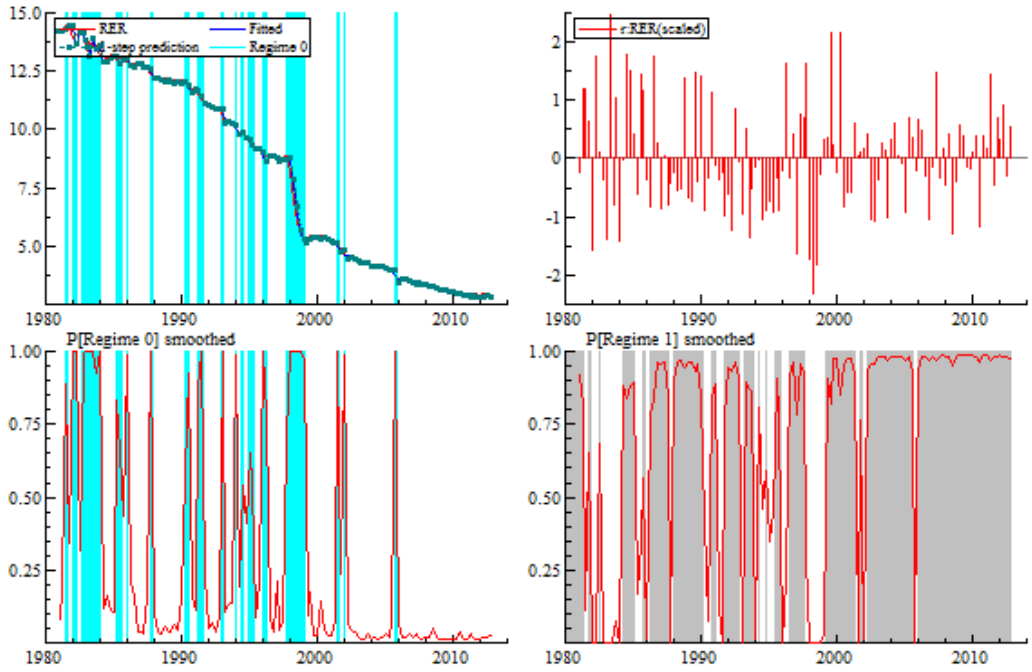

Figure 3. Regime classification based on smooth probabilities method

Regime Shift

Estimated transition probabilities are presented in the matrix P below:

$$P = \begin{bmatrix} 0.50 & 0.18 \\ 0.49 & 0.82 \end{bmatrix}$$

The matrix shows that the estimated transition probabilities indicate that none of the regimes are permanent. For example, there is a 50 percent probability of staying in a volatile state, which is lower than the probability of staying in the stable state (82%). This means that the stable state is more persistent than the volatile state. Further, the transition

probability from stable toward the volatile state is 18%, which is much smaller than that of volatile toward stable (49%).

Moreover, the estimated ergodic probabilities indicate that Indonesia experienced periods of stability 74% of the time, with an average duration of 5.28 quarters. The ergodic probability of the volatile state shows that Indonesia experienced volatile periods 26% of the time, with an average duration of 1.94 quarters. Thus, there were only a few episodes of currency crises in the Indonesian economy during 1980–2012. In addition, from the regime property of RE below (Table 5), the estimated model can accurately detect the currency crises in the late 1997. This is not only indicated by high real exchange rate but also demonstrated by a high average of probability. Therefore, the inferred probabilities for a volatile state have high informative content regarding the Asian currency crises of 1997.

Table 5. Currency crisis episodes

	Months	Average of Probability
Regime 0: volatile state		
1981(3) - 1981(3)	1	0.886
1982(1) - 1982(2)	2	1.000
1982(4) - 1984(1)	6	0.986
1985(2) - 1985(3)	2	0.742
1986(1) - 1986(1)	1	0.987
1987(4) - 1987(4)	1	1.000
1990(2) - 1990(3)	2	0.752
1991(2) - 1991(3)	2	0.935
1993(1) - 1993(1)	1	1.000
1994(1) - 1994(1)	1	0.988
1994(3) - 1994(3)	1	0.541
1995(1) - 1995(2)	2	0.603
1996(1) - 1996(2)	2	0.890
1997(4) - 1999(1)	6	0.946
2001(3) - 2001(3)	1	1.000
2002(1) - 2002(1)	1	0.986
2005(4) - 2005(4)	1	
Total: 33 quarters (25.78%) with average duration of 1.94 quarters		
Regime 1: stable state		
1981(1) - 1981(2)	2	0.866
1981(4) - 1981(4)	1	0.655
1982(3) - 1982(3)	1	0.683
1984(2) - 1985(1)	4	0.873
1985(4) - 1985(4)	1	0.565
1986(2) - 1987(3)	6	0.891
1988(1) - 1990(1)	9	0.937
1990(4) - 1991(1)	2	0.861
1991(4) - 1992(4)	5	0.902
1993(2) - 1993(4)	3	0.873
1994(2) - 1994(2)	1	0.807
1994(4) - 1994(4)	1	0.592
1995(3) - 1995(4)	2	0.851
1996(3) - 1997(3)	5	0.907
1999(2) - 2001(2)	9	0.928
2001(4) - 2001(4)	1	0.761
2002(2) - 2005(3)	14	0.969
2006(1) - 2012(4)	28	0.976
Total: 95 quarters (74.22%) with average duration of 5.28 quarters		

Dynamic Model Estimation Results

Table 6 shows the regime switching dynamic model estimation results. The intercept is characterized as regime dependent. The parameter estimates on the lag of RER indicate that the current value of RER was strongly influenced by its lags. In the case of lag one and two of RER, the regression results show that they are regime dependent whereas the third lag shows a different result. This suggests the existence of inertia, where RER in the

previous period influenced the expectations of private agents toward RER at the present time. The results also show that the degree of uncertainty in RER is higher in the volatile state than in a stable state and the probability of being in a volatile state is around 50%.

Table 6. Estimation result

	Coefficient	t-value	t-prob
Regime-dependent intercepts			
C(0)	-0.377243	-1.66	0.099
C(1)	-0.0303671	-2.46	0.015
Coefficients			
RER_3	0.161283	2.22	0.028
RER_1(0)	1.35343	8.13	0.000
RER_1(1)	1.25394	19.1	0.000
RER_2(0)	-0.497171	-2.50	0.014
RER_2(1)	-0.415025	-5.16	0.000
Σ (0)	0.289155	7.28	0.000
Σ (1)	0.0513628	5.00	0.000
p_{0|0}	0.501511	3.00	0.000
p_{0|1}	0.182880	3.12	0.002

RERM and Exchange Rate Crisis Episodes

Table 7 below summarizes the relationship between the real exchange rate misalignments with episodes of exchange rate crisis experienced by Indonesia. This paper attempts to answer the question of whether the exchange rate crisis episodes in a particular quarter is always preceded by a real exchange rate misalignment. From the table, it can be seen that of the 17 episodes of the crisis, 10 of which are always preceded by a quite high real exchange rate misalignment (compared to the average value of misalignment within 5 years).

The largest impact currency crisis experienced by Indonesia was during the Asian crisis in the late decade of the 1990s. Based on the classification regime, exchange rate crisis experienced by Indonesia during the period of 1997 (4) - 1999 (1). If further review, the high pressure on the rupiah has occurred since 1995 (4) in which the rupiah has undergone a misalignment of about 23%. The degree of misalignment was getting bigger and it reached 68% in the 3rd quarter of 1997, which ended with the exchange rate crisis in the 4th quarter in the same year.

Table 7. Crisis episode and real exchange rate misalignment

Periods	Duration of crisis	Probability	Degree of Misalignment 1 quarter before (%)	5 years average of misalignment (%)
1981(3) - 1981(3)	1	0.886	35.26*	20.13
1982(1) - 1982(2)	2	1.000	25.93*	
1982(4) - 1984(1)	6	0.986	15.45	
1985(2) - 1985(3)	2	0.742	3.07	
1986(1) - 1986(1)	1	0.987	3.39	6.74
1987(4) - 1987(4)	1	1.000	5.73	
1990(2) - 1990(3)	2	0.752	22.23*	
1991(2) - 1991(3)	2	0.935	30.39*	15.99
1993(1) - 1993(1)	1	1.000	28.39*	
1994(1) - 1994(1)	1	0.988	18.49*	
1994(3) - 1994(3)	1	0.541	10.99	
1995(1) - 1995(2)	2	0.603	1.59	
1996(1) - 1996(2)	2	0.890	22.74	59.49
1997(4) - 1999(1)	6	0.946	67.60*	
2001(3) - 2001(3)	1	1.000	32.12*	15.58
2002(1) - 2002(1)	1	0.986	22.67*	
2005(4) - 2005(4)	1		16.87*	

* The degree of misalignment in corresponding quarter exceeded the average degree of misalignment within 5 years. It shows that 10 of the 17 episodes of exchange rate crisis was preceded by a misalignment.

CONCLUSION

This paper measured the misalignments of Indonesian real exchange rates and connecting it with the currency crisis experienced by Indonesia during the period of 1980-2012. The misalignment estimates were derived by employing BEER approach, whereas the currency crisis episodes were obtained by utilizing the regime switching model.

Of interest from the findings is that most of the currency crisis episodes experienced by Indonesia is always preceded by an overvalued exchange rate. Several episodes of the crisis are even preceded by a quite high misalignment of the rupiah against the dollar, especially in the period of the Asian crisis in late 1997. The results of misalignment calculation and classification of exchange rate crisis episodes showed that 10 of 17 currency crisis events were always preceded by a high degree of misalignment in the rupiah. Conversely, a low misalignment showed a strong association with episodes of the stables exchange rate as shown in the time period after 2005.

In terms of economic policy, there are several important recommendations for Indonesia. First, re-alignment of fiscal and monetary policies. Re-alignment and consistency of macroeconomic policies are very important to provide a clear signal on the financial market so that it can reduce the source of speculation. Second, guaranteeing the sustainability of the balance of payments in the long run. This means that Indonesia must be able to increase the export growth of the manufacturing industry to compensate for the decline in commodity exports due to declining world prices. Sustainability of the balance of payments also means reducing dependence on short-term capital flows to cover the current account deficit. Third, improve the supply side of the economy to increase economic growth and economic diversification. Improvement of the supply side means investing in the infrastructure sector, both economic and social, so as to reduce logistics

and transportation costs and increase labor productivity. The improvement in the supply side also means deregulation and de-bureaucratization to encourage direct investment.

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