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A REGIME SWITCHING ANALYSIS OF INDONESIA'S EXCHANGE MARKET PRESSURE

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This paper examines the extent to which the Indonesia's currency crisis can be accounted for by macro and micro economic fundamentals by employing Markov-switching approach under cross-generation crisis models. In order to represent the speculative attack in the economy, the study utilized one of the measures that is most widely adopted to signal the breakup of a crisis, the Exchange Market Pressure Index (EMPI). This paper found the following. First, liquidity (DC), real exchange rate (RER2) and ratio of banking credit to GDP (BCred) were found to significantly influence the EMPI, indicating that the behavior of EMPI has the characteristic that is predicted by the first, second, and third generation of crisis model found to significantly influence the EMPI, indicating that the behavior of EMPI has the characteristic that is predicted by the first, second and third generation of crisis models. Second, the LR test showed that regime switching dynamic model is more robust than ordinary dynamic model in explaining the EMPI, suggesting that speculative attacks tend to have the characteristics of multiple equilibria. Third, the transition probability matrix results showed that the tranquility regime was more persistent than the volatile regime.

Keywords: Exchange market pressure; regime switching; currency crisis; money supply; credit.

JEL Classification: F30, F31, F33, E51

1. Introduction

Perspectives on currency crisis have developed significantly, especially since the Asian crises in the late 1990s. Such developments are shown by the evolution of currency crisis models, which have progressed from the first generation to the third generation. Currency crises have been extensively analyzed in the literature with a variety of analytical tools proposed to identify crisis episodes. One of the measures that is most widely adopted to signal the breakup of a crisis is the Exchange Market Pressure Index (EMPI) (Bertoli *et al.*,

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2010). EMPI is usually related to changes in internal and external variables of any economy.

In the speculative attacks study, exchange rate changes tend to be non-linear with changes in economic fundamentals. At a certain time period, the economy is characterized by a continuous period of exchange rate appreciation, while in other periods there is a tendency of continuous period of depreciation. Therefore, the economy that experienced speculative attacks tends to have the characteristics of multiple equilibria. On the basis of that reason, the EMP analysis using linear model will likely contain misspecification errors.

This paper examines the extent to which the Indonesia's currency crisis can be caused by macro and micro economic fundamentals as suggested by first, second and third generation models by adopting a two-regime Markov-switching EMPI model which represents a nonlinear approach. In the Indonesia case study, several studies using non-linear approach were aimed at proving the crisis model (Ford *et al.*, 2007) and analyzing the source of crisis (Cerra and Saxena, 2002). In the context of literature on currency crises related to Indonesia, the present study contributes primarily on two broad fronts. First, it modifies the calculation of EMPI, especially in the context of weight used in the nominal exchange rate component (Bertoli *et al.*, 2010) and the use of interest rate which is taken in levels, not in the first-difference form typically used (Klaassen and Jager, 2006). Second, based on this EMPI calculation, this paper tries to analyze how macro and micro fundamentals influence EMPI under the cross-generation crisis model.

The paper is organized into seven sections. Section 2 reviews the relevant literature as the foundation for the model development and analysis. Section 3 explains briefly the conceptual framework as the basis of variable and regression technique selection. Data and unit root procedure are mentioned in Section 4, followed by econometric methodology, empirical findings and discussion in Sections 6 and 7 respectively. The conclusion and implications of the study concludes the paper.

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2. A Brief Review of Literature

In this paper, crisis refers to an intense increase in speculative pressure on the country's currency. Hence, such pressures can be represented by EMPI, which is the sum of the exchange rate change reserve change and level of interest rate, weighted by their respective standard deviation. The insight is that, if there is an attack on exchange rate, either the exchange rate would depreciate, or interest rate would be raised to prevent the attack, or the central bank would sell foreign currency to support the exchange rate level (Cerra and Saxena, 2002).

EMPI is a widely used measure representing pressures taking place in an economy (see for example, Eichengreen *et al.*, 1995, 1996; Kaminsky *et al.*, 1998, 1999; Bertoli *et al.*, 2010). EMPI was first developed by Girton and Roper (1977), who analyzed the monetary policy stance of central bank. EMPI not only provides an overview of successful attacks against the currency of a country, but also gives an overview of unsuccessful attacks (Kaminsky *et al.*, 1998; Goldstein *et al.*, 2000).

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The attempt to model currency crises was initiated by Krugman (1979), who developed what has been understood as the first generation of crisis model. Krugman's work was based on a model developed by Salant and Henderson (1978) focusing on speculative attacks on government-controlled price of gold. Krugman's model emphasizes that under the assumption of small and open economies, a country with a fixed exchange rate regime will experience speculative attacks on its currency when there are unsustainable credit expansions and unsound economic fundamentals (Chui, 2002).

In this sense, the first generation model sees the currency crisis as a consequence of an inconsistent macroeconomic policy stance. On the one hand, government maintains its fixed exchange rate system. On the other, the government constantly increases domestic credit (DC) to finance its budget, in order to achieve domestic economic objectives, such as investment and employment. Such inconsistencies provoke speculative attacks, which can potentially escalate into a currency crisis. There are ample studies (for example, Agenor *et al.*, 1992; Feridun, 2009; Ford *et al.*, 2007; Lahiri and Vegh, 2000; Sachs *et al.*, 1996) that support this notion of a "fundamental problem."

Discussions on the determinants of crises have developed further with the emergence of the second generation model. In contrast to the first generation model, the second model emphasizes that speculative attacks can grow into a crisis, even in cases where monetary and fiscal policy stance are consistent with the exchange rate regime. This model also contends that governments may encounter temptations in terms of leaving the exchange rate regime and engaging in expansionary monetary and fiscal policies to support internal economic objectives.

Such conditions create negative expectations in the market. In this sense, a minor change in macroeconomic policy, as a response to changes in private agents' expectations, may potentially end with the collapse of the fixed exchange rate regime. Such conditions, then, reinforce agent expectations. This shows the existence of multiple equilibria and self-fulfilling expectations, which are understood as the characteristics of this model.

Moreover, in contrast to the first generation model, which believes that speculative attacks accommodate linear behavior, the second generation model indeed formalizes the existence of nonlinearity in the relationship between changes in monetary policy and speculative attacks (Obstfeld, 1994, 1996). The probability of the existence of multiple equilibria will be considerably higher when speculative attacks are conducted by large numbers of traders with heterogeneous expectations.

The emergence of the Asian crisis in the late 1990s triggered further discussions on the main causes of currency crises. This leads to the development of the third generation model, whose main contribution is to include the banking crisis aspect in the context of the currency crisis model. More specifically, this model sees the main cause of the banking crisis as morally hazardous practices (Krugman, 1998; McKinnon and Pill, 1998). Good economic conditions, and the existence of government guarantees in financial sectors, serve as signs of a better return and minimum risks, which then attract capital inflows to a country. Such inflows encourage the domestic banking sector to deal with excessive lending for overvalued private investments. This condition potentially leads to the creation of bad loans in the banking sector (Goldstein *et al.*, 2000). Consequently, bad loans will

force a reduction in asset values and create a higher degree of uncertainty in the market. In this situation, speculative attacks will occur and generate sudden capital outflow, reserve depletion and a high degree of depreciative pressure.

Some studies have specifically employed the third generation model to explain currency crises in different countries. Kaminsky and Reinhart (1999) show that along with the implementation of a policy of financial liberalization, a banking crisis is highly related to the occurrence of a currency crisis. More specifically, Demirgüc-Kunt and Detragiache (1998) explain how the fragility of the banking system influenced the banking crisis, and in the case of Turkey, there is a significant relationship between the banking crisis and the currency crisis (Feridun, 2009).

One of the models explaining the linkage between the banking crisis and the currency crisis is the moral hazard model (McKinnon and Pill, 1998; Krugman, 1998). Based on this model, the main source of the banking crisis is the emergence of excessive lending with a high degree of risk. Such excessive lending is mainly due to implicit government guarantees. Most of this lending is allocated to financial assets purchased at significantly high or unreasonable prices. As the banking sector experiences liquidity problems, major sharp corrections in asset prices take place (Corsetti *et al.*, 1998; Krugman, 1998).

It is critical to note that a sharp decline in an asset's price can become a self-fulfilling process, which means that its impact might not only hit one particular bank, but also the whole banking sector in a country. If government reacts to a banking crisis by printing more money to bail out banks with liquidity problems, the crisis can be categorized as falling under the first generation model. Hence, it can be said that through the moral hazard model, a connection between the first generation and third generation crisis models can be drawn.

In addition to the moral hazard model, the banking sector crisis can also be explained through the illiquidity model, which was developed by Diamond and Dybvig (1983) and Chang and Velasco (2001). The illiquidity model emphasizes that there is a potential bank-run when a bank faces an illiquidity risk (Chui, 2002). The inability of a bank to fulfill demands for cash from its depositors can have a dysfunctional impact, not only on large-scale withdrawal of funds from that particular bank, but also on other banks, due to self-fulfilling process.

Both the moral hazard and the illiquidity models are related to the first and second generation crisis models (Chui, 2002). Flood and Marion (1999) and Burnside *et al.* (2001) employed a combination of the first and second generation models to explain factors determining banking and currency crises.

Burnside *et al.* (2001) explain that the relationship between first and second generation models can be observed through the twin banking-currency crises. In cases where all the liabilities of the banking sector are under government guarantee, if the domestic currency faces devaluation pressures, the banking sector will experience currency risks. When some of banking liabilities are transferred into government liabilities, it will create a fundamental problem, as predicted by the first generation model. Moreover, if speculative attacks are influenced by the decision of whether or not a bailout will take place, multiple equilibria will occur as predicted by the second generation model (Chui, 2002).

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Therefore, Burnside *et al.* (2001) conclude that twin banking-currency crises may occur as a consequence of government guarantees (fundamental-based problem). However, the timing of the crisis is significantly influenced by the expectation of private agents (belief-driven) as the second generation model predicts. Such combination of analyses and models is known as a cross-generation model, which has been applied in ample studies on currency crisis (for example, Ford *et al.*, 2007; Cerra and Saxena, 2002; Kumah, 2007; Wyplosz, 2001). The desire to employ a cross-generation framework in currency crisis research is also supported by Flood and Marion (1999). They maintain that in order to identify the causes of a currency crisis, it is crucial to consider not only the fundamental driving factors, but also belief-driven multiple equilibria. Consequently, this leads to the need to identify the appropriate variables which are able to accommodate a cross-generation framework to explain the currency crisis.

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3. Conceptual Framework

In the context of crises model, this paper uses EMPI as a dependent variable. In order to understand the nature of currency crises, the cross-generational model is developed by accommodating three crises generation theories, which are represented by independent variables. The first generation theory maintains that the currency crises is mainly caused by inconsistency in macroeconomic policy or known as fundamental problem. This inconsistency is shown by conflicting policy between maintaining the exchange rate at certain levels with expansionary policy, either in fiscal or monetary sides. Hence, the variables that can be used to represent this condition are narrow money to GDP ratio (M1/GDP), domestic credit to GDP ratio (DC/GDP) and government expenditure to GDP ratio (FIS/GDP). It is expected that these variables have positive relationship with EMPI.

The second crises generation model refers to the role of expectation of economic agent as the source of crises. In the perspective of the second crises generation model, even if there is no problem in the fundamentals, the currency crises can still happen in the case when a currency tends to be overvalued. This condition will lead to speculative attack and creates multiple equilibria in the foreign exchange market. Thus, real exchange rate (RER2) can be considered as the most relevant proxy of exchange rate misalignment. It is expected that RER2 will affect EMPI positively, which means that as Rupiah depreciates against USD, the EMPI will tend to increase.

As for the third crises generation model, it shows that the depreciative pressure on a currency can be due to the emergence of banking crises. Credit booms for speculative investment will cause an increase in bad debt in the banking industry, which in turn will create depreciative pressure in the local currency. Thus, an increase in ratio of banking credit to GDP (BCred/GDP) and money multiplier (M2Mul) reflect the vulnerability of banking sector. It is expected that these variables have positive relationship with EMPI.

Thus, through the accommodation of three crises generation theory in one model, it is expected that the existence of fundamentals, problems, multiple equilibria and banking sector vulnerability can be verified in the context of Indonesian's exchange rate crises. This cross-generational model implies the need of regime switching approach for the analysis.

4. Data

EMPI was built using three variables that were considered to be most affected when the pressure on foreign exchange and the money markets increased. Following the work of Eichengreen *et al.* (1995), EMPI has been developed as a proxy for the currency crisis. The occurrence of a currency crisis is shown by currency depreciation pressure that exceeds its long-term value, depletion of foreign reserves and changes in domestic interest rate, in response to high pressure in the money and foreign exchange markets. When there is pressure, in terms of significant depreciation of domestic currency, the central bank's response is to use foreign reserves to intervene in foreign exchange markets and to increase the domestic interest rate.

In order to show pressure within the domestic economy, the EMPI was formulized as follows:

$$\text{EMPI}_t = \omega_1 \Delta e_{i,t} + \omega_2 i_{i,t} - \omega_3 \Delta r_{i,t}, \tag{1}$$

where EMPI_t is the speculative pressure index; $e_{i,t}$ is the value of the rupiah against the US dollar (rupiah/dollar); $i_{i,t}$ is the domestic interest rate (this study did not use interest rate changes for reasons argued by Klaassen and Jager (2006)); $r_{i,t}$ is the domestic stock of foreign reserves; ω_i is the weight given to each component of EMPI. Therefore, EMPI_t is a weighted index which measures the depreciation of the rupiah against the US dollar, increase in domestic interest rates and the depletion of foreign exchange reserve.

The weight refers to the inverse of the standard deviation of each series over the period January 1990 to September 2008. The standard deviation was calculated using the standard formula and not logarithmic form, since logarithmic difference is a poor approximation of rate of change and will result in a lower variance in the distribution of existing (Bertoli *et al.*, 2006).

The analysis employed monthly observations, over the period January 1990 to September 2008. All data was collected from International Financial Statistic (IFS). The ratio of real DC to GDP was calculated as DC divided by consumer price index (CPI), which was then divided by real GDP.

The ratio of M1 to GDP was calculated as M1 divided by the CPI, which was then divided by real GDP. Ratio of fiscal to GDP was obtained from real government expenditure divided by real GDP and interpolated into monthly periods. RER2 was calculated in two stages. First, the natural logarithm of the average exchange rate (rupiah/dollar) was calculated, and then multiplied by the US CPI. It was then divided by the domestic CPI or denoted as follows:

$$\text{RER} = \text{Log}\, e\left(\frac{P_{\text{US}}}{P_{\text{ind}}}\right). \tag{2}$$

CPI used was the CPI with base year 1995 (June 1995 = 100). Second, the results of the first stage was reduced by the average value of the previous 12 months or denoted as follows:

$$\text{RER2} = \text{RER}_t - \overline{\text{RER}}. \tag{3}$$

Result of this second stage shows the deviation of RER on the average one year earlier.

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Table 1. Unit Root Test

Variable	Adj. *t*-stat.	Prob.
EMPI	−2.588142*	—
M1/GDP	−4.520157	0.0002
FIS/GDP	−2.933660	0.0431
DC/GDP	19.87710**	—
RER2	−6.496653	0.0000
M2Mul	−4.035448	0.0089
BCred/GDP	−1.971080*	—

Note: *unit root test for EMPI and BCred/GDP used Elliott–Rothenberg–Stock DF-GLS test since PP test could not provide conclusive result (EMPI 5% critical value = −1.942282 and BCred/GDP 5% critical value = −1.942303).
**unit root test for DC/GDP used Elliott–Rothenberg–Stock Point-Optimal test for the similar reason as above. DC/GDP 5% critical value = 3.181250.

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M2Mul was calculated as the ratio of M2 to base money. As for BCred/GDP, it was obtained as position of outstanding loan granted by banks (in rupiah and other currencies) divided by CPI and then divided by real GDP.

Unit root test was conducted to all series by PP test. Table 1 presents the results of the unit root test, which indicates that at 5% critical value, all series are stationary at levels. This means that all series follow I(0) processes.

5. Econometric Methodology

This paper employed a Markov-switching dynamic model. The estimation involved two processes, the data generating process and the regime generating process. The Markov-switching model was first developed by Hamilton (1989). Hamilton utilizes a two-state mean switch model of order four to analyze the business cycle of America. His model can be summarized as follows:

$$y_t = \mu(s_t) + \left[\sum_{i=1}^{4} \alpha_i (y_{t-i} - \mu(s_{t-i}))\right] + u_t$$

$$u_t | s_t \sim \text{NID}(0, \sigma^2) \quad \text{and} \quad s_t = 1, 2. \tag{4}$$

Based on Equation (4), changes between regimes occurred in the mean parameter, μ. Krolzig (1997) classifies the above equation as two-state Markov-switching Mean-Autoregressive model, MSM (2)-AR (4). Once the data generating process has been specified in the form of the AR model, an identification of the regime-generating process is carried out to obtain the value of each parameter in different regimes. In the context of the regime-generating process, it is assumed that s_t as an unobserved state follows a first-order

Markov-process. This means that the current regime, s_t only depends on the previous regime, s_{t-1}. Hence, the transition of probability can be summarized as follows:

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

$$\forall\, ij \in \{1,\ldots,M\}, \tag{5}$$

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 arranged in a matrix as follows.

$$P^* = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1M} \\ p_{21} & p_{22} & \cdots & p_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ p_{M1} & p_{M2} & \cdots & p_{MM} \end{bmatrix}. \tag{6}$$

This study employed regime switching dynamic model as presented in Equation (7) below.

$$\begin{aligned} y_t &= \alpha_0(s_t) + \sum_{i=1}^{p_0} \alpha_i y_{t-i} + \sum_{j=1}^{k}\sum_{i=q_j}^{p_j} \beta_{i,j} x_{j,t-i} + \varepsilon_t \\ \varepsilon_t &\sim \text{IID}(0, \sigma^2), \end{aligned} \tag{7}$$

where y_t = EMPI, y_{t-i} = lag of EMPI, $x_{j,t-i}$ = independent variables in period t and lag of the independent variables.

6. Empirical Findings and Discussion

In order to ensure that there was at least one long-run relationship among series, the Johansen cointegration test was employed. As presented in Table 2, all series are cointegrated with at least three cointegrating equations, based on trace statistic or maximum Eigenvalue and p-values.

Table 3 presents the estimation results of the regime switching dynamic model. Parameter estimates on the lag of EMPI indicate that the current value of EMPI was strongly influenced by the lag of EMPI. A positive coefficient for the lag of EMPI demonstrates that the AR model specification was an appropriate decision in examining the

Table 2. Cointegration Test

# of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.302844	228.0527	125.6154	0.0000
At most 1	0.250510	147.9671	95.75366	0.0000
At most 2	0.147239	83.95057	69.81889	0.0025
At most 3	0.122869	48.59130	47.85613	0.0426

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Table 3. Estimation Result of Multivariate Regime Switching Model

	Coefficient	*t*-Value	*t*-Prob.
Regime-dependent intercepts			
C(0)	0.751365	1.87	0.063
C(1)	−49.1692	−7.38	0.000
Coefficients			
Inertia factor			
EMPI_1	0.504456	15.0	0.000
EMPI_3	0.185741	4.86	0.000
EMPI_4	0.0810210	1.98	0.049
Immediate impact			
M1/GDP	−0.509547	−0.427	0.670
FIS/GDP	13.3865	1.20	0.233
DC/GDP	0.362288	1.85	0.067
RER2	0.820945	10.7	0.000
BCred/GDP	0.904225	2.83	0.005
M2Mul	−0.0627720	−1.64	0.102
Impulse response function			
M1/GDP_1(1)	44.4929	13.3	0.000
FIS/GDP_1(1)	472.247	9.21	0.000
FIS/GDP_3(1)	1173.41	35.6	0.000
FIS/GDP_4(1)	−143.485	−7.49	0.000
FIS/GDP_5(0)	53.5400	2.46	0.015
FIS/GDP_5(1)	−467.140	−15.7	0.000
FIS/GDP_6(0)	−18.3518	−2.60	0.010
FIS/GDP_6(1)	247.707	9.63	0.000
DC/GDP_3(0)	−0.355862	−1.78	0.077
DC/GDP_5(1)	−2.49050	−1.93	0.056
RER2_1(0)	−0.218080	−2.24	0.026
RER2_1(1)	−6.16316	−5.62	0.000
BCred/GDP_1	−1.11642	−2.88	0.004
BCred/GDP_3	0.817842	2.48	0.014
BCred/GDP_4	1.06004	3.93	0.000
BCred/GDP_5	−1.42286	−6.04	0.000
M2Mul_1(1)	0.567460	3.57	0.000
M2Mul_2(1)	−1.98159	−9.11	0.000
M2Mul_4(1)	5.28330	6.05	0.000
Σ	0.145230	20.2	0.000
p_{0|0}	0.963380	70.0	0.000
p_{0|1}	0.590161	4.13	0.000

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behavior of the EMPI. Furthermore, it can be seen that the estimates of the coefficients of the lag of EMPI are not only positive, but also smaller with more distant lag used in the model. This suggests the existence of inertia, where EMPI in the previous period influenced the expectations of private agents toward EMPI at the present time.

Parameter estimates for the coefficient of M1/GDP, M2Mul and FIS/GDP indicate that these three variables were not statistically significant. In contrast to the other fundamental variables, the DC/GDP coefficient is statistically significant (at 6.7% critical value). DC is the DC of the central bank, which becomes part of base money. A positive coefficient means that an increase in DC/GDP amplified pressure on the economy that is represented by EMPI. It also means that liquidity factors influenced the movement of EMPI, as predicted by the first generation model. This finding is consistent with the results of Kaminsky *et al.* (1998), Lestano *et al.* (2003) and Jacobs *et al.* (2004). It implies that the macro fundamental factor, which is the inconsistency in the macroeconomic policy stance, contributed to the occurrence of the currency crisis in Indonesia.

The parameter estimates results also show that the FIS/GDP coefficient is not statistically significant. This finding implies that EMPI was not affected by changes in the amount of government budget relative to GDP. Based on this condition, the characteristics of inconsistency between the fiscal policy and efforts to maintain the exchange rate at a certain level, as shown by the first generation model, did not occur during the period of this study.

Another immediate impact, which is statistically significant, is the RER. A positive estimated parameter coefficient for RER2 means that the pressure on EMPI was higher as the rupiah depreciated. A depreciated rupiah created the expectation in private agents that the depreciation trend was likely to continue. This led to more pressure on the EMPI, and thus created a crisis which was a self-fulfilling phenomenon. This result strengthens previous findings from the coefficient of the lag of EMPI, which proves that the expectation of private agents contributed to changes in EMPI through the inertia mechanism. The implication of this particular situation is that there was the possibility of a jump effect happening in the economy, which ultimately resulted in multiple equilibria in exchange rates.

The parameter coefficient for the ratio of commercial bank credit to GDP (BCred/GDP) is also positive and statistically significant. BCred/GDP can be used to identify the vulnerability of the banking sector (see for example, Kaminsky, 2003; Kaminsky *et al.*, 1998; Berg and Pattillo, 1999; Edison, 2003; Demirgüc-Kunt and Detragiache, 1998; Eichengreen and Arteta, 2000). Theoretically, an increase in DC/GDP indicates a higher level of credit risk in the banking sector. Furthermore, its positive coefficient implies that excessive credit from commercial banks increased the potential for bad debt and credit risk, which in turn lowered the performance of the banking sector and at the same time, increased the EMPI, as predicted by the third generation model.

Estimated transition probabilities are presented in the matrix P below:

$$P = \begin{bmatrix} 0.96 & 0.59 \\ 0.04 & 0.41 \end{bmatrix}. \tag{8}$$

The matrix shows that the estimated transition probabilities indicate that none of the regimes are permanent, since all the estimated transition probabilities are below one, except

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Table 4. Indonesian Crisis Periods

	Months	Average of Probability
Regime 0* : *Tranquility state		
1990(07)–1990(11)	5	1.000
1991(01)–1997(07)	79	0.992
1997(10)–1998(05)	8	0.957
1998(09)–1998(10)	2	1.000
1998(12)–1999(02)	3	1.000
1999(04)–2001(01)	22	0.985
2001(03)–2001(07)	5	1.000
2001(11)–2008(09)	83	0.999
Total 207 months (94.52%) with average duration of 25.88 months		
Regime 1*: *Volatile state		
1990(12)–1990(12)	1	0.967
1997(08)–1997(09)	2	1.000
1998(06)–1998(08)	3	1.000
1998(11)–1998(11)	1	1.000
1999(03)–1999(03)	1	1.000
2001(02)–2001(02)	1	0.998
2001(08)–2001(10)	3	0.896
Total: 12 months (5.48%) with average duration of 1.71 months		

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for the period of early 1990s, late 1998s and early and mid 2001s (Table 4). For example, there is a 96% probability of staying in the stable state, which is higher than the probability of staying in the volatile state (41%). This means that the stable state is more persistent than the volatile state. Further, the transition probability from stable towards the volatile state is 4%, which is much smaller than that of volatile toward stable (41%).

Moreover, the estimated ergodic probabilities indicate that Indonesia experienced periods of stability 95% of the time, with an average duration of 25.88 months. The ergodic probability of the volatile state shows that Indonesia experienced volatile periods 5% of the time, with an average duration of 1.71 months. Thus, there were only a few episodes of high exchange market pressure in the Indonesian economy during 1990–2008. In addition, from the regime property of EMPI below, the dynamic model can accurately detect the currency crises in the mid of 1997. This is not only indicated by high market pressure but also demonstrated by the high average of probability. Therefore, the inferred probabilities for a volatile state have high informative content regarding the Asian currency crises of 1997.

The previous section showed that the change in EMPI is affected by high liquidity in the economy, a high tendency of bank credit relative to GDP and RER. The high liquidity in the economy (expansionary monetary policy) shows a macro fundamental problem where the macroeconomic policy for domestic purposes, such as employment and investment, conflict with the effort of maintaining the exchange rate at a certain level. As predicted by the first generation model, this situation will result in speculative attacks on domestic currency.

However, from the fiscal policy perspective, the estimation results show that the Indonesian government's fiscal policy is well maintained, so there is no inconsistency between the orientation of fiscal policy and the effort of maintaining the exchange rate. Another fundamental difference from the first generation model lies in the DC variable. An increase in DC is a manifestation of monetary policy as part of the central bank's policy discretion. However, along with the implementation of policy to maintain the exchange rate at a certain level, the central bank basically has no autonomy in monetary policy, unless it is willing to abandon the exchange rate policy. Therefore, although expansionary monetary policy might affect the economy in the short term by increasing economic activities, at the same time it gives a signal of inconsistencies in the market. This lack of consistency then affects the formation of economic agents in the market.

With the increase in liquidity, the economy experiences an imbalance in money and the foreign exchange market, thus putting depreciative pressure on domestic currency. In these circumstances, the central bank should use its reserves to defend the exchange rate. At this time also, speculative attacks against domestic currency may occur ending in an exchange rate crisis. Theoretically, this can be classified as a crisis that stems from the fundamental problems predicted by Krugman (1979), but through a different channel. This is not through an expansionary fiscal policy, but through an expansionary monetary policy.

Other estimation results show that BCred to GDP ratio affects EMPI. This means that excessive credit can lead to an exchange rate crisis, or in other words that there were micro fundamental problem, specifically in the banking sector. This excessive credit in banking sector occurs as a result of improved economic performance and global investment trends. In addition to the above two factors, higher bank lending is also driven by implicit and explicit government guarantee on banks. The existence of the government guarantee then caused morally hazardous practices, which essentially led to two important consequences. The first is risky investment by the private sector which ended with the financial crisis and the currency crisis, as predicted by the third generation crisis model. The second is the potential burden on the government budget to bail out the failing bank. This second consequence is basically related to the first generation crisis model. Therefore, the third generation model is seen as a resurrection of the first generation model with a new fundamental element (Blaszkiewicz, 2000).

High liquidity and vulnerability in the banking sector led to fundamental imbalances. Such imbalances may turn into a crisis when there is a perception in the market that there should be a correction in the exchange rate due to overvaluation of the domestic currency against the US dollar. The estimation results show an element of the overshooting phenomenon, in which RER depreciation will only further increase the pressure on the economy. Hence in the case of high liquidity and credit, and overvaluation of domestic currency, a negative sentiment will emerge in the market, resulting in herding behavior, in which foreign investors pull capital out of Indonesia, not only because of bad investment, but also caused by the wave of capital withdrawal by other investors. This self-fulfilling process in turn will lead to overshooting and jump effect in the exchange rate equilibrium (multiple equilibria).

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In circumstances where there is a speculative attack on domestic currency, the central bank's response is to increase domestic interest rates through open market operations, in order to prevent a further depreciation of domestic currency. However, a higher interest rate will cause greater pressure in the banking sector and exacerbate existing problems. Such conditions may encourage the financial and currency crisis to deepen.

Overall, it can be stated that the EMPI in the case of Indonesia showed fairly complex characteristics in which all elements of the crisis models, ranging from first to third generation, became part of the factors that influenced the EMPI. This complexity arose because the crisis not only involved the foreign exchange market but also the domestic banking sector.

As the parameter estimation is very instrumental to analysis, the diagnostic test is very important to be carried out. The diagnostic tests were first conducted to assess the error properties of the estimated model. A test was also conducted to evaluate regime switching against a linear model. Table 5 shows the results of diagnostic tests for the regime switching model. The first step in the process of model testing is to ensure the white noise residuals, which are normally distributed, have zero mean, constant variance and are serially uncorrelated.

In the context of normal distribution, the residual was tested using the normality test developed by Doornik and Hansen (1994), derived from Shenton and Bowman (1977). 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.

The next diagnostic test was the heteroscedasticity test to the model specification. Using an ARCH test, the results showed 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.

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Table 5. Diagnostic Test for Multivariate Regime Switching Model

No of observations	219
No of parameters	52
AIC criterion	−0.203726641
Log-likelihood	74.3080672
Linearity LR-test [$Chi^2(17)$]	234.87 [0.0000]**
Normality test [$Chi^2(2)$]	4.5974 [0.1004]**
ARCH 1–7 test: F(1,174)	3.4009 [0.0670]***
Portmanteau(36): $Chi^2(34)$	41.661 [0.1179]***

** Log-likelihood test shows that regime switching specification is better than linear model
** residuals from MS-IA(4) specification is normally distributed
*** residuals from MS-IA(4) specification is white noise
*** residuals from MS-IA(4) specification is white noise

The next procedure was a portmanteau test, which identified whether there was serial correlation between the residuals. This test is similar to the Box–Pierce test, but with a degree of freedom correction as suggested by Ljung and Box (1978). It is designed as a goodness-of-fit test in stationary, autoregressive moving-average models. The portmanteau test showed that it could not reject the null hypothesis, which means that there was no autocorrelation based on a 36-lag test.

Another important implication from diagnostic test is the robustness of the regime-switching model. A likelihood ratio (LR) test can be employed to determine which model specification is better. In this study, 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 in explaining the behavior of EMPI. The chi-square value obtained from the test was 286,53 with p-value close to zero, which means that the null hypothesis was rejected and it was concluded that the regime-switching specification fitted the data better than the linear autoregressive counterpart.

The regime-switching estimates shows that period can be divided into two regimes, stable and volatile, as indicated in Figure 1 by the dark bar and the unshaded regions. Through smoothed probabilities method, it can be observed that the volatile state has limited occurrence; as indicated by the dark bars, these periods are concentrated in the middle parts of the sample period, in the mid of 1997, the mid and late of 1998, early 1999 and early and late 2001. The volatile states in 1997 coincide with the Asian financial crisis,

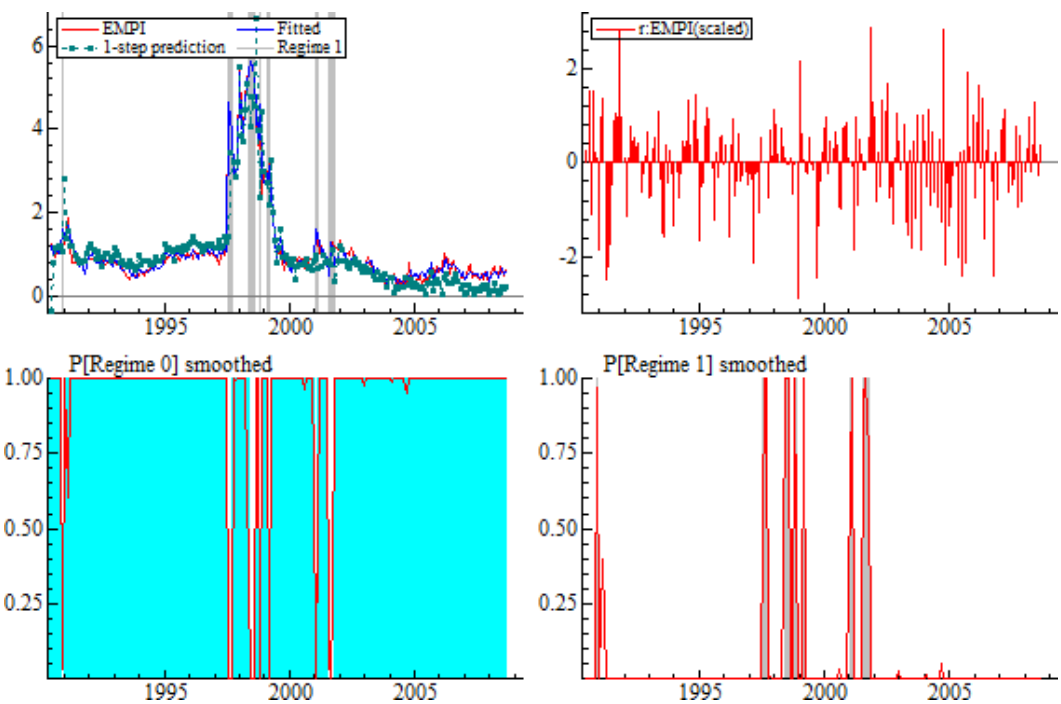

Figure 1. Regime Classification Based on Smooth Probabilities Method

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while the high pressures during 2001 correspond to Latin America debt crisis. Periods of stable state (indicated by the unshaded regions) dominate the picture, which means that stable states tend to have longer duration than volatile states. Furthermore, the estimation result of endogenous regime by employing Markov-switching model shows that the model can predict accurately the volatile and stable periods, especially during the late 1990s financial crisis periods.

7. Conclusion

This paper examines the extent to which the Indonesia's currency crisis can be accounted for by macro and micro economic fundamentals by employing Markov switching approach under cross-generation crisis models. This study is able to confirm the Indonesian currency crisis as both a fundamental and self-fulfilling phenomenon. EMPI was influenced by liquidity in the economy, the RER and the vulnerability of the banking sector. The high level of liquidity in the economy exposed inconsistencies in the macroeconomic policy stance, when the economic authority tried to maintain the exchange rate at a certain level at the same time. Such inconsistencies become a signal for the correction of the exchange rate in the market, and a sharp correction can lead to speculative attacks that result in an exchange rate crisis.

Moreover, the self-fulfilling process was shown in how excessively risky credits and investments took place as a consequences of *over optimistic expectations* from both global and domestic business players in the Indonesian economy as well as morally hazardous practices in the microeconomic sector of the financial market, which urged excessive capital inflows, especially of short-term debt, denominated in foreign currency. This related to the changing value of short-term loans, which was notably higher than the availability of foreign reserve. Morally hazardous practices also escalated the growth of credit to finance less productive activities. Such vulnerable or fragile conditions in the financial sector potentially led to a financial crisis, especially when there were shocks and *herding behavior* from private agents.

With the rupiah being overvalued against the US dollar, which was the anchor currency, it was a signal to correct the value of the rupiah. In addition, shocks experienced by other regional currencies also became triggers for corrections to the rupiah. At this point, a self-fulfilling crisis occurred. Considering the significance of these three variables, consistency of macroeconomic policy stance becomes a necessary condition for maintaining the stability of the exchange rate. In addition, prudential banking management and supervision as well as anticipation of sudden capital reversal through financial sector regulation can decrease the risk of a crisis that is sourced from panic or self-fulfilling actions.

In general, this study concludes that the determinants of EMPI show complex characteristics, as all elements of crisis theory which are proposed in the first, second and third generation become factors influencing EMPI. This complexity implies that both fundamental and self-fulfilling variables contribute to explaining changes in EMPI in the economy. Therefore, a cross-generation framework becomes a relevant argument in analyzing the exchange rate crisis in Indonesia.

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