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EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises

Macroeconomic Vulnerability in Indonesia

by

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EAST ASIAN DEVELOPMENT NETWORK

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Early Warning System for Macroeconomic Vulnerability in Indonesia

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1. INTRODUCTION

1.1 BACKGROUND

The financial crisis that swept over East-Asian countries since the latter part of 1997 has quickly deteriorated into an economic and social crisis. East Asia's crisis foretells a continuing loss in human potential that echoed for years after this crisis has passed[1]. Moreover, the crisis has changed the political life in the East Asian countries instantly.

However, The East Asian countries immediately took steps to solve the crisis. Asian Development Bank[2] reported that countries throughout the region are moving fast to recover their economic performances by enacting new policies and adopting more transparent ways of doing business. They made a significant progress in addressing the various policy issues that is faced by them. As Asian Development Bank reported, in 1998, the five countries most affected by the Asian financial crisis continue to recover. Growth accelerated rapidly past after the crisis in Indonesia and Malaysia, and more moderately in the Philippines and Thailand. In the Republic of Korea, growth decelerated slightly but remained strong.

Three years since the financial crisis began, Indonesia has achieved considerable political reform, re-establish Indonesian democracy, and focus on the challenge of broadly based political, economic, and military reform. Indonesia has made a significant progress in addressing the various policy issues. However, there are still many problems faced by

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[1] The effects of the crisis are acute in Indonesia, and severe in Thailand, Korea, Malaysia, and The Philippines. The World Bank (1998) "East Asia :The Road to Recovery", reported the crisis is likely to have many dimensions, falling incomes, rising absolute poverty, declining public services, threats to educational and health status, and increased crime and violence.

[2] Asian Development Bank (2001)

Indonesia. This makes the economic recovery in Indonesia left behind by other crisis countries in the region.

Nevertheless, publications such as *The Economist*[3] and *Far Eastern Economic Review*[4] in 2001 reported that there are several dangerous signals/symptoms to recession in Asia, particularly in Japan, Singapore, and Taiwan. Japan continuous to struggle with its own problem of a dis-functional financial system and weak consumer demand. Singapore and Taiwan have both experienced two quarters of shrinking GDP. Singapore's has fallen at an annual rate of 11% in the first half of the year and Taiwan's at a rate of 6%. South Korea's economy also has slowed sharply, while the second-quarter figures for Malaysia and Thailand are likely to show that they face a more immediate problem: the wrenching collapse in international demand for their exports.

The 1997 crisis and the forthcoming recession as reported by some publications showed us that the economy in the world is becoming more integrated and as consequence the interdependence among economies will grow stronger. In this case, a shock in an economy will be immediately transferred to the others. Although the shock happened in a well-performed economy, it doesn't mean that the developing countries are not influenced. Moreover, it is possible that developing countries such as Indonesia will be affected more badly due to the weakness of its economic fundamental.

Finally, we can construe that it is needed to develop such a mechanism to detect any early symptoms on economic crisis so that crisis possibilities can be detected and anticipated. In this case, early warning system for economic fragility is one of the methods to identify and anticipate crisis in the future. Development of an early warning system is very crucial for every country and it is not easy to construct an early warning system that can be applied for every country due to the unique characteristics of each country.

The purpose of this study is to develop an early warning system for macroeconomic vulnerability in Indonesia. While the Government of Indonesia has indicated the focus to set right and improve economic performance, it is quite thoughtful of need to detect and anticipate the crisis in the future. As the development of economic progresses, detection and anticipation will be made by taking into account overall changes

[3] "*A Global Game of Dominoes*", The economist (2001)
[4] " Asia's Economic Future: Choices That Will Shape The Recovery", Far Eastern Economic Review (2001)

on economic situation in Indonesia. The early warning system that is developed must be suitable and have a high predictive power for Indonesian economic condition.

1.2 THEORETICAL BACKGROUND

The need to develop a good surveillance device to detect and anticipate the economic shock is becoming important after economic crisis occur in many areas (Adiningsih, 2001). So far, there are several researchers that have developed an early warning system, for instance Kaminsky and Reinhart (1997 and 1999)[5] and Herrera & Garcia (1999).[6] In the early stage, Kaminsky specifically developed an early warning system for financial crisis possibilities. Kaminsky and Reinhart (1997) have examined the potential causes and the symptoms of currency crises whether those symptoms can be detected with sufficient advance so as to allow governments to adopt pre-emptive measures. Kaminsky and Reinhart examine the available evidence on currency crises to propose a specific early warning system. They narrow its focus to identifying the various indicators suggested by alternative explanations of currency crises. They compare the relative merits of alternative approach in providing early indicators of currency crisis and based on this comparison, propose a specific methodology for the design of an early warning system.

Otherwise, a study that has been done by Tjahjono[7], which used Kaminsky and Reinhart approach, has failed to identify crisis in Indonesia. Also, there were several bad signals on the countries that are assumed to be "no crisis countries", that is Singapore and Hong Kong.

Meanwhile, Herrera and Garcia (1999) developed an early warning system (EWS) of a country's macroeconomic fragility. The idea of Herrera & Garcia is to have an instrument that helps policy makers identify and anticipate situation in which crises are more likely to happen.

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[5] Kaminsky, Lizondo and Reinhart (1997)"Leading Indicators of Currency Crises", IMF Working Paper, International Monetary Fund. Also, Kaminsky, Graziela L and Carmen M. Reinhart (1998) "The Twin Crises: The Causes of Banking and Balance of Payment Problems". American Economic Review. November

[6] Herrera, Santiago and Conrado Garcia (1999) "User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries". World Bank Working Paper. November.

[7] Tjahjono, Dwi Endy. 1998. Economic Fundamental, Contagion Effect, and Asian Crisis. Buletin Ekonomi Moneter dan Perbankan, September.

There are three main basic differences between Herrera & Garcia's model and Kaminsky (1997) that are:

1. The main interest of Herrera & Garcia's model is to have an operational tool. The ultimate objective is to build the simplest possible early warning system to be updated monthly at the lowest feasible cost.
2. The aggregation method of the individual leading indicators into a composite index and the way this index is used as a signaling device, because Herrera & Garcia believe that for a crisis to take place the set of leading indicators must jointly drift in the same direction over some period of time.
3. The exclusive focus on Latin American Countries, estimating the models and showing details on a country-by-country basis.

Contagion effect is suspected to play an important role in Asian economic crisis, since the crisis started from Thailand and swap over the region. So, knowing whether contagion really plays an important role in the crisis is important.

World Bank (2000) defines contagion as the cross-country transmission of shocks or the general cross-country spillover effects (broad definition). Contagion can take place both during "good" times and "bad" times. Then, contagion does not need to be related to crises. However, contagion has been emphasized during crisis times. Meanwhile, the restrictive definition of contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks.

Contagion is conveyed through several links. *Financial links* exist when two economies are connected through the international financial system. One example of financial link is when open-end mutual funds forecast future redemptions after there is a shock in one country. Mutual funds need to raise cash, and consequently they sell assets in third countries. *Real links* have been usually associated with international trade. When two countries trade among themselves or if they compete in the same foreign markets, a devaluation of the exchange rate in one country deteriorates the other country's competitive advantage. As a consequence, both countries will likely end up devaluing their currencies to re-balance their external sectors. Other types of real links, like foreign direct investment across countries, may also be present.

There are a lot of studies on contagion effect. Eichengreen, Rose, and Wyplosz (1996)[8] analyzed the role of contagion on currency crises. Using thirty years of panel data from 20 industrialized countries, they examined contagion in foreign exchange markets by using a framework that distinguished two channels of international transmission of speculative attacks. The first channel is trade link, and the second channel is macroeconomic similarities. They found evidence that speculative attack elsewhere increase the probability of an attack on domestic currency. Contagion effect appears to spread more easily to countries that are closely tied by international linkages than to countries in similar macroeconomic conditions. Kaminsky and Reinhart (2000)[9] analyzed how fundamental based contagion could rise because of both trade links and financial links. They examined the role of various creditors, including international banks and mutual funds, trader's potential cross-market hedging, and bilateral and third party trade in spread of crises. They found evidence that contagion is more regional than global. The probability of domestic crisis rises sharply if a core group of country is already infected. It is difficult to distinguish the channel of transmission, because most countries that are linked in trade are also linked in finance. From the analysis of two potential victims of contagion, which are Argentina after Mexico and Indonesia after Thailand, the results indicate that financial linkages were the more likely causes. Meanwhile, Tjahjono (1998) examined the contagion effect on Asian crises by using Probit model. The result indicated that both economic fundamental condition and contagion effect significantly had contribution on currency crisis. Indeed, the contagion effect had larger contribution than the fundamental condition.

[8] Barry Eichengreen, Andrew K. Rose, and Charles Wyplosz, 1996, "Contagious Currency Crises), NBER working Paper, No. 5681

[9] Graciela L. Kaminsky and Carmen M. Reinhart, 2000, "On Crises, Contagion, and Confusion", Journal of International economics 51

2. METHODOLOGY

2.1 MODEL SELECTION

To construct Indonesian early warning system, we follow the model that has been developed by Santiago Herrera and Conrado Garcia (1999) as explained above. The reason for adopting the Herrera & Garcia model is based on the advantages of the model as follow:

- the model is the simplest model for early warning system
- the model can be updated monthly
- the model has the lowest feasible cost
- the model aggregating the variables and then generating the signals depending on the behavior of the composite index. The reason for adopting this strategy is that to take place the set of leading indicators for an economic crisis must jointly drift in the same direction over some period of time.

2.2 THE STAGES OF HERRERA & GARCIA'S MODEL

2.2.1 Determining the crisis period

To determine the crisis period, Herrera-Garcia define an Index of Speculative Pressure (ISP) as follows:

$$ISP = \Delta\% \text{ exchange rate} + \Delta\% \text{ interest rates} - \Delta\% \text{ international reserves}$$

All the variables (monthly percentage changes) were standardized to have mean zero and unit variance. A crisis is defined as period in which $ISPt > \mu + 1{,}5\sigma$ (where μ is the sample mean and σ is the standard deviation of the ISP)

2.2.2 Determining leading indicator of crisis

The variables used are adopted from Herrera-Garcia's model. The Herrera & Garcia's leading indicators are:

1. M2 / Reserves
2. Real domestic credit growth
3. Real effective exchange rate
4. Inflation rate (there is consistency of this variable as determinants of banking crises according to Demirguc-Kunt and Detragiache[10])

Besides, the variables used since they are similar with the result of leading indicator of Indonesian economic crisis using Kaminsky and Reinhart approach (1999)[11]. Susatyo (2002)[12] has investigated leading indicator of Indonesian economic crisis using the Kaminsky-Reinhart approach. The results show that the variables chosen here are good variables as leading indicators. This can be seen from their low noise to signal ratio.

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[10] Demirguc-Kunt and Enrica Detragiache (1997)"Banking Crises around the World: Are there Common Threads?"

[11] Kaminsky and Reinhart, 1997, "Leading Indicators of Currency Crises, IMF Working Paper, July

[12] Using data period 1990-2000 with monthly basis, the study used 14 variables to identify leading indicators. The variables are as follow (respectively from the best performance as leading indicator): real exchange rate, M2/reserves, inflation, real domestic credit growth, international reserves, real interest rate, stock price, ratio of lending rate to deposit rate, commercial bank deposits, ratio of domestic credit to GDP, export, import, and M2 multiplier.

Characteristic / Performance of Indicators

Indicator	Threshold[13]		Signal[14]				Good Signal A / (A+C)	Bad Signal B / (B+D)	Noise / signal[15]
	Upper	Lower	91-96	96-99	99-01	Σ			
Real exchange rate	48.088	-6.391	0	16	6	22	44.44	6.74	0.15
M2/Reserve	8.799		1	8	2	11	22.22	3.37	0.15
Real domestic credit growth	0.657	-0.410	4	20	4	28	55.56	8.99	0.16
Inflation	0.515	-0.929	5	14	1	20	38.89	6.74	0.17
International reserves		-9.770	2	4	0	6	11.11	2.25	0.20
Real interest rate	21.810	10.177	7	21	4	32	58.33	12.36	0.21
Stock market price	14.585	-13.523	3	9	2	14	25.00	5.62	0.22
Credit interest rate/deposit rate	11.601	-11.188	4	9	1	14	25.00	5.62	0.22
Commercial bank deposits		-1.755	3	5	0	8	13.89	3.37	0.24
Domestic credit/GDP	4.088		2	6	2	10	16.67	4.49	0.27
Export		-14.111	2	4	1	7	11.11	3.37	0.30
GDP		-1.719	4	5	0	9	13.89	4.49	0.32
Import	29.755		2	2	0	4	5.56	2.25	0.40
M2 multiplier	11.281	-10.489	5	4	4	13	11.11	10.11	0.91

Sources: Susatyo (2 002) and calculated

[13] The threshold is mean ± 2 standard deviation ($\mu + 2\sigma$)
[14] Estimation period is from January 1991 until May 2001
[15] Ratio of bad signal to good signal [B / (B+D)] / [A / (A+C)]

Herrera-Garcia then constructed an index of macroeconomic vulnerability (IMV) with the variables, standardized to have mean zero and unit variance, circumventing the issue of weighting the individual indicators differently. The IMV is computed as the sum of standardized variables.

$$IMV = REER + RDG + M2/R + \Pi$$

REER = Real effective exchange rate
RDG = Real Domestic Credit Growth
M2/R = M2/International reserves
Π = Inflation

The signals will be extracted from the behavior of the composite index (while in the Kaminsky case, each individual variable generates signals that are then aggregated into the composite index). The assumption for the aggregation procedure is that the leading variables drift more or less in the same direction or have common element in their behavior prior to the crisis. If this is not the case, it will not be a good indicator.

2.2.3 Signal-generating mechanism

We apply 2 transformations or filters to the IMV to generate signal[16]:

1. The levels model (simple model)
2. The ARIMA residual model

2.2.3.1 The Levels Model (Simple Model)

A characteristic of all the computed IMV is that their volatilities change through time. The index is particularly volatile, so the standard deviations used are computed from the conditional variance of the series estimated by a Generalized Autoregressive Conditional Heteroskedastic (GARCH) model. The feature of these types of models is

[16] The reason for choosing these models is, based on Herrera-Garcia's research in 8 developing countries in Latin American Countries (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, and Venezuela), simple model performs the best in signaling the crisis in Latin American Countries and ARIMA residual model performs second best (Herrera-Garcia, 1999). Moreover, we choose ARIMA model because this method is popular for its success in forecasting. The forecast obtained from this method are more reliable than those obtained from the traditional econometric modeling, particularly for short-term forecast (Gujarati,1995).

that the variance of the IMV is taken to be an ARMA process that is estimated simultaneously with the mean of the series. The GARCH (p,q) model that is used is:

$$IMV_t = a_0 + a_1 IMV_{t-1} + e_t$$

$e_t = v_t \sqrt{h_t}$, v is white noise with $\sigma_v = 1$

and $\hat{h}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$

with the conditional standard deviations, the threshold was computed and the signaling device is complete.

Signal-generating mechanism of simple model

In the Simple Model, signal-generating mechanism is conducted by constructing the threshold for the IMV with the conditional standard deviations of GARCH Model. The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

The steps of Simple Model

- Compute the IMV index.
- Construct the thresholds for the IMV with the conditional standard deviations of GARCH[17] model.

  The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

2.2.3.2 The ARIMA residual model

[17]Developed by Engle,R.(1982) " Autoregressive Conditional Heteroscedasticity with estimates of the variance of UK inflation", Econometrica, 50,987-1007 and Bollerslev, T. " Generalized Autoregressive Conditional Heteroscedasticity", Journal of Econometrics, 31, 307-327.
GARCH (Generalized Autoregressive Conditional Heteroscedasticity) is a generalization of the ARCH model, in which the conditional variance of u at time t is dependent not only on past squared disturbances but also on past conditional variances).

In the regression and exponential smoothing models, it was assumed that Y_t was statistically independent, that is, the error terms (et) were random. If this had not been the case, we should use in our model past values of the time-series variable and/or current and past values of the error terms (Gaynor & Kirkpatrick, 1994). The ARIMA model is a procedure for accomplishing this. The ARIMA model consists of extracting the predictable movements (pattern) from the observed data through a series of iterations.

This model is also known as Box-Jenkins methodology. The assumption for this model is the time series has to be stationer (the mean and variance are constant). An ARIMA model describes the normal or regular behavior for the IMV, so the residuals summarize the deviations from normal behavior. We then construct a moving average of the residuals and a signal is generated when this statistic exceeds zero.

Signal-generating mechanism of ARIMA Residual Model

Meanwhile, in the ARIMA Residual Model, signal-generating mechanism occurs when the residuals of the model summarize the deviations from normal behavior and a signal is generated when this statistic exceeds zero.

The steps of ARIMA Residual Model

1. Determine a tentative ARIMA model

We determine the values of p and q in the ARMA process to be fitted by computing the ACF and PACF of stationary time series. If we have to difference a time series *d* times to make it stationary and then apply the ARMA (p,q) model to it, we say that the original time series is ARIMA (p,d,q). This tentative model is then estimated.

2. Choosing the best model

We choose the goodness of fit of the model by using diagnostic checking. We choose the model with the least number of parameters and smallest root mean square error (RMSE). The smaller RMSE, the better the overall fit of the model and the future forecast can be more accurate.

The diagnostic checking is conducted through 3 steps of checking.

- *Analyzing the residual*

  To see if the residuals estimated from this model are white noise (stochastic error terms, that has zero mean, constant variance, and non-autocorrelated). If they are not, the process is started all over again (therefore, the Box-Jenkins method is iterative).

- *Testing the parameters by using t test*

$$t = \frac{\text{point estimate of parameter}}{\text{standard error of estimation}}$$

t ratio should be significantly greater than a predetermined critical value. Terms whose t ratios are not significant should be dropped and the model recalculated with the remaining terms.

- *Testing the parameter of redundancy*

The best Box-Jenkins model is always the one with the least number of parameters. Redundancy occurs when higher-order models are used when a lower-order model would suffice. The correlation matrix for estimate parameter provides a means for recognizing the existence of parameter redundancy.

After selecting the best model, the next step is to conduct a signal-generating mechanism. Signal will generate if the residuals of the model summarizes the deviations from normal behavior and a signal is generated when this statistic exceeds to zero.

2.3 Model for Contagion Effect

Meanwhile, to evince the existence of contagion effect for Indonesian economic crisis, we develop a model as below:

$$Crisis_{j,t} = aD(Crisis_{i,t}) + bMacro_{j,t} + e$$

Where:

$Crisis_{j,t}$ = dummy variable for country j in period t, which determination is based on ISP (Index of Speculative Pressure).

$Crisis_{j,t} = 1$ if $ISP > \mu + 1.5\,\sigma$ and $Crisis_{j,t} = 0$ otherwise

$D(Crisis_{,i,t})$ = contagion variable

$D(Crisis_{,i,t}) = 1$, if there is speculative attack in country i,

$D(Crisis_{,i,t}) = 0$, otherwise, which determination is based on ISP

$Macro_{j,t}$ = economic fundamental of country j in period t

j = Indonesia

i = other countries in Asia region, especially Thailand, Malaysia, Korea, the Philippines

$$Macro_{j,t} = \sum AK_{n,t}.B_n$$

where:

$Ak_{n,t}$ = credit quantity of indicator n in period t

B_n = weigh of indicator n, counted by inverse ratio of noise to signal in each indicator

To illustrate economic fundamental of Indonesia (variable of economic fundamental), we use 14 economic indicators that is assumed as the most appropriate indicator in detecting crisis signal. Kaminsky and Reinhart (1999) showed that each indicator performed differently in detecting possibility of crisis. Each indicator therefore are weighted based on the inverse of noise to signal ratio (NSR). The bigger the weigh the bigger it is in inducing crisis. Then each indicator is classified into 4 levels, based on maximum and minimum value of change in each indicator. Each level has credit quantity. The bigger the credit quantity, the better the condition will be. The 4 levels are level 1 (strong) with credit quantity 4, level 2 (medium) with credit quantity 3, level 3 (risky) with credit quantity 2, and level 4 (weak) with credit quantity 1.

For variable of contagion, this study identify the possibility of speculative attack from speculators in Thailand, Malaysia, Korea, and the Philippines, since the crises in these countries occur earlier than the crisis in Indonesia. We identify the speculative attacks by using Index of Speculative Pressure (ISP).

3. DATA ANALYZING

3.1 Data collection & sources of data

The data is collected mainly from the Bank Indonesia with monthly basis. Meanwhile the sample period is 1990:05 - 2001:05.

3.2 Determining crisis period

The first step of the research is determining the crisis period by using Index of Speculative Pressure. The variables of ISP are interest rate, exchange rate, international reserves and each of them expressed in monthly percentage changes. All the variables were standardized to have mean zero and unit variance. A period is defined as crisis in which $ISPt > \mu + 1{,}5\sigma$ (where μ is the sample mean and σ is the standard deviation of the ISP).

Table 1 below summarizes the dates when the ISP surpasses the threshold.

A total of 8 crises resulted within ten years (1990.05 up to 2001.05) and will be used in the analysis.

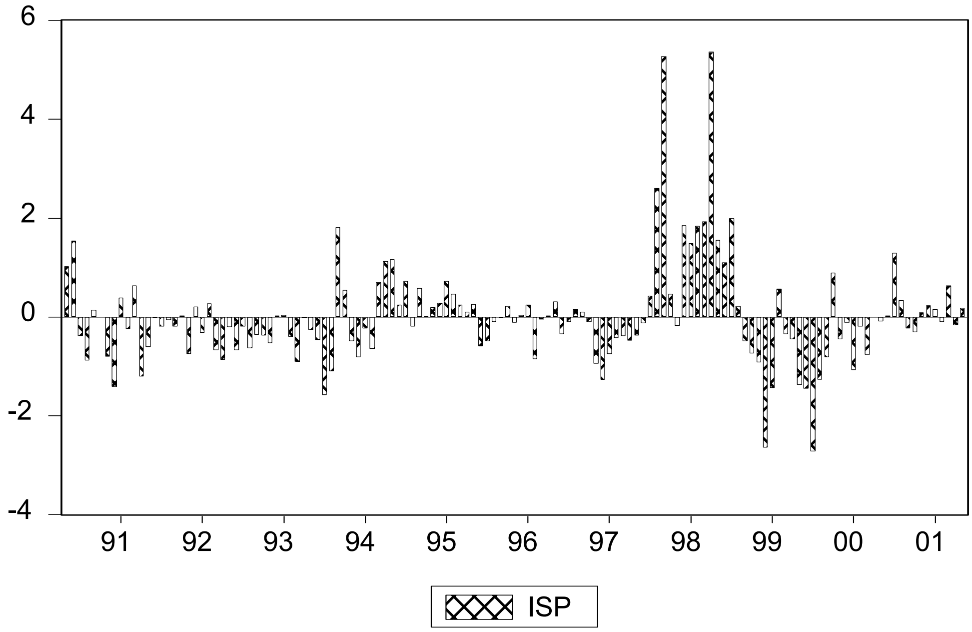
Table 1

The crisis period in Indonesia

1990:05 – 2001:05	
Year	**Month**
1993	September
1997	August, September, December
1998	February, March, April, July

Meanwhile, Herrera and Garcia stated that if a crisis occurs within 4 months of another one, they are counted as one episode. From the table above, it can be seen that Indonesian crisis in 1997 (8,9,12) and 1998 (2,3,4,7) happened within 2 months of another one. Therefore, we concluded that Indonesian crisis in 1997 and 1998 is one episode of crisis.

Graph of Index of Speculative Pressure



3.3 Leading Indicator

The Index of Macroeconomic Vulnerability (IMV) was standardized to have mean zero and unit variance. The variables are:

$IMV = REER + RDG + M2/R + \Pi$

REER = Real effective exchange rate

RDG = Real Domestic Credit Growth

M2/R = M2/International reserves

Π = Inflation

The signals are extracted from the behavior of the composite index (while in the Kaminsky case, each individual variable generates signals that are then aggregated into the composite index). The assumption for the aggregation procedure is that the leading variables drift more or less in the same direction or have common element in their behavior prior to the crisis. If this is not the case, it will not be a good indicator.

3.4 Signal-Generating Mechanism of The Simple Model

The reason for using GARCH Model (Simple Model) is that the volatilities of IMV through time. In this model, the standard deviations used are computed from the conditional variance of the series estimated by a Generalized Autoregressive Conditional Heteroskedastic (GARCH). The feature of these types of models is that the variance of the IMV is taken to be an ARMA process that is estimated simultaneously with the mean of the series. The GARCH (p,q) model that is used is:

$$IMV_t = a_0 + a_1 IMV_{t-1} + e_t$$

$e_t = v_t \sqrt{h_t}$, v is white noise with $\sigma_v = 1$

and $\hat{h}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$

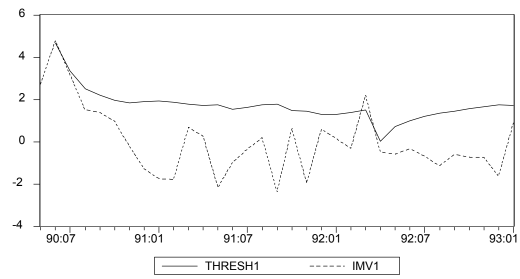
The threshold for the IMV is constructed with the conditional standard deviations of GARCH Model. The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

We use two approaches to analyze the data, first, by dividing the data into 4 sub samples. Second, by analyzing the data as a whole. Below are the results of both analyses.

3.4.1 Result of The Simple Model 1 (data divided into 4 sub samples, normalized per sub sample)

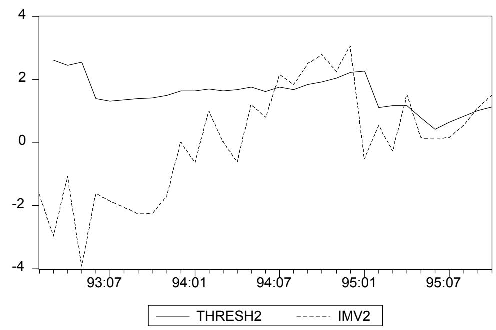
First Sub sample (1990:05 – 1993:01) N=33

GARCH's combination for the first sub sample is (1,0). The result can be seen in the right side. Signals for crisis will be generated if the IMV exceeds the threshold.



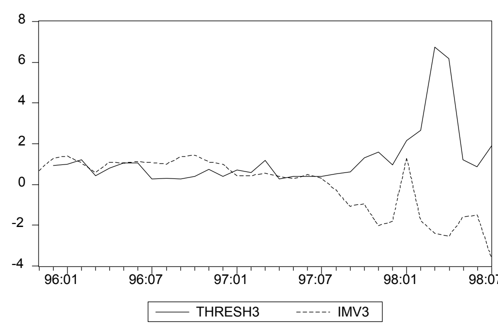
Second Sub sample (1993:02 – 1995:10) N=33

GARCH's combination for the second sub sample is (1,1).



Third Sub sample (1995:11 – 1998:07) N=33

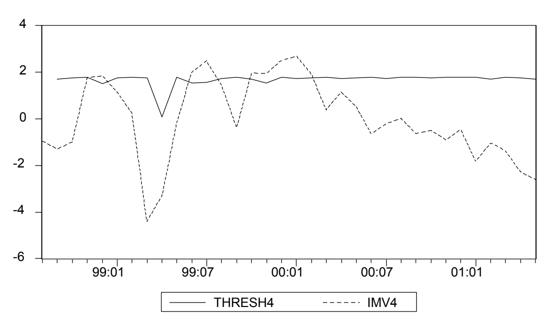
GARCH's combination for the third sub sample is (2,0).



Fourth Sub sample (1998:08 – 2001:05)

N=34

GARCH's combination for the fourth sub sample is (0,1). The result can be seen below.

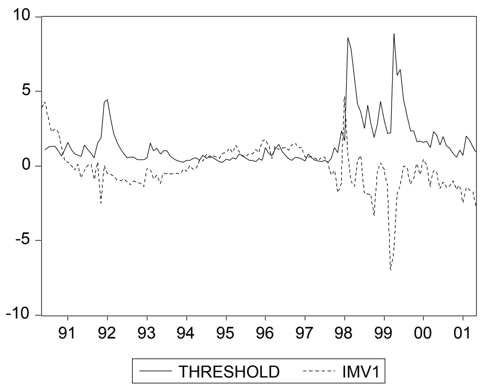


Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will happen if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	24 month window prior to each crisis	Signal generated by Simple Model	False/good signal
1993 (9)	1991 (9) – 1993 (8)	1990 (6) 1992 (3)	2 signals generated, 1 of them is false signal
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (7,8,9,10,11,12) 1995 (4,**9,10,12**) 1996 (**1,3,4,6,7,8,9,10,11,12**) 1997 (**1**)	21 signals generated by Simple Model within 3 years. 14 signals are good signals

3.4.2 Result of The Simple Model 2 (data is not divided)

GARCH's combination for this approach is (1,1). The result can be seen below. Signals for crisis will be generated if the IMV exceeds the threshold. There are 40 signals for crisis generated in this approach.



Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will be happened if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	24 month window prior to each crisis	Signal generated by Simple Model	False/good signal
1993 (9)	1991 (9) – 1993 (8)	1990 (6,7,8,9,10,11)	6 signals generated, all of them are false signals
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (7,9,10,11,12) 1995 (1,2,3,4,5,6,7,**8,9,10,11,12**) 1996 (**1,2,4,5,6,7,8,9,10,11,12**) 1997 (**1,3,4,5,6,7**)	34 signals generated by Simple Model. 22 signals are good signals

3.5 Signal-Generating Mechanism of ARIMA Residual Model

Signal-generating mechanism in this model occurs when the residuals summarize the deviations from normal behavior and a signal is generated when this statistic exceeds to zero.

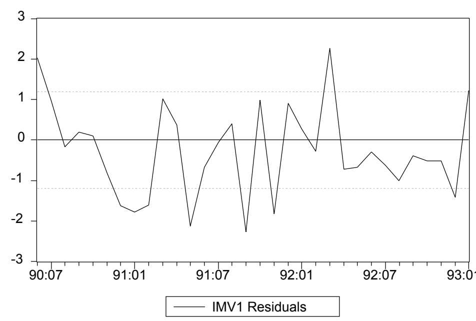
As in Simple model, we also use two approaches to analyze the data, first, by dividing the data into 4 sub samples. Second, by analyzing the data as a whole. Below are the results of both analyses.

3.5.1 Result of The ARIMA Residual Model 1 (data divided into 4 sub samples, normalized per sub sample)

Since the number of sample in this study is quite large, we decide to divide the sample into four sub samples.

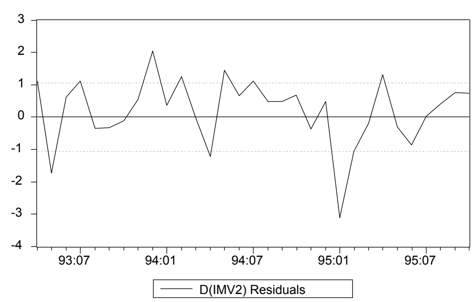
First Sub sample (1990:05 – 1993:01) N=33

ARIMA's combination for the first sub sample is (1,0,1). The result can be seen in the right side. Signals for crisis will be generated if statistic value exceed zero (positive) and it's mean generate signal for crisis.



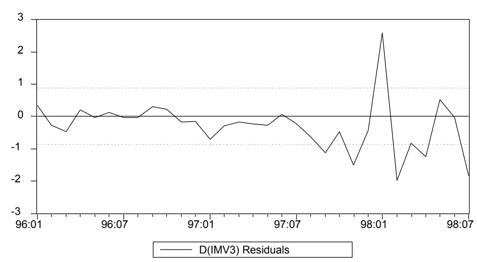
Second Sub sample (1993:02 – 1995:10) N=33

ARIMA's combination for the second sub sample is (1,1,0). The result can be seen in the right side.



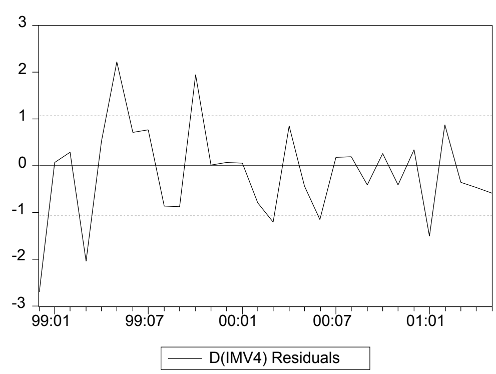
Third Sub sample (1995:11 – 1998:07) N=33

ARIMA's combination for the third sub sample is (1,1,2). Signals for crisis will be generated if statistic value exceed zero (positive) and it's mean generate signal for crisis.



Fourth Sub sample (1998:08 – 2001:05) N=34

ARIMA's combination for the first sub sample is (3,1,3).



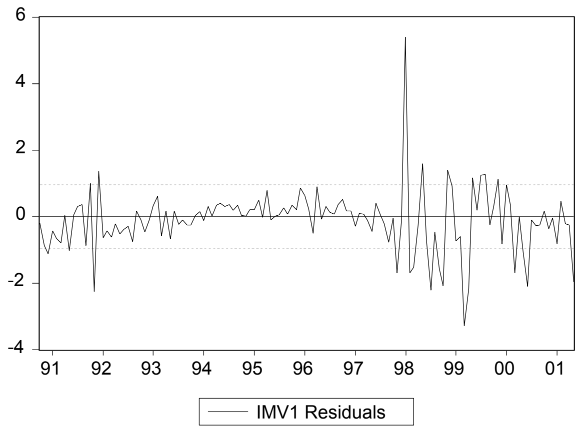
Signal generated then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will happen if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	**24 month window prior to each crisis**	**Signal generated by ARIMA**	**False/good signal**
1993 (9)	1991 (9) – 1993 (8)	1990 (6,7,9,10) 1991 (3,4,8,**10,12**) 1992 (**3**) 1993 (**1,4,6,7,**11,12)	16 signals generated by ARIMA Residual, 7 signals are good signals. 9 signals are false signals.
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (1,2,5,6,7,8,9,10,12) 1995 (4,7,**8,9,10**) 1996 (**1,4,6,9,10**) 1997 (**6**)	20 signals generated by ARIMA Residual, 9 signals are good signals.

3.5.2 Result of The ARIMA Residual Model 2 (data is not divided)

The combination of the ARIMA model for this approach is {(1,5),0, (8,14)}. The result can be seen below. Signals for crisis will be generated if the IMV exceeds the threshold. Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will be happened if it turns out outside of 24 months prior to each crisis.

Graph of ARIMA Residual Model (Data not divided)



Index of Speculative Pressure	**24 month window prior to each crisis**	**Signal generated by ARIMA Model**	**False/good signal**
1993 (9)	1991 (9) – 1993 (8)	1991 (4,6,7,8,**10,12**) 1992 (**9**) 1993 (**1,2,4,6,**11,12)	13 signals generated, 7 of them are good signals
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (2,3,4,5,6,7,8,9,10,11,12) 1995 (1,2,4,6,7,**8,9,10,11,12**) 1996 (**1,2,4,6,7,8,9,10,11,12**) 1997 (**2,3,6,7**)	35 signals generated by Simple Model. 19 signals are good signals.

3.5.3 Result of Contagion Effect

Using Probit model as explained above, the result is as follow:

$$\text{Crisis} = 3.052 - 0.022\ \text{FUND} + 0.619\ \text{CONTA}$$

$$\text{z stat} \quad (-3.4395) \quad (1.3645)$$

From the result above, it can be seen that with neither $\alpha = 5\%$ nor $\alpha = 10\%$, only variable of economic fundamental significantly affect the crisis or speculative attacks in Indonesia. The coefficient of variable economic fundamental is negative, meaning that the stronger the economic fundamental of a country, the less possibility of speculative attack to occur. While contagion variable, with neither $\alpha = 5\%$ nor $\alpha = 10\%$, do not significantly affect crisis or speculative attacks in Indonesia.

Next, this study use only 4 economic indicators that is used as leading indicators in early warning system, that are: real exchange rate, M2/Reserve, inflation, and real domestic credit growth. The result is as follows:

$$\text{Crisis} = 0.7563 - 0.264\text{FUNDA4} + 0.7089\ \text{CONTA}$$

$$\text{z stat} \quad (-2.5905) \quad (1.6580)$$

From the results above, with $\alpha = 10\%$, both variable of economic fundamental and variable of contagion, significantly have contribution on the speculative attacks. The negative sign in fundamental variable coefficient implies that the stronger economic fundamental of a country, the less possibility that speculative attacks to occur. Whereas the contagion factor has a positive sign, this implies that the crisis in a country will induce speculators to attack other countries.

4. Conclusions

1. In general, the results of detecting Indonesian early warning system with the Simple Model and ARIMA residual model (using the split data and not split data) are the same.
2. We can predict the crisis period because within 24 months prior to the crisis the signals have issued (the model flashed warning sign).
3. There are some signals flashed with relatively high intensities but not followed by crisis in 1993 and 1994. However, it doesn't mean that the signals are false. The Indonesian economic condition at that time was still strong (this can be noticed from economic growth, inflation, international reserves, etc) and had good non-economic stability. In addition, the government capability to control national economic was still high because market liberalization has not been fully opened yet, where at this time the regional economic condition was strong as well (high economic growth of Asian countries).
4. Meanwhile, the result of identifying contagion effect by using 14 variables of economic fundamental and three countries for variables of contagion showed that only variables of economic fundamental affect significantly to the crisis or speculative attack in Indonesia
5. Whereas by using 4 variables of economic fundamental, with α =10%, both variables of economic fundamental and contagion factor significantly have contribution in speculative attacks
6. The four leading indicators that are used as leading indicator to detect economic crisis in Indonesia also perform well as a means to find out if there is a role of contagion effect in economic crisis in Indonesia

BIBLIOGRAPHY

Adiningsih, Sri. 2001. "*Economic Indicators as Early Warning System: the Indonesian Case*". Presented at East Asian Development Network Third Annual Meeting, Singapore.

Demirguc-Kunt, Asli and Enrica Detragiache (1997)"*Banking Crises around the World: Are there Common Threads*?"

Eichengreen, B., Rose, A., and Wyplosz, C., 1996. "Contagious Currency Crises". *NBER, Working Paper*, No. 5681.

Engle,R. 1982. "Autoregressive Conditional Heteroscedasticity with Estimates of The Variance of UK Inflation", *Econometrica*, 50,987-1007

Gujarati, Damodar N. 1995. "*Basic Econometrics*" Third Edition. McGraw-Hill Book Company. New York.

Hardy, Daniel C and Ceyla Pazarbasioglu. 1998. "*Leading Indicators of Banking Crises: Was Asia Different*?". IMF Working Paper. June.

Herrera, Santiago and Conrado Garcia. 1999. "*User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries*". World Bank Working Paper. November.

Kaminsky, Graziela L. 1999. "*Currency and Banking Crises: The Early Warnings of Distress*". IMF Working Paper 178.

Kaminsky, Graciela. Lizondo, Reinhart.1997. "*Leading Indicators of Currency Crises*". IMF Working Paper, July.

Kaminsky, Graciela L and Carmen M. Reinhart. 1998. "The Twin Crises: The Causes of Banking and Balance of Payment Problems". *American Economic Review*, November.

Kaminsky, Graciela L. and Carmen M. Reinhart. 2000. "On Crises, Contagion, and Confusion". *Journal of International Economics* 51.

Kawai, Masahiro, Richard Newfarmer and Sergio Schmukler. 2001. "*Crisis and Contagion in East Asia: Nine Lessons*". World Bank Working Paper, February.

Simone, Alejandro. 2001. "*In Search of Coincident and Leading Indicators of Economic Activity in Argentina*". IMF Working Paper, March.

Tjahjojo, Endy. 1998. "Economic Fundamental, Contagion Effect, and Asian Crisis". *Buletin Ekonomi Moneter dan Perbankan*, September.

--------, 1998. "*East Asia, The Road to Recovery*", The World Bank.

--------, 2001. "*Asian Development Outlook*". The Asian Development Bank.

The Economist . 2001. "*A Global Game of Dominoes*".

Far Eastern Economic Review. 2001. " *Asia's Economic Future: Choices That Will Shape The Recovery*".