External Vulnerability Indicators: The Case of Indonesia

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Abstract

This paper aims to find indicators that can be used to monitor Indonesia's external vulnerability as well as an early warning system of crisis. The study is conducted by evaluating a number of indicators deployed in the previous studies by using signaling method. An analysis of external vulnerability is facilitated by separating the pressure of vulnerabilities into four zones, namely normal, alert, cautious, and suspected crisis. The study obtains 12 external indicators that are then aggregated to produce a composite index of external vulnerability. The selected indicators and the composite index are well able to capture the external vulnerability.

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Introduction

1.1 Background

The economic crisis that swept over Asian countries in 1997–1998 was the worse experience for Indonesia. At the time, Indonesian economy is growing fairly high with stable inflation, but the impact of Bath depreciation spread to most countries in Asia and as a result, Indonesia fell in a very deep crisis. During the crisis, Indonesia's economy contracted the highest, reaching 13.1% in 1998. Meanwhile, economic growth in Thailand, Malaysia, South Korea, and Philippine in the same year contracted respectively by 10.5%, 7.4%, 6.9%, and 0.6% (Simorangkir, 2012).

This Asian crisis was not able to be predicted by various models developed prior to 1997–1998. The first generation model of crisis developed by Krugman (1979) explains that the crisis could occur if the government did not implement appropriate macroeconomic policies through money creation to cover the fiscal deficit. While the second generation developed by Eichengreen & Wyplosz (1993) and Obstfelt (1994) are also not suitable to explain the onset of the Asian crisis. According to this model, the crisis caused by investor behaviour who expects there will be a devaluation so that they tend to invest their funds in foreign currency. This action ultimately deplete official reserve assets and make the country was unable to maintain fixed exchange rate regimes. Krugman (1999) ultimately develop a third generation model to explain the Asian crisis in which the role of the financial system became a central point of crisis.

In three models mentioned above, basically the economic crisis in a country depends on two main things, namely the vulnerable conditions and the triggers. The difference between those crisis models lies in the indicators used as reference to describe the vulnerability of economy. If the indicators increased then the level of vulnerability rose and the probability of crisis would increased.

In 1990s, Indonesian economy is already vulnerable. Dabrowski (2001) describes that short term external debt position is swollen, current account is always deficit, and ratio of exports to external debt is very low. The condition is also accompanied by a low foreign exchange reserves so emerged a doubt about Indonesia's ability to meet its external obligations. In such conditions, when the first outbreak occurred in Thailand, the investors rushed to attract their fund from Indonesia. Even worse, the ratio of money supply to foreign reserves is rising so that causing panic in the market and encourage irrational actions such as the sale of domestic assets. As a result, the exchange rate depreciates very deep and triggering high inflation. Foreign reserves are depleted and interest rates are raised very high caused economic contraction. Indonesia then fell into deep economic crisis since that time.

Thus, the efforts to identify and to measure vulnerability indicators becomes indispensable. By using these indicators, then we can develop a mechanism to detect an early symptoms of the economic crisis, so potential crisis can be detected and anticipated. In this case, the early warning system is one method that can be used to identify and to anticipate economic crisis in the future.

This study aimed to identify which indicators can be used as an early warning system for economic vulnerability in Indonesia, especially if the vulnerability pressure comes from external sector. Thus, the evaluation of indicators limited to

the indicators related to external sector only. It is based on the experience of the crisis in 1997–1998 which shows that the world economy is becoming more integrated and inter-state dependence is becoming stronger. If the shock occurs in one country then it will quickly spread to other countries. The shock transmission from one country to another is reflected from various external indicators. The problem is which external indicators are the most appropriate for use. Furthermore, from the selected external vulnerability indicators, in order to facilitate monitoring of the external sector vulnerabilities, will be constructed composite index that is able to reflect the vulnerability of the external sector as a whole.

1.2 Theoretical background

1.2.1 Definition of Crisis

One of the important things when identifying indicators that can capture the level of vulnerability is the definition of the crisis itself. Crisis is defined differently by each researcher, as well as the methods used to quantify crisis definition. Chui (2002) sums up the crisis definition used by various researchers such as Goldman Sachs, JP Morgan, Frankel & Rose, and Kumar, Moorthy & Perraudin. In general, the similarity of the researchers in defining crisis is significant depreciation of the exchange rate.

Other researchers, such as Eichengreen (1996) and Kaminsky (1998) used an index called the Exchange Market Pressure (EMP) as a basis for determining the crisis. Eichengreen used three variables to measure the EMP namely changes in exchange rates, interest rates, and official reserve assets position. While Kaminsky used only two variables, namely changes in exchange rate and reserves position.

Several researchers also used three variables when calculate the EMP, but the weights used by researchers differ from one another. Herrera-Garcia (1999) used these three variables when calculated the Index of Speculative Pressure (ISP) which is used to determine crisis periods and give equal weight to each variables. While Eichengreen (1996) gives the weights based on the standard deviation of each variable. Sachs (1996) used the weights based on the standard deviation of each variable relative to the standard deviation of all variables. Kaminsky (1998) also did a weighting based on the standard deviation of each variable but relative to the standard deviation of exchange rate depreciation.

Herrera-Garcia (1999):

$$ISP = Standardize(\Delta e) + Standardize(\Delta i) - Standardize(\Delta r)$$

Eichengreen (1996):

$$EMP_{i,t} = \frac{1}{\sigma_e}\frac{\Delta e_{i,t}}{e_{i,t}} - \frac{1}{\sigma_r}\left(\frac{\Delta rm_{i,t}}{rm_{i,t}} - \frac{\Delta rm_{US,t}}{rm_{US,t}}\right) + \frac{1}{\sigma_i}\Delta\left(i_{i,t} - i_{US,t}\right)$$

Sachs (1996):

$$EMP_{i,t} = \left(\frac{1/\sigma_e}{\left((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i)\right)}\right)\frac{\Delta e_{i,t}}{e_{i,t}} - \left(\frac{1/\sigma_r}{\left((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i)\right)}\right)\frac{\Delta r_{i,t}}{r_{i,t}} + \left(\frac{1/\sigma_i}{\left((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i)\right)}\right)\Delta i_{i,t}$$

Kaminsky (1998):

$$EMP_{i,t} = \frac{\Delta e_{i,t}}{e_{i,t}} - \frac{\sigma_e}{\sigma_r}\frac{\Delta r_{i,t}}{r_{i,t}} + \frac{\sigma_e}{\sigma_i}\Delta i_{i,t}$$

Where: *ISP* = Index of Speculative Pressure

EMP = Exchange Market Pressure

e = Nominal exchange rate

i = Interest rate

r = Foreign reserves position

1.2.2 Selection of Indicators

Research on indicators that are leading to the crisis have been conducted by various researchers. Among these are Eichengreen (1996) who conducted a study of 20 industrialized countries in order to capture the contagious effect of crisis. While Kaminsky (1998) did the research with the signaling approach.

Chui (2002) summarised the research into three different methods. The first method is signaling approach. Signaling method analyzed the behavior of an indicator with a certain threshold level. If the indicator passes the threshold, then the signal of crisis is given. The chosen threshold is the threshold which the most able to identify the signal of crisis.

The second method is discrete method which can analyze probability of crisis. Basically, the discrete method used probability distribution function of the crisis periods and tranquil periods. While the third method is more concerned with the relationship between certain variables with the crisis.

Other researchers, Babecký, Havránek, Matějů, Rusnak, Šmídková, and Vašíček (2011), used both discrete and continuous models. In the discrete model, the method used dynamic panel logit models, whereas the continuous model used panel VAR models.

In general, the most widely used methods are signaling and discrete models. In signaling method, threshold selection is done in non-parametric. Threshold is determined based on a certain percentille. An indicator is said to issue a signal whenever it departs from its mean beyond a given threshold level. A signal that is followed by a crisis within specific time, Kaminsky (1998) used next 24 months, is called a good signal, while a signal not followed by a crisis within that interval of time is called a false signal.

Signaling Methods

Table 1

	Crisis (within 24 months)	No Crisis (within 24 months)
Signal was Issued	A	B
No signal was issued	C	D

Where:

A = The number of periods in which the indicator issued a good signal

B = The number of periods in which the indicator issued a bad signal

C = The number of periods in which the indicator failed to issue a signal

D = The number of periods in which the indicator refrained from issuing a signal

The standard method to measure the effectiveness of the indicators in signaling method as an early warning indicator is determined by the indicators' ability to issue good signals and to avoid false signals. The common parameters which can capture this ability is Type I and Type II of statistical error and noise to signal ratio. The noise to signal ratio is obtained by dividing false signals measured as a proportion of periods in which false signals could have been issued, by good signals measured as a proportion of periods in which good signals could have been issued (Kaminsky, 1998). As a guideline, the lower the noise to signal ratio then the better the indicator.

$$\textit{Type I error} = \alpha = P(\textit{reject H0}|\textit{H0 is true}) = C/(A+C)$$

$$\textit{Type II error} = \beta = P(\textit{not reject H0}|\textit{H0 is false}) = B/(B+D)$$

$$\textit{Noise to signal ratio} = \frac{B/(B+D)}{A/(A+C)}$$

An indicator is said to be a leading indicator of crisis if it has a noise to signal ratio not greater than 1 (Chui, 2002). Meanwhile, the threshold of crisis is determined by minimizing α and β or, in other words, has the smallest noise to signal ratio.

On the other hand, discrete method (a parametric approach) evaluates the conditional probability of a crisis. If y defined variable of crisis (*1* if the crisis occurred and *0* otherwise) and x defined as a potential indicator with β as the parameter, then the probability of crisis can be stated as follows:

$$P(y=1) = f(\beta' x)$$

where $f(\beta' x)$ is a probability distribution function. If we assume the distribution is logit, then

$$P(y=1) = \frac{exp(\beta' X)}{1+exp(\beta' X)} \quad \text{and} \quad P(y=0) = \frac{1}{1+exp(\beta' X)}.$$

Parameter β is estimated using maximum likelihood method and logit regression.

Meanwhile, in terms of the indicators, the researchers used different data sets. Eichengreen (1996) evaluated 10 indicators while Kaminsky (1998) evaluated up to 105 indicators.

1.2.3 Composite Index

Some researchers calculated a composite index of the vulnerability indicators. This is done with the consideration that each indicators has a different performance and influence. The assumption for the composite procedure is that the vulnerability indicators drift more or less in the same direction or have a common element in their behaviour prior to the crisis. Kaminsky (2000) suggest to set up a composite index for each country using a weighted average of a number of indicators that give a signal.

$$I_t = \sum_{j=1}^{n} \frac{S_t^j}{\omega^j}$$

where S_t^j is equal to *1* if the indicator *j* sent a signal at time *t*, n defined as the total number of the indicators, and ω^j stated noise to signal ratio of indicator *j*. The composite index, either simple aggregation or weighted based on the noise to signal ratio, illustrates the vulnerability of a country at a given period.

The OECD also developed a composite indexing methodologies in order to construct a composite leading indicators. Since each indicator has different scale of measurement, then the indicators should be normalized before aggregated into one composite index. Normalization is done by reducing each observation with their average and dividing by the mean absolute deviation for each indicators. Then the result added with 100 for each data. Finally, each indicators multiplied by their respective weights to obtain aggregate value and created the index.

2. Methodology

Research for Indonesia's external vulnerability indicators have already done by Majardi (2009). The vulnerability indicators selected by using panel data of 151 developing countries as the members of IMF. However, the use of panel data is less precise because not all countries have a significant economic relationship with Indonesia. Therefore, this study only used 31 countries (including Indonesia) as a sample.

Reduction of the countries in the sample is conducted by considering that contagious effect will have significant impact if the crisis comes from close ties countries, both in terms of exports and investment transactions. The reduction is also considering the countries in the region and the availability of data. Countries sample selected based on main destination countries of Indonesia's export, countries of origin of the investors for direct investment and portfolio investment, countries in the ASEAN region, emerging countries in the same peer group rating, and European countries affected by the crisis recently.

List of Countries in the Sample

Table 2

10 main destination countries of export[1]	Top 10 countries of origin of DI[2]	Top 10 countries of origin of PI[3]	ASEAN countries[4]
1. China	1. Singapore	1. US	1. Brunei Darussalam
2. Japan	2. Japan	2. Luxembourg	2. Malaysia
3. US	3. Luxembourg[5]	3. England	3. Philippines
4. India	4. England	4. Norway	4. Singapore
5. Singapore	5. US	5. UAE	5. Thailand
6. Malaysia	6. South Korea	6. Singapore	6. Vietnam
7. South Korea	7. China	7. Switzerland	7. Myanmar
8. Thailand	8. France	8. Kuwait	8. Cambodia
9. Netherland	9. Hongkong	9. Japan	9. Laos
10. Taiwan	10. Canada	10. China	

Sample	
1. China	16. Philippines
2. Japan	17. Kuwait
3. US	18. Canada
4. India	19. Australia[6]
5. Singapore	20. Germany[7]
6. Malaysia	21. Brazil[8]
7. South Korea	22. South Africa[7]
8. Thailand	23. Saudi Arabia[7]
9. Netherland	24. Mexico[7]
10. England	25. Russia[7]
11. France	26. Argentina[7]
12. Hongkong	27. Turkey[7]
13. Norway	28. Greece[9]
14. UAE	29. Portugal[9]
15. Switzerland	30. Italy[9]

[1] Position in 2012, Taiwan is not included as sample based on the degree of his exposure to Indonesia. [2] Based on the country of origin of foreign direct investment in 2012. [3] Based on the country of origin of portfolio investment (stocks) in January – June 2013. [4] Only 4 countries chosen as samples takes into account of the economic size of the country and the level of exposure to Indonesia. [5] Luxembourg was not chosen because it is the tax havens country. [6] Australia selected with consideration of the proximity of the region, diplomatic relations, and the economy (2.6% share of non-oil & gas exports). [7] Germany chosen with consideration of economic relations (2.0% share of non-oil & gas exports). [8] Countries in the peer group rating. [9] European countries affected by the crisis last few years.

Meanwhile, the external indicators which will be evaluated consists of 29 indicators. Those indicators obtained from various researchers like Majardi et al. (2009), Chui (2002), IMF (2000), Kaminsky et al. (1998), Babecký et al. (2001), Eichengreen et al. (1997).

List of Candidate External Vulnerability Indicators

Table 3

No	Variables	Description
1	DSR	Debt Service Ratio
2	IRSTED	Reserves position/Short-term external debt position
3	IRMS	Reserves position/Monthly average of imports
4	IRBM	Reserves position/Broad money
5	RES	Changes in reserves position/12 months of imports (moving average)
6	NETPIIR	Short term capital flows/Reserves position
7	CAGDP	Current account/GDP
8	EDPGDP	Public sector external debt/GDP
9	EDX	External debt/Current account receipt
10	EDGDP	External debt/GDP
11	AVIN	Average interest rate of external debt
12	IRM0	Reserves position/base money
13	IRGDP	Reserves position/GDP
14	IR	Official reserve assets position
15	GIR	Growth of reserves position
16	FDIED	Foreign direct investment/Total external debt
17	KAGDP	Capital account/GDP
18	DSGDP	Debt service/GDP
19	TBGDP	Trade balance/GDP
20	XM	Export/Import
21	DX	Change in exports
22	DM	Change in imports
23	DTOT	Change in term of trade
24	DXP	Change in export price
25	FDIGDP	Foreign direct investment/GDP
26	STDTOEXTDEBT	Short term external debt/Total external debt
27	FDIINGDP	Net inflows FDI/GDP
28	FDIOUTGDP	Net outflows FDI/GDP
29	RGX	Growth of real exports

The definition of a crisis in this study used EMP indicator as described by Herrera-Garcia (1999). EMP formed by three variables, namely changes in exchange rates, interest rates, and foreign reserves position. All the variables were standardized to have mean zero and unit variance.

$$EMP_{i,t} \equiv Standardize(\%\Delta e_{i,t}) + Standardize(\Delta i_{i,t}) - Standardize(\%\Delta r_{i,t})$$

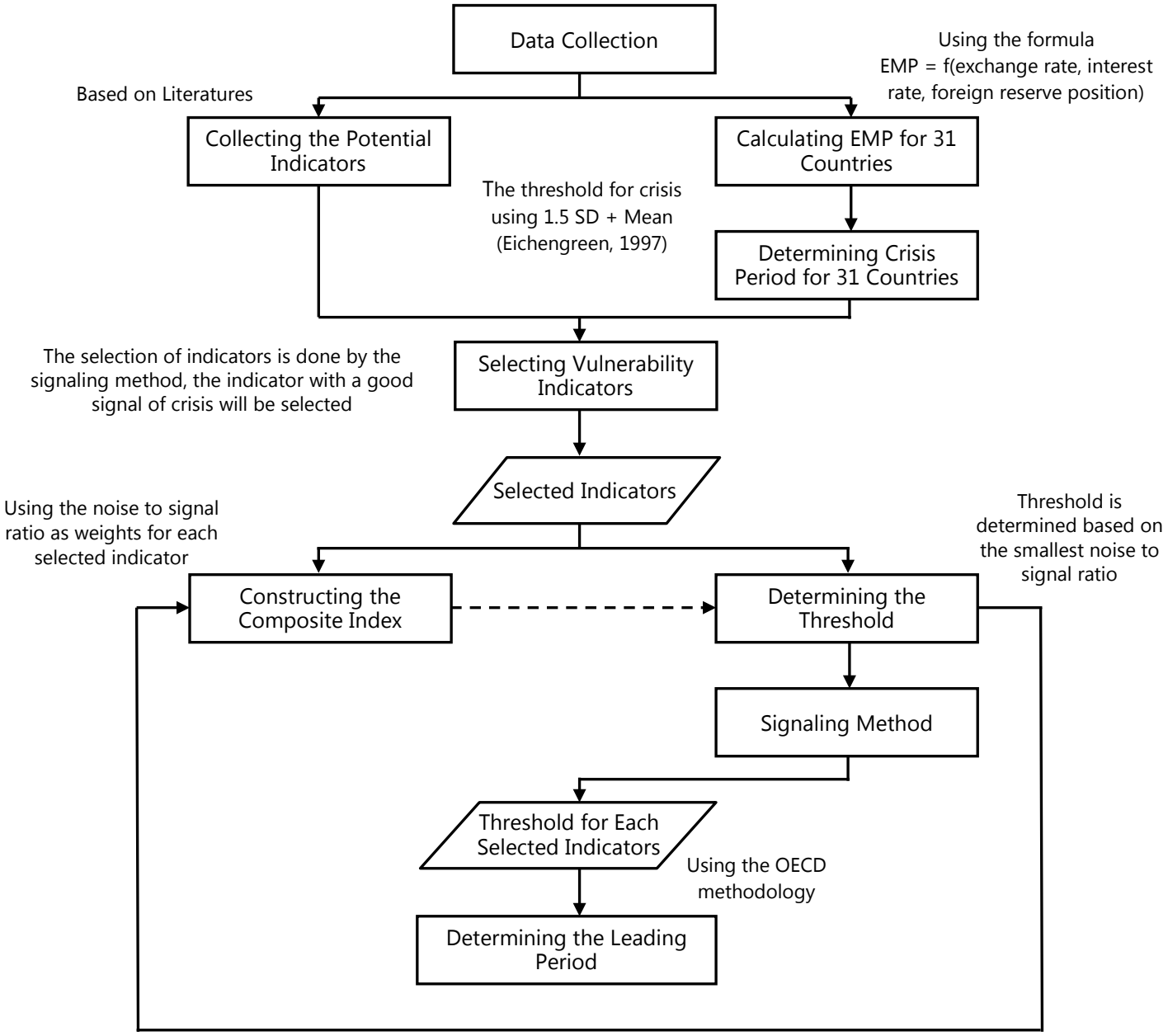
Furthermore, A crisis is defined as period in which EMP moves one-half standard deviation above the average, as done by Eichengreen (1997).

$$CRISIS = \begin{cases} 0, if\ EMP < \mu + 1.5\sigma \\ 1, if\ EMP > \mu + 1.5\sigma \end{cases}$$

Selection of vulnerability indicators and the threshold for each indicators were done by signaling method. Monitoring the signals on the signaling method performed until a two years period, as was done by Kaminsky (1998).

Lastly, the construction of the composite index will use OECD methodology with the help of CACIS software. Meanwhile, the weight for each selected indicators will be determined referring to the Kaminsky (2000) by using weights derived from the noise to signal ratio of each indicator.

Diagram 1: Construction of Indonesia's External Vulnerability Indicators



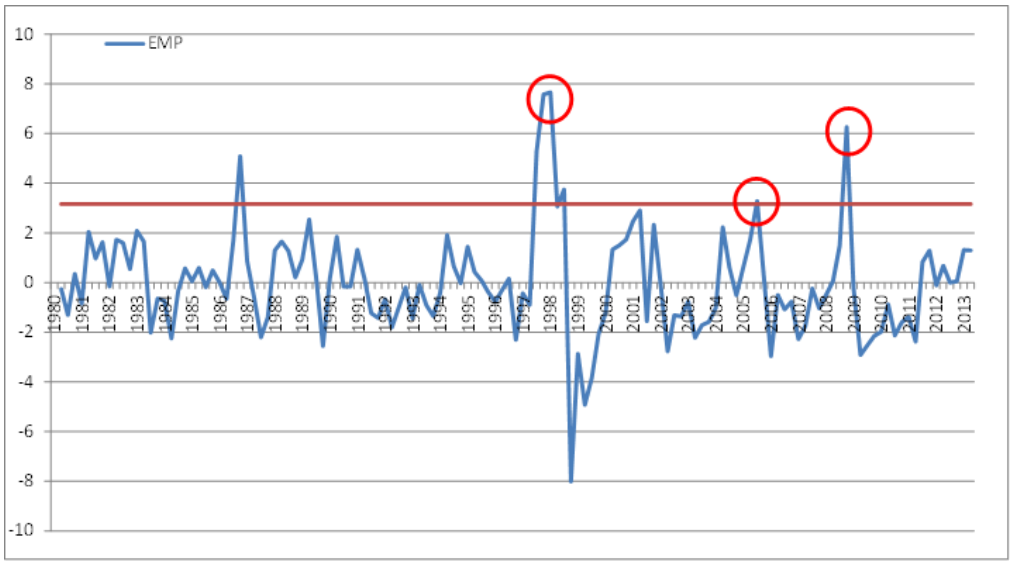
3. Empirical Results

3.1 Definition of Crisis

The data is collected from 31 countries, including Indonesia, with quarterly basis. Meanwhile the sample period is 1980Q1 to 2013.Q2. The first step of this research is determining the crisis periods by using EMP. The EMP is calculated to capture the high pressure periods on the exchange rates. In other words, the EMP is used to capture the level of vulnerability in each sample periods. Herrera-Garcia method used when calculating EMP and this method is able to capture the pressure on the exchange rate volatility. This is indicated by the movement of the EMP which is quite volatile with a few spikes in the sample periods inline with the exchange rate movements.

For Indonesia, Herrera Garcia method is able to identify the crisis that occurred in 1997–1998, 2005 and 2008. At such periods seem that EMP moves exceed the crisis threshold.

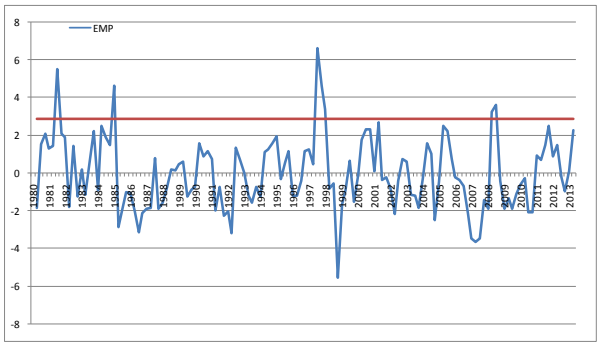
EMP of Indonesia — Graph 1



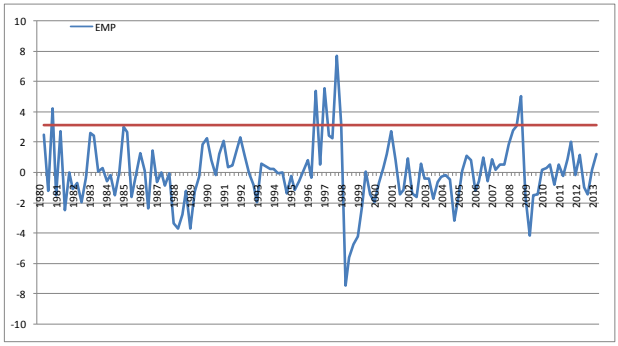
Likewise with the other sample countries, this method is able to capture most of the crisis. For example, the crisis in Thailand and South Korea can be well identified as shown with EMP movements exceed the crisis threshold at 1997–1998. So did with the crisis in Greece at 2012 and the crisis in Mexico at 1980s and 1990s can be captured by EMP.

EMP of Thailand, South Korea, Greece, and Mexico Graph 2

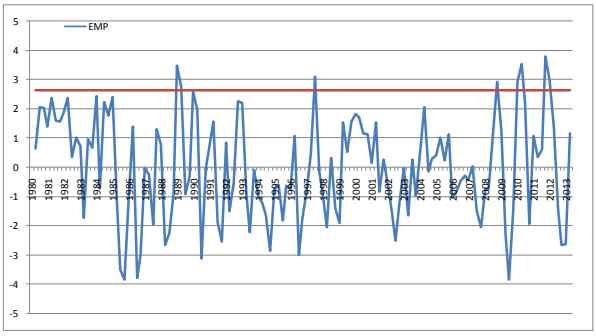
Thailand



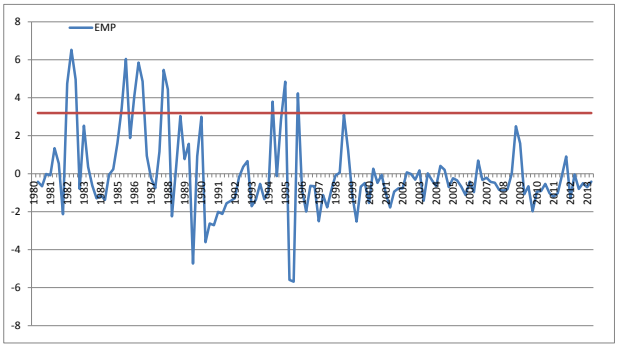
South Korea



Greece



Mexico



3.2 Selection of Indicators

The selection of indicators are done by using the signaling method. Chui (2002) requires that the chosen indicators should have a noise to signal ratio not greater than one. However, the research used more stringent criteria by chosing noise to signal ratio below 0.5 for each indicators. Using this requirement, we have 12 indicators met the criteria.

The Smallest Noise to Signal Ratio for Each Potential Indicators

Table 4

No	Indicators	The Smallest Noise to Signal Ratio	No	Indicators	The Smallest Noise to Signal Ratio
1	DSR	0.30	16	FDIED	0.70
2	IRSTED	0.46	17	KAGDP	0.60
3	IRMS	0.38	18	DSGDP	0.78
4	IRBM	0.42	19	TBGDP	0.38
5	RES	0.35	20	XM	0.61
6	NETPIIR	0.13	21	DX	0.52
7	CAGDP	0.09	22	DM	0.52
8	EDPGDP	0.98	23	DTOT	0.70
9	EDX	0.47	24	DXP	0.55
10	EDGDP	0.48	25	FDIGDP	0.19
11	AVIN	0.78	26	STDTOEXTDEBT	0.04
12	IRM0	0.61	27	FDIINGDP	1.58
13	IRGDP	0.87	28	FDIOUTGDP	2.28
14	IR	0.70	29	RGX	0.97
15	GIR	0.56			

From the result above, in order to complete the analysis of monitoring, threshold for each indicator will be determined. Each indicator will be divided into four stages of pressure, namely normal, alert, cautious, and suspected to crisis. The suspected crisis area is determined from the standard deviation which gives the smallest noise to signal ratio.

Threshold for Selected External Vulnerability Indicators

Table 5

No	Variables	Threshold		
		Alert	Cautious	Suspected Crisis
1	DSR	31.62	38.26	44.90
2	STDTOEXTDEBT	18.91	19.83	20.76
3	EDX	170.68	214.86	259.03
4	EDGDP	51.10	60.42	79.07
5	IRMS	4.39	3.82	3.25
6	IRBM	27.69	24.69	21.68
7	IRSTED	149.97	128.37	106.78
8	RES	–37.56	–50.60	–63.63
9	CAGDP	–1.42	–2.26	–3.10
10	TBGDP	–0.16	–1.17	–2.18
11	FDIGDP	–0.16	–0.37	–0.58
12	NETPIIR	–2.15	–3.41	–4.66

Furthermore, the threshold of alert and cautious determined arbitrarily by a margin of 0.25 standard deviations from the threshold of suspected to crisis. For example, if the threshold for IRMS obtained from the average plus one standard deviation, then the alert threshold is obtained from the average plus 1.25 standard deviation and the cautious threshold derived from the average plus 1.5 standard deviations. The normal area will be marked with green colour, alert area marked in yellow, cautious area marked in pink, and suspected to crisis area marked in red. Graph for each selected indicators and their threshold can be found in the Appendix. The threshold resulted by this research are not too different when compared with the results obtained by other researchers.

Threshold for Selected Indicators by Other Researchers

Table 6

	EDGDP			EDX			DSR			CAGDP		
	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis
Present Research	51.1	60.4	79.1	170.7	214.9	259.0	31.6	38.3	44.9	–1.4	–2.3	–3.1
Majardi (2009)	50.2	55.6	86.3	150.5	189.4	215.4	27.8	36.4	43.5	–1.5	–2.4	–3.1
IMF (2000)		50.0			200.0							
Chang (2007)		66.6										
Kappagoda	30.0	40.0	50.0	100.0	150.0	200.0						
Reinhart (2010)		60.0	90.0									
Greene (2010)		50.0	80.0		120–150	200–250						
Reinhart (2003)		60.0	150.0									
Maastricht Criteria												
UN-ESCAP	48.0	48–80	80.0	132.0	132–220	220.0	18.0	18–30	30.0			
CAA		70.0			150.0			20.0				
Deutsche Bank											–3.0	

	IRSTED			IRMS			IRBM			STDTOEXTDEBT		
	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis
Present Research	150.0	128.4	106.8	4.4	3.8	3.2	27.7	24.7	21.7	18.9	19.8	20.8
Majardi (2009)	180.7	110.0	68.0	4.3	3.8	3.5	28.1	20.0	15.7			
Calafell (2003)		100.0										
Mishev (2010)		100.0			3.0			20.0				

	RES			TBGDP			FDIGDP			NETPIIR		
	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis	Alert	Cautios	Crisis
Present Research	–37.6	–50.6	–63.6	–0.2	–1.2	–2.2	–0.2	–0.4	–0.6	–2.2	–3.4	–4.7
Majardi (2009)	–43.0	–66.0	–88.0									

Next, to answer the question whether the selected external vulnerability indicators are capable to providing an early warning to the crisis, the performance of these indicators will be evaluated at some period of crisis, 1997–1998 crisis, 2005 crisis, and the global crisis of 2008.

In the 1997–1998 crisis, external vulnerability indicators have shown abnormality condition. This is reflected by four liquidity indicators, namely DSR, IRSTED, IRMS, and IRBM, lie outside the normal area, even up to several periods. Furthermore, the other liquidity indicators (RES, FDIGDP, and NETPIIR) go beyond the suspected crisis threshold at 1997Q4. This problem mainly driven by the low foreign exchange reserves and high external debt position.

In the other side, Indonesia also faced a solvency problem as reflected by four solvency indicators (CAGDP, EDX, EDGDP, and STDTOEXTDEBT) lies outside the normal area for several periods. Current account deficit and the external debt position which higher than the ability to pay was the cause of this solvency problems.

Thus, it can be concluded that Indonesia's external sector in the period, even starting from some previous period, is already vulnerable. In such circumstances, only waiting for a trigger factor for the occurrence of a crisis. The trigger then came from the depreciation of Bath which later affected the Indonesian economy.

Heat Map for external vulnerability indicators during the crisis period 1997–1998 Table 7

INDICATORS	1996Q3	1996Q4	1997Q1	1997Q2	1997Q3	1997Q4	1998Q1	1998Q2	1998Q3	1998Q4
DSR	10.81	10.56	37.39	35.02	34.93	64.18	56.20	47.22	56.86	58.75
IRSTED	48.16	55.94	57.35	61.34	61.08	51.46	50.52	58.81	66.44	77.69
IRMS	3.42	3.90	3.90	4.13	4.04	3.32	3.41	4.15	4.98	6.41
IRBM	14.87	15.62	16.20	16.57	17.68	19.33	33.92	33.95	45.80	32.53
RES	–1.98	56.11	13.70	25.09	–1.70	–72.40	–16.06	47.66	41.53	82.90
FDIGDP	2.80	2.50	3.84	2.07	2.34	–0.76	–2.18	1.69	–0.67	0.12
NETPIIR	3.81	11.04	5.05	5.18	3.05	–30.98	–21.36	9.80	0.52	–1.18
CAGDP	–3.60	–1.55	–3.59	–1.80	–2.34	–0.47	4.34	3.08	7.84	2.31
TBGDP	2.29	4.10	2.36	5.68	3.66	6.96	20.92	22.84	23.76	10.99
EDX	314.12	307.61	300.19	289.72	282.01	272.83	270.46	280.24	281.76	297.09
EDGDP	82.11	79.26	77.47	75.74	75.72	80.30	94.88	120.80	160.20	175.68
STDTOEXTDEBT	19.08	19.01	19.00	18.87	18.81	18.74	18.57	17.96	17.63	17.50

Meanwhile, in the 2005 crisis, five liquidity indicators (IRSTED, IRMS, IRBM, RES, and NETPIIR) had entered alert zone since though not to give a signal. The pressure mainly concerns from the adequacy of international reserves and foreign capital outflow. In terms of solvency, highly external debt position and current account surplus dwindling until reach the deficit in 2005Q3 was the cause of the pressure on the domestic economy.

However, the external pressure is not as strong as in the period of pressure on the eve of the crisis of 1997–1998. This is understandable because the root cause of

the crisis in 2005 was the increase of fuel price which then impacted the domestic economy.

Heat Map for external vulnerability indicators during the 2005 crisis

Table 8

INDICATORS	2004Q3	2004Q4	2005Q1	2005Q2	2005Q3	2005Q4	2006Q1	2006Q2	2006Q3	2006Q4
DSR	20.35	25.11	17.07	24.30	17.29	16.30	14.91	17.28	15.07	22.91
IRSTED	140.99	147.33	144.48	143.13	124.66	145.67	167.28	175.70	184.63	206.32
IRMS	6.28	6.10	5.70	5.02	4.16	4.55	5.30	5.20	5.49	5.36
IRBM	32.27	32.04	32.73	30.10	26.37	28.85	31.21	29.09	29.91	28.15
RES	–0.88	25.48	–4.58	–32.09	–48.65	57.78	70.80	0.33	29.09	2.94
FDIGDP	0.54	1.21	1.24	5.29	2.45	2.57	1.57	1.20	1.09	1.48
NETPIIR	2.66	3.45	2.04	–2.19	7.26	8.86	10.24	–1.52	1.27	4.87
CAGDP	3.14	0.83	0.30	0.62	–1.62	1.04	3.46	2.17	3.93	2.22
TBGDP	9.18	8.52	4.61	5.72	4.87	8.85	7.85	7.73	8.91	7.60
EDX	171.65	161.94	150.42	143.37	138.18	124.25	124.97	120.26	114.92	107.21
EDGDP	56.46	55.06	53.79	52.38	51.45	46.63	45.41	42.42	39.43	35.92
STDTOEXTDEBT	17.44	17.45	17.68	16.72	17.07	17.72	17.31	16.59	16.67	15.56

In 2008Q4, deteriorating global conditions led to an outflow of foreign capital. This factor coupled with a decline in foreign exchange reserves add to pressure on vulnerability of liquidity indicators. Meanwhile, solvency indicators are relatively safer except the ratio of short-term external debt to total external debt which deteriorated along with the increase of short-term external debt position.

Heat Map for external vulnerability indicators during the 2008 crisis

Table 9

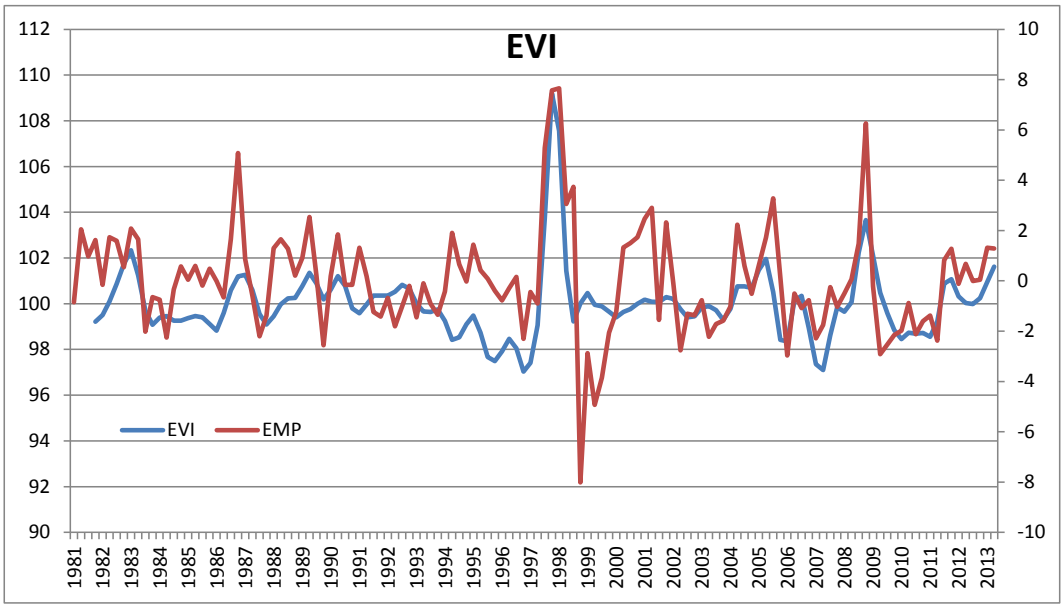
INDICATORS	2007Q3	2007Q4	2008Q1	2008Q2	2008Q3	2008Q4	2009Q1	2009Q2	2009Q3	2009Q4
DSR	13.99	20.19	15.09	16.74	13.60	24.56	20.98	23.42	17.40	22.59
IRSTED	225.44	207.03	206.20	207.70	203.61	174.98	202.52	203.95	198.65	208.71
IRMS	5.97	6.23	5.99	5.48	4.85	4.28	4.92	5.71	6.70	7.11
IRBM	32.32	31.99	34.25	32.34	29.61	30.04	33.28	30.66	30.86	29.24
RES	22.03	44.29	20.97	4.29	–19.90	–45.28	28.71	27.15	50.66	41.05
FDIGDP	1.94	2.34	1.96	1.23	2.34	1.65	1.68	1.10	0.68	0.35
NETPIIR	3.26	–0.77	4.76	6.94	0.22	–7.75	3.31	2.66	5.30	5.79
CAGDP	1.90	3.02	2.28	–0.76	–0.67	–0.54	2.37	1.80	1.22	2.47
TBGDP	6.62	8.29	6.26	4.10	3.98	3.55	5.34	5.69	4.75	6.82
EDX	102.17	100.29	99.83	94.87	90.41	93.54	98.07	107.08	123.44	121.77
EDGDP	32.70	32.21	32.82	31.40	29.68	30.08	29.69	30.29	33.03	31.76
STDTOEXTDEBT	17.02	19.47	19.11	18.98	18.46	19.03	17.94	18.36	18.67	18.32

The analysis of external vulnerability indicators during crisis periods in Indonesia has shown that the resulting vulnerability indicator may give a warning or signal before the crisis occurred. Thus, the twelve selected indicators has been able to describe the level of vulnerability of external sector and can be used as a monitoring and early warning system to predict the crisis.

3.3 Composite Index

The composite index is calculated using weights based on the noise to signal ratio for each selected indicator. This research used an OECD methodology to obtain external vulnerability index (EVI). The index is aggregated from external vulnerability index, so it can be used to show the vulnerability of the external sector in general.

External Vulnerability Index vs EMP — Graph 3



The result of EVI has shown in Graph 3. In general, EVI movements cointegrated with EMP. This graph also supported by low noise to signal ratio, amounting to 0.1. Thus, EVI is able to send a good signal to detect the occurance of crisis in the next two years and can be used as leading indicator for EMP.

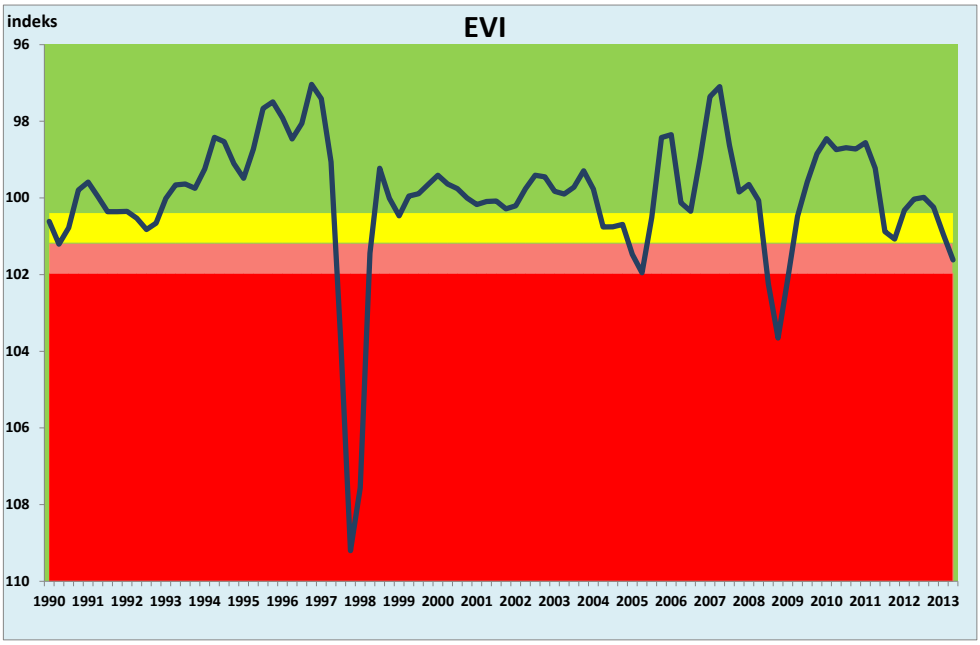
Furthermore, the noise to signal ratio also provides information about suspected crisis threshold. In this case, the smallest noise to signal ratio is obtained by using the threshold of 1.25 standard deviations above the average. The other thresholds will be determined using the difference of 0.25 standard deviations from suspected crisis threshold. Because of EVI movements and crisis are unidirectional, then the higher EVI means external vulnerability has increased. So the level of cautious and alert must be placed below the suspected crisis threshold. Thus, the cautious threshold determined by 1 standard deviation above the average and the alert threshold determined by 0.75 standard deviation above the average.

Threshold and Noise to Signal Ratio for External Vulnerability Index — Table 10

No	Variables	Threshold			Noise to signal ratio
		Alert	Cautious	Suspected Crisis	
1	EVI	100.39	101.18	101.96	0.1

From the results, it appears that EVI is able to identify the pressure in 1997–1998, 2005, and 2008. In 1997–1998, EVI send a signal before the crisis occured. It can be seen from the EVI movement through the suspected crisis area. EVI movements also indicated the pressure from external sector when the crisis occured in 2005, although not to exceed the suspected crisis threshold.

External Vulnerability Index — Graph 4



4. Conclusion

This study evaluated a number of external indicators with the aim to establish an early warning system of crisis from external side. The data used in this study was obtained from the 30 countries that have close ties with Indonesia, both from an economic standpoint or in terms of regionality and peer group ratings.

By using the signaling method, this research resulted in 12 indicators that need to be monitored on a regular basis in order to identify the pressures of the external sector. Of the twelve indicators then compiled a composite index of external

vulnerability (EVI) in order to capture the level of pressure in the external sector as a whole. The threshold for composite index has been tested for its ability to provide a signal through the events previous crisis (1998, 2005, and 2008).

The twelve indicators coupled with the composite index is also feasible to use to predict the crisis. The signal issued by one of the external vulnerability indicators is a sign of increased external vulnerability for two years ahead.

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