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CURRENCY CRISES AND CONTAGION CHANNELS IN ASIAN ECONOMIES

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ABSTRACT

This study examines multiple transmission mechanisms that propagate and amplify shocks across Asian nations owing to financial turbulence with emphasis on global shock transmission between economies that prioritise 'trade' and 'financial' connections in four countries: Indonesia, Korea, Malaysia, and the Philippines. Based on the logit estimation outcomes, a higher degree of trade openness amplifies the implications of shocks on the economy. Relevant implications are drawn for optimal regional monitoring and the coordination of integration as the economic fundamentals associated with the currency crises complements the first-generation models of speculative attacks.

Keywords: Currency crisis; Exchange market pressure (EMP); Extreme value theory (EVT).
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I. INTRODUCTION

Regional integration has been extensively discussed from a global economics perspective given its essentiality in policymaking. Nevertheless, this measure inevitably instigates currency crisis, amplifies price fluctuations, and induces financial crisis morbidity despite its role in resolving the global financial crisis (ECOWAS Commission, 2009). Consequently, this study aims to examine the contagion impact and global shock transmission between economies with an emphasis on trade and financial linkage.

Rungcharoenkitkul and Unteroberdoerster (2012) and Rose (2015) suggest that high levels of trade and financial integration does not induce a high risk of contagion in the region and financial volatility as opposed to past literature (Eichengreen *et al*., 1996; Glick and Rose, 1999; Rejeb and Boughrara, 2015). Frost and Saiki (2014), corroborated with IMF (2009), find that financial integration potentially rebalances economic growth through high domestic demands. Nevertheless, Abdullah *et al*. (2018) proposed that financial liberalisation risk-sharing is only beneficial in developed economies compared to their emerging counterparts. Thus, this study examined the role of contagion channels (specifically the trade and financial linkage to currency crisis) in selected Asian economies with varying levels of economic development and integration.

The current study also strives to bridge existing knowledge gaps in two ways. First, extensive research involving the Exchange Market Pressure (EMP) index has been performed to determine crisis episodes. One of the limitations of the extant literature on defining the currency crisis using EMP is that it could instigate econometric concerns, such as random threshold selection (Haile and Pozo, 2008; Karimi and Voia, 2015) and the common assumption that the EMP series is normally distributed, which leads to inconclusive results.[1] Past studies implied that speculative series frequently reflect non-normal behaviour with excess kurtosis and asymmetry (Jansen and de Vries, 1991). This study aims to ascertain a standard threshold level that determines the number of currency pressure episodes with an objective statistical approach, such as the Extreme Value Theory (EVT), which justifies potential conundrums using explanatory variable values.

Following current empirical works, much research incorporated a degree of integration and trade and financial openness into a panel technique comprising a sample of countries to explore the crisis elements and proof of financial contagion. Nevertheless, policymakers could benefit from examining the key determinants of higher economic vulnerability to crisis or contagion in one country compared to others given the inconsistent integration level in Asia Pacific economies (Ye and Mikic, 2016). The current study examines crisis factors and transmission in Indonesia, Malaysia, South Korea, and the Philippines with varying levels of macroeconomic fundamentals and integration given the paucity of empirical works on individual country transmission channels.

[1] From the literature, a currency crisis occurs when the widely-acknowledged EMP values exceed a specified: an overall mean of the index and 1.5 to 3 times the pooled standard deviation of the calculated index. (Eichengreen *et al*., 1995; Kaminsky *et al*., 1998; Gunsel *et al*., 2010)

The study outcomes on EVT implies that high currency flexibility is related to high fluctuations. Meanwhile, the logit estimation results disclosed that (1) a higher degree of trade openness amplifies the shocks effects on the economy, (2) currency crisis is transmittable to primary trade partners or competitors, and (3) optimal and resilient macroeconomic fundamentals may not insulate economies from crises. Policymakers should exercise caution in pursuing external liberalisation and market deregulation while nations should develop efficient regional monitoring and the coordination of integration.

The remaining sections are organised as follows: Section II elaborates on the means of defining the currency and logit approaches while Section III discloses the empirical outcomes. Meanwhile, Section IV concludes the study.

II. METHODOLOGY

A. The EMP Index

The current research adopts Weymark's (1995, 1998) method in EMP index development. Specifically, Weymark (1995, 1998) establishs an IS-LM-AS- type small open economy model under the price stickiness assumption with a parameter (conversion factor) constituting the relative weight of exchange rate changes and intervention change in the EMP index. The EMP index is expressed as follows:

$$EMP_t = \Delta e_t + \eta \Delta r_t \tag{1}$$

where Δe_t implies the exchange rate change at time t and Δr_t denotes the foreign reserve change with $\Delta r_t=(R_t-R_{t-1})/B_{t-1}$ and B_{t-1} indicating the central bank-issued monetary base.[2] Meanwhile, $\eta=\partial\Delta e_t/\partial\Delta r_t$ reflects the negative exchange rate elasticity in terms of foreign exchange reserves. The EMP index development necessitates the elasticity estimation, η. This study utilises the two-stage least squares to predict index elasticity where the contemporaneous one-month lagged values of both exogenous and endogenous variables were deemed potential instruments. Instrument validity is subsequently evaluated following Sargan's (1958) methods.

B. Identify the Currency Crisis with EMP Index

The EVT serves to outline the possibility of abnormal behaviours or rare occurrences to manipulate the information contained within the series tails and structure statistical models for novel phenomena. Most of the financial data and EMP are fat-tailed following past literature (Danielsson, 2011; Rocco, 2014; Karimi and Voia, 2015; Guru and Sarma, 2016). In line with EVT, the distribution function F(x) demonstrated a heavy tail [Frechetif if tails vary regularly (slowly) at infinity].

$$\lim_{t\to\infty} \frac{1-F(tx)}{1-F(t)} = x^{-\alpha}, \text{ for } x > 0, \propto > 0 \tag{2}$$

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[2] According to Girton and Roper (1977), nominal base money refers to international reserves and net domestic assets. Thus, $\Delta B_t/B_{t-1}=(\Delta R_t+\Delta D_t)/B_{t-1}$.

where α implies the tail index and parameter γ denotes the inversed tail index $\propto$, γ=1/α, which governs the shape of the tail regardless of the precise form of underpinning distribution function F(x).[3] Parallel to past research on a specific tail index, α, that shapes parameter estimators, Hill estimators implied the most extensively utilised counterpart. [4] In obtaining the Hill estimate of the tail index, the sample X_i, i=1,…,N is sequenced in descending order where $X_{(1)} \geq \cdots \geq X_{(N)}$. The Hill estimator is presented as follows:

$$\hat{\xi}_{n,k}^{Hill} = \frac{1}{k}\sum_{i=1}^{k} logX_{i:n} - logX_{k+1:n} \tag{3}$$

The Hill estimator relies on the parameter k, which characterises the cut-off between the observations allegedly belonging to the distribution centre and those involving the upper tail. As such, the order statistics $X_{i:n}$ with $1 \leq i \leq k$ could imply extreme realisations. The asymptotic properties of Hill's estimator are employed to select the cut-off values (Longin and Solnik, 2001; Haile and Pozo, 2008; Karimi and Voia, 2015). Monte Carlo simulations are also utilised to identify the optimum level of cut-off values based on sample size n and $df.F(x)$ in which the Mean Square Error (MSE) for the tail index was the smallest. The optimal cut-off selection depends on the following algorithm (Rocco, 2014):

1. Simulate data through Monte Carlo from a known distribution, F, within the attraction domain of a Frechet distribution with tail index;[5]
2. Compute the Hill estimator for α involving distinctive k selections;
3. Choose the k value for which the MSE is minimal.

The Hill tail index and corresponding tail observation of the actual EMP are predicted upon identifying the number of cut-off parameters. Any EMP index values exceeding the threshold outlined the extreme positive observation of the EMP index, which indicated high currency market pressure.

C. Logit Model

In terms of variable assessment, the study adopts Haile and Pozo's (2008) model to evaluate crisis probability in a specific nation through pertinent channels, trade, and finance. Regarding contagious channels, the 'crisis elsewhere' variable is developed following Van Rijckeghem and Weder (2001) and Glick and Rose (1999) for financial and trade channels, respectively. The logit model is also incorporated to estimate the transmission probability based on financial crises and determine the channels through which contagions occur. Haile and Pozo (2008) expressed the crisis probability in a country as follows:

$$(C_{it} = 1) = prob\left[\beta_0 + \beta_1 X_{it} + \gamma_1 Trade_{ij} + \gamma_2 Finance_{ij} + \epsilon_{it} > 0\right] \tag{4}$$

[3] See Haan and Ferreira (2010) for a more comprehensive, detailed, and technical introduction.
[4] Hill estimator, a non-parametric approach, is commonly used in the first EVT applicants to finance.
[5] According to Blattberg and Gonedes (1974), the distribution with higher kurtosis (fatter tails) were adequately represented by student (or *t*) distribution. Thus, the common choice for *F* is the standard student *t* distribution when modelling financial data (Rocco, 2014).

where C_{it} implies an indicator variable first denoted as a unit if a country was impacted by an episode and zero otherwise. The extreme EMP series values denotees a crisis episode. Essentially, EVT served to ascertain extreme EMP values.[6] The extensively-employed Hill estimator was adopted for tail index estimation and extreme value identification. As the Hill estimator is sensitive to the cut-off parameter selection where a small sample and other biases could impact its outcomes (Aggarwal and Qi, 2009), an optimal cut-off parameter was chosen to minimise the asymptotic mean square error of estimator following Karimi and Voia (2015), whose research utilised the Monte Carlo techniques recommended by Longin and Solnik (2001) and Haile and Pozo (2008). [7]

The X_{it} denotes a vector of macroeconomic control variables. Regarding macroeconomic fundamental variables, such as credit growth, average annual GDP growth, inflation rate, current account to GDP, trade to GDP, and financial asset and liabilities to GDP, the indicators strongly proposed in Kaminsky *et al*. (1998), Feridun (2008) and Hegerty (2010) are selected.The trade openness (trade to GDP) and financial openness (financial asset and liabilities to GDP) variables characterised the financial integration level (Gunsel *et al*., 2010; Rose, 2015; Idris *et al*., 2017).

$Trade_{ij}$, which reflects trade contagion channels, was measured by the weighted average of crises elsewhere, $\sum_{j=1}^{n-1} m_{ij}^{trade} c_{jt}$, $i \neq j$, where c_{jt} implies the crisis in country j at time t. The weight, m_{ij}^{trade} is designed to represent the limits of trade linkage (bilateral trade or competition in other markets) between countries i and j. The trade linkage measure is expressed below following Glick and Rose (1999):

$$m_{ij}^{trade} = \sum_l \left\{ \left[(x_{jl} + x_{il}) / (x_j + x_i) \right] \left[1 - \frac{|(x_{il} - x_{jl})|}{(x_{il} + x_{jl})} \right] \right\}; for\ l \neq j\ or\ i \tag{5}$$

where x_{jl} implies bilateral exports from country j to country l and x_j indicates aggregate bilateral exports from country j. Country j is regarded as the 'first victim' or 'ground zero' when crises initially affected nations. This index denotes a weighted average involving the essentiality of exports to country l for ground zero countries and country i.

The $finance_{ij}$, which implies the financial linkage measure between the nations in their competition for funding, is assessed by the weighted average of crises elsewhere, $\sum_{j=1}^{n-1} m_{ij}^{finance} c_{jt}$, $i \neq j$, where c_{jt} reflects the crisis in country j at time t. Similar to Glick and Rose (1999), Rijckeghem and Weder (2001) measures the financial linkage weight, $m_{ij}^{finance}$, as follows:

$$m_{ij}^{finance} = \sum_l \left\{ \left[(b_{jl} + b_{il}) / (b_j + b_i) \right] \left[1 - \frac{|(b_{il} - b_{jl})|}{(b_{il} + b_{jl})} \right] \right\}; for\ l \neq j\ or\ i \tag{6}$$

[6] As the EMP components are all speculative in nature and speculative series frequently display non-normal behaviour with fat tails, a traditional method that identifies the crisis episode by placing priori assumptions of normality and using arbitrary threshold are invalid (Jansen and De Vries, 1991; Pontines and Siregar, 2008; Guru and Sarma, 2016).

[7] See Scarrott and Macdonald (2012), Rocco (2014), and Karimi and Voia (2015) for further discussion.

where b_{jl} denotes bank lending from the common lender country *l* to country *j* and b_j implies total bank lending to country *j*. The first equation component involves the overall importance of the common lender nation for countries *i* and *j* while the second counterpart ascertaines the degree to which countries *j* and *i* compete for funding from the same creditor nation.

The quarterly data between 1990 (Q1) and 2014 (Q4) derived from the International Financial Statistics, Direction of Trade Statistics, and Bank for International Settlement are used in this research. Table 1 presents the variable descriptions employed in this study together with the projected sign.[8]

Table 1.
Explanatory Variables and Crisis

This table provides detail data description of all variables considered in this study and the projected sign.

Variable	Description	Projected Sign
Gross domestic product growth	The quarterly series of GDP used to compute GDP growth rate: $\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \times 100$. Recession often precedes financial crises.	Negative
Inflation rate	The quarterly series of consumer price index used to compute the inflation rate: $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100$	Positive
Current account to GDP	The quarterly series of current account and GDP used to compute current account to GDP: $\frac{CA_t\ (millions, US\ Dollar)}{GDP_t\ (millions, US\ Dollar)}$	Negative
Trade openness	The quarterly series of imports, exports used to compute trade openness: $\frac{(Export + Import)}{GDP}$	Negative
Financial openness	The quarterly series of assets, liabilities and GDP used to compute financial linkage: $\frac{Asset + Liabilities}{GDP}$	Negative
Budget balance to GDP	The annual series of Cash surplus/deficit used.	Negative
Broad money to reserve	The ratio of the M2 to reserve measures used in available foreign exchange reserves. It captures the extent to which the liabilities of the banking systems are backed by foreign currencies.	Positive
Trade linkage	The average quarter aggregate bilateral trade flows from "ground zero country" and sample countries to sample countries' top fourteen trade partners.	Positive
Financial linkage[9]	The engagement of consolidated bank lenders from 18 major countries with sample countries. The 18 major countries that reported bank lending by nationality of lending institutions are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK and US.	Positive

8 Please refer to Kaminsky *et al*. (1998), and Ghazi *et al*. (2013) for the projected sign.

9 Complete data on consolidated bank loan statistic from Bank for International Settlements (BIS) were only available starting from 1998Q4

III. ESTIMATION RESULTS

A. The EMP and Currency Crisis

Figure 1 illustrates the EMP indices between 1990:01 and 2014:09 for Indonesia, Korea, Malaysia, and the Philippines. [10,11] Reportedly, the currency pressure in Indonesia and Korea charted a period of stability pre-1997 albeit drastically fluctuating from mid-1997 to the end of 2002. This occurrence corroborates the fact that Indonesia and Korea implemented a more flexible exchange rate regime post-1997. The currency pressure in Malaysia indicates various fluctuations throughout the sample duration excluding the 1998-to-2005 period following the implementation of a fixed exchange rate regime. Regarding the currency pressure in the Philippines, the Pesos proved extremely volatile throughout the sample period following its adoption of a floating exchange rate regime since 1984. Based on the EMP index, the currency pressure fluctuated throughout highly flexible exchange rates compared to when they were fixed, thus implying the association of flexible currencies with high fluctuation risks (Bleaney and Francisco, 2008).

Appendix (Table A.1 and Figure A.1) depicts preliminary assessments encompassing the Shapiro-Wilk normality test and Q-Q plot.[12,13] The EMP series are fat-tailed and not normally distributed, thus affirming the drawback of employing mean and standard deviation to denote the extreme EMP value and crisis episode and contradicting past study outcomes. [14] Based on the research results, the EVT denotes a more objective and viable statistical approach to examine tail distribution behaviour and determine the crisis episode.

Figures 1 to 4 illustrate the EMP series and EMP series threshold or extreme values. Extreme 'tail' observations for Indonesia (see Figure 1) disclosed large EMP fluctuations with 18 extremely high depreciating pressure episodes (months) between 1997 and 2002.[15] The outcomes corresponds to the Asian financial crisis, which began in Thailand and extended to Indonesia in July 1997. Notably, Indonesia was safely out of the Asian financial crisis in 2002. In line with Figure 1, Indonesia experienced three extremely high-pressure episodes (months) between 2008 and 2009 and four high-pressure episodes (months) in 2013. The crisis episodes ranging from 2008 to 2009 and in 2013 resulted from the global financial crisis (subprime crisis) and United States policy responses.[16]

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[10] Since all the EMP index components were stationary at first difference level with the Dickey-Fuller Generalised Least Squares (DF-GLS), first difference data were used to construct EMP index.

[11] Sample period ranged from 1993:01 to 2014:09 due to limited data availability for the industrial production index (output).

[12] Razali and Wah (2011) and Mendes and Pala (2003) suggested the Shapiro-Wilk test as the strongest normality test.

[13] The Q-Q plot is the graph of the quartiles that renders it possible to assess goodness of fit in a series of a parametric model. The graph should have a linear form if the parametric model fits the data well. The more linear the Q-Q plot, the more appropriate the model is in terms of goodness of fit (Loy *et al*., 2016).

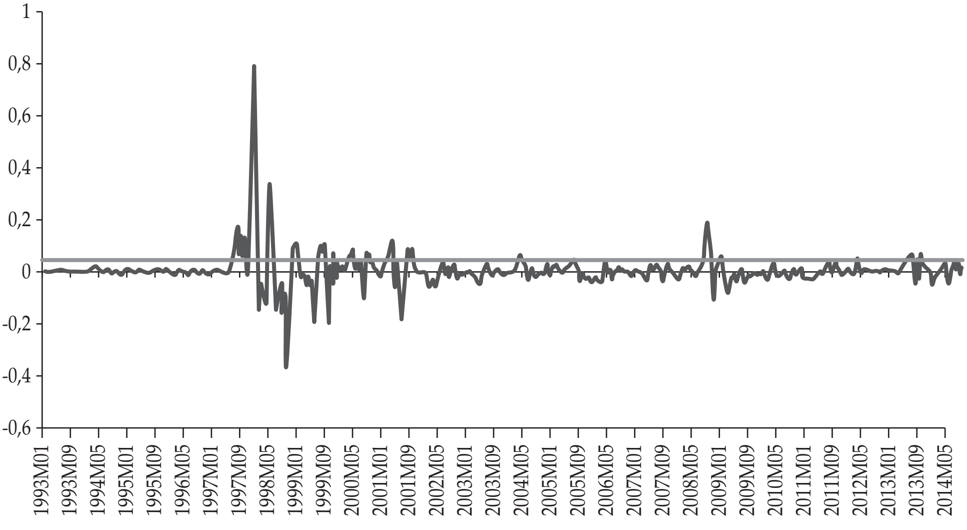
[14] Fat tails are defined as tails of the distribution with a higher density than what is predicted under the assumption of normality: extreme outcomes that occur more frequently than predicted by the normal distribution (Danielsson, 2011).

[15] See Appendix, for the extreme 'tail' observations detected.

[16] According to the Bank Indonesia Economic Report (2013), the downward pressure on the Rupiah was due to the first signal of tapering off in the Fed's monetary stimulus in response to the domestic factors related to inflation expectations in 2013.

Figure 1.
Exchange Market Pressure and Crisis Episodes in Indonesia

This figure shows monthly estimates of EMP for Indonesia over the period 1993:01 to 2014:10. Positive value of EMP indices indicates a depreciation of the domestic currency. The horizontal line above the horizontal axis is considered as the threshold of a crisis episode. Any EMP observations greater than the threshold are considered as crisis episodes.



Based on Figure 2, Korea encountered four high-pressure episodes (months) between 1991 and 1993, 15 high-pressure episodes between 1997 and 1999, and 10 episodes between 2007 and 2009. The high pressure between 1992 and 1993 could result from high integration with the global economy through exchange rate system liberalisation and capital and interest rate controls. The Korean stock market was opened in the early 1990s (Frankel, 1993). The foreign exchange rate policy, which maintained a weak Won, resulted in a large-scale current account deficit and depreciation to Won. The crisis episodes ranging from 1997 to 1999 and 2007 to 2009 paralleled the Asian and global financial crises.

Figure 2.
Exchange Market Pressure and Crisis Episodes in Korea

This figure shows monthly estimates of EMP for Korea over the period 1990:01 to 2014:09. Positive value of EMP indices indicates a depreciation of the domestic currency. The horizontal line above the horizontal axis is considered as the threshold of a crisis episode. Any EMP observations greater than the threshold are considered as crisis episodes.

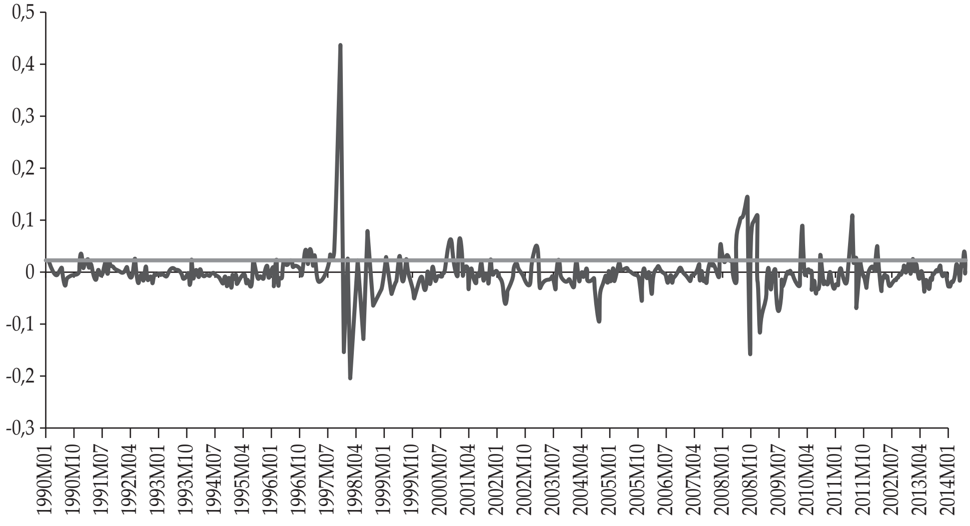


Figure 3 denotes the extremely high pressure in Malaysia between the sample period of 1990 and 2013. Resultantly, Malaysia experienced high EMP towards the end of December 1992 as Bank Negara Malaysia went beyond its boundaries to engage in the foreign exchange market and lost billions of dollars (Ariff, 1998). The country also experienced eight high-pressure episodes (months) between 1997 and 1998, four between 2008 and 2009, and two between 2011 and 2012 (see Appendix). Meanwhile, the pressure episodes from 1997 to 2008 corresponded to the Asian and global financial crises. The global recessions in 2011 could have instigated high EMP as Malaysia was impacted by the low external demand.

Figure 3.
Exchange Market Pressure and Crisis Episodes in Malaysia

This figure shows monthly estimates of EMP for Malaysia over the period 1993:01 to 2014:09. Positive value of EMP indices indicates a depreciation of the domestic currency. The horizontal line above the horizontal axis is considered as the threshold of a crisis episode. Any EMP observations greater than the threshold are considered as crisis episodes.

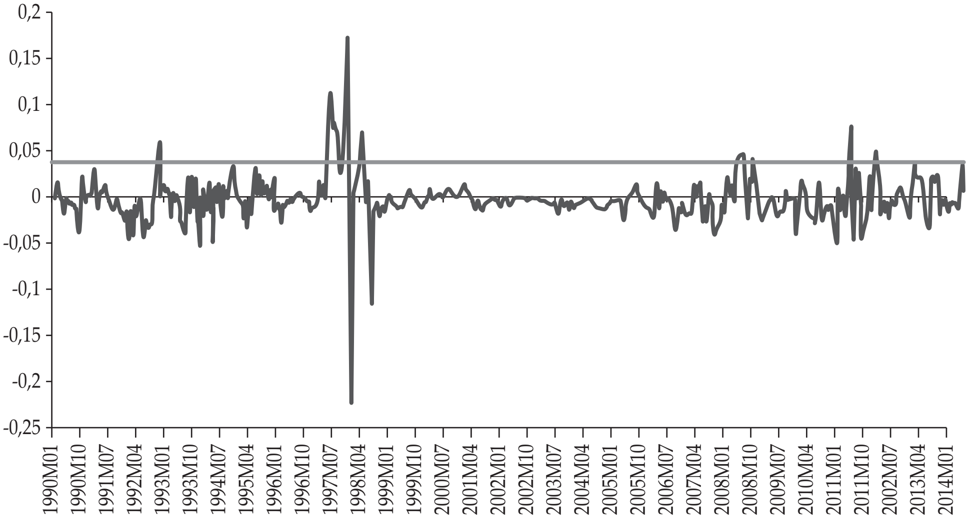
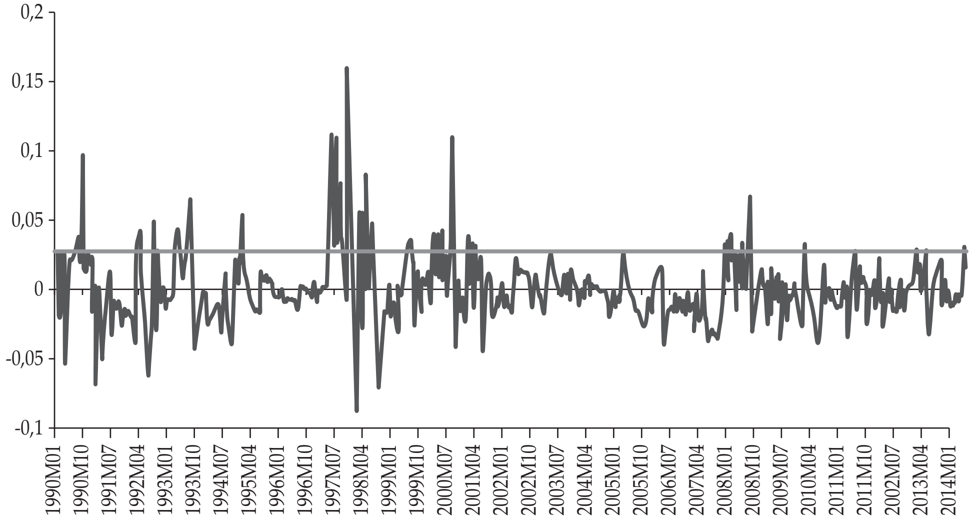


Figure 4, which illustrates extremely high pressure in the Philippines, revealed six episodes between 1991 and 1993, 16 between 1997 and 2000, and three in 2008. The Philippines encountered an economic slowdown and recessions in 1990 and 1991, respectively, owing to debt overhang, monetarist policies, and loss of confidence. The country also experienced a power crisis between 1992 and 1993 (Bautista and Lim, 2006). The crisis episode from 1997 to 2003 and 2008 resulted from the Asian and global financial crises. Based on the EVT outcomes depicted in Figures 1 to 4, the extreme 'tail' observation in Korea, Indonesia, and the Philippines indicated that the aforementioned nations encountered frequent crises with most episodes identified from 1997 to 2008. Notably, the countries were more crisis-prone compared to Malaysia owing to their reformed (flexible) exchange rate regime.

Figure 4.
Exchange Market Pressure and Crisis Episodes in the Philippines

This figure shows monthly estimates of EMP for Philippines over the period 1993:01 to 2014:10. Positive value of EMP indices indicates a depreciation of domestic currency. The horizontal line above the horizontal axis is considered as the threshold of crisis episode. Any EMP observations greater han the threshold are considered as crisis episodes.



B. Estimation Results for Crisis and Currency Crisis Determinants

Table 2 demonstrates the logit estimation outcomes of five distinctive models for Indonesia, Korea, Malaysia, and the Philippines.[17] Model specifications (1) to (5) examine possible functional forms between crisis and individual explanatory variables apart from robustness-checking.[18] Model (1) constitutes all explanatory variables, macroeconomic fundamentals (GDP growth, inflation rate, M2 to reserves and current account to GDP), the degree of integration (trade openness and financial openness) and contagion effects (trade linkage and financial linkage) while Model (2) entails macroeconomic fundamentals and degree of integration variables albeit excluding contagion effects. Meanwhile, Model (3) encompasses macroeconomic fundamental and contagion effect variables while Model (4) solely includes macroeconomic fundamental variables. Lastly, Model (5) comprises all the significant explanatory variables from Models (1) to (4). The McFadden R -squared analysis concludes a good fit for all the models excluding Models (1) and (2) in the case of Malaysia (see Table 1). Contrarily, the AIC (lowest AIC) implies the preferability of Models (1) and (5) for Indonesia while Model (5) is preferable for Korea, Malaysia, and the Philippines. As such, Model (5) is selected for this study to make inferences.

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17 The monthly frequency of extreme value episodes was transformed to a quarterly basis since most of the explanatory variables were only available at the quarterly and annual frequency.

18 Robust covariance and Huber/White were selected to ensure that the standard error estimates were robust to heteroscedasticity and misspecification of the correlation between groups. The McFadden R-squared for the value between 0.2 and 0.4 suggested that there was a very good fit of the models (Domencich and McFadden, 1975). In addition, the Akaike Info Criterion (AIC) was also applied to determine the model that best fit the data (Gunsel *et al*., 2010).

Following the Model (5) outcomes, economic fundamentals are inextricably linked to the currency crisis and complements the first-generation models of speculative attacks. Current account balance to GDP and government budget balance to GDP can significantly instigates potential currency crises. Past study outcomes conceded to this notion as current account and fiscal incongruencies could justify crises and the possibility of occurrence (Feridun, 2008; Haile and Pozo, 2008; Gunsel *et al*., 2010, Hegerty, 2010; Rose, 2015). Currency crises rely on authorities' capacity to sustain fiscal balance. The logit estimation outcomes derived from Models (1), (2), and (3) for the Philipinnes discloses that GDP growth substantially increases the probability of currency crises, thus suggesting that the Philippines, which experienced notable and steady GDP growth, should exercise caution concerning the risk of such 'prosperity'.

The logit estimation findings disclose that a high degree of trade integration can escalates crisis vulnerability in all four countries except Malaysia. Additionally, a high degree of trade openness amplified the shock effects on the economy. The outcomes for trade linkage proves to be constantly significant in the four aforementioned nations, thus implying the currency crisis contagion among primary trade partners or competitors. Gunsel *et al*. (2010), and Nezky (2013) asserts that the devaluation in one country frequently causes other counterparts to bear the economic repercussions following trade spillovers and high trade deficit, subsequently exerting depreciation pressure on its currency to avoid loss through their competitiveness. Regardless, GDP growth is found to be insignificant in Models (4) and (5).

Financial integration does not relate to crisis (excluding Korea) in line with, Haile and Pozo (2008), and Gimet (2011). Specific works (Neaime, 2012; Rose, 2015) contended that financial linkage could be disregarded in recent crisis transmission as national economic sectors may not be wholly developed following the low internationalisation level. Unsurprisingly, financial linkage proved to be significant in South Korea. The Korean financial system is highly established and globally connected in Asia based on the IMF Financial System Stability Assessment (FSSA). The negative sign of financial linkage for Korea denoted that high financial linkage through common bank lenders led to a low probability of crisis vulnerability. The study outcomes highlighted the limited role of common bank lenders in the contagious spread of a crisis given the sole inclusion of the financial sector link through a common bank lender. Potential scholars could examine this drawback and the multitude of financial sector mechanisms.

Table 2.
Logit Estimation of Determinants of Currency Crises

The table reports the logit estimation of determination of currency crises. Model specification (1) to (5) examined possible functional forms between crisis and individual explanatory variables. a, b and c denote significance at 1 percent, 5 percent and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
Indonesia					
Constant	-7.5832[a]	-10.695[a]	-2.0278	-4.541[a]	-5.041[b]
Inflation	-0.2099	-0.1326	-0.0328	0.1218	-
GDP growth	0.1009	0.0879	0.0838	0.0574	-
Budget deficit	-1.043[b]	-1.028[a]	-1.251[a]	-1.163[a]	-1.054[a]
Current account to GDP	-21.3212	-19.0874	-7.1852	-2.2968	-
M2 to reserve	-0.2688	0.3967	-0.2525	0.5891[c]	-0.0191
Trade Openness	11.259[b]	13.223[b]	-	-	5.0392
Financial Openness	3.5829	4.6311	-	-	-
Trade Linkage	8.2354[c]	-	9.7230[b]	-	7.1157[b]
Financial Linkage	-0.7802	-	-0.1489	-	-
McFadden *R*-Squared	0.3393	0.2969	0.2936	0.2251	0.2973
Akaike Info criterion	1.0871	1.0954	1.099	1.1418	1.0203
Korea					
Constant	-8.157[a]	-8.929[a]	-5.083[a]	-5.215[a]	-7.386[a]
Inflation	0.3561	0.4662	0.5344	0.5794	-
GDP growth	-0.0360	-0.0473	-0.0703	-0.0719	-
Budget deficit	1.3598[a]	1.2734[a]	1.0767[a]	1.0113[a]	1.2550[a]
Current account to GDP	74.077[a]	61.524[a]	74.097[a]	63.941[a]	70.196[a]
M2 to reserves	0.0334	0.3161	0.1745	0.3057	-
Trade Openness	7.4507[b]	6.0788[c]	-	-	5.7057[b]
Financial Openness	-51.305	-16.043	-	-	-
Trade Linkage	7.8437[b]	-	6.5124[b]	-	7.6657[c]
Financial Linkage	-1.8855[c]	-	-1.6830[c]	-	-1.8247
McFadden *R*-Squared	0.3933	0.3677	0.3459	0.3214	0.3726
Akaike Info Criterion	0.9517	0.9414	0.9681	0.9565	0.8937
Malaysia					
Constant	13.199[b]	14.010[b]	-5.573[a]	-5.388[a]	10.9656[b]
Inflation	0.5762	0.3556	0.3566	0.2213	-
GDP growth	0.0252	0.0506	-0.0877	-0.0528	-
Budget deficit	0.3554	0.9991[b]	-0.5093	0.3184[c]	0.4209
Current account to GDP	26.253[b]	39.186[a]	4.9695	14.580[b]	27.019[b]
M2 to reserves	0.5064	1.2406[b]	0.1939	0.9707[a]	0.6785
Trade Openness	-11.95[a]	-12.96[a]	-	-	-10.90[a]
Financial Openness	-10.181	-9.6108	-	-	-
Trade Linkage	6.5545[c]	-	10.012[b]	-	6.4833
Financial Linkage	1.7341	-	2.3167	-	-
McFadden *R*-Squared	0.4243	0.4285	0.2592	0.2062	0.4009
Akaike Info Criterion	0.6864	0.6719	0.7774	0.8245	0.6287

Table 2.
Logit Estimation of Determinants of Currency Crises (Continued)

	(1)	(2)	(3)	(4)	(5)
			Philippines		
Constant	-3.3852	-6.876[a]	-2.8273	-6.102[b]	-5.318[a]
Inflation	0.4339	0.5212	0.3352	03939	-
GDP growth	0.0818[c]	0.0687[c]	0.0608[c]	0.0415	0.0455
Budget deficit	0.3142	0.3498	-0.3987	-0.3479	-
Current account to GDP	-12.7453	-4.2864	-14.3616	-1.4560	-
M2 to reserve	-1.0398	0.1790	-0.3121	0.9665	-
Trade Openness	5.8786[c]	6.1278[b]	-	-	4.2486[b]
Financial Openness	-5.1078	-3.4510	-	-	-
Trade Linkage	8.6627[b]	-	9.2054[a]	-	5.9256[a]
Financial Linkage	-1.9412	-	-2.6047	-	-
McFadden R-Squared	0.2745	0.1931	0.2198	0.1224	0.2291
Akaike Info Criterion	0.9297	0.9613	0.9357	0.9828	0.8338

IV. CONCLUSION

Past research indicated multiple financial crisis episodes that have continued increasing since the 1990s. The frequent occurrence of currency crises has garnered scholars' and policymakers' attention to examine potential crisis determinants. The current study emphasised crisis factors with a thorough investigation of the role of economic fundamentals amidst crises and their transmission channels. The EMP index functioned as a crisis indicator to determine the presence of speculative attacks on the currency. Central banks could promptly address potential crises through exchange rate management tools, including exchange rate market and capital control intervention. Based on the EVT outcomes, countries encountered frequent crisis episodes when the currency pressure fluctuated with the implementation of highly flexible exchange rate arrangements. Thus, a floating currency resulted in high volatility risks.

Concrete evidence following the logit findings demonstrated the inconsistency between macroeconomic fundamentals in terms of a large budget deficit and current account balance to GDP and the possibility of a currency crisis. Relevant policies must be developed to support the macroeconomic balance and prevent currency crises given the insufficiency of optimal and resilient macroeconomic fundamentals to insulate economies from crises. The findings also denoted the essentiality of monitoring variable development by policymakers to minimise depreciation pressure on the respective currencies. Economic crisis vulnerability was primarily caused by deeper global integration where crises are contagious through trade linkage. Summarily, countries should exercise caution in pursuing external liberalisation and market deregulation with efficient regional monitoring and the coordination of integration.

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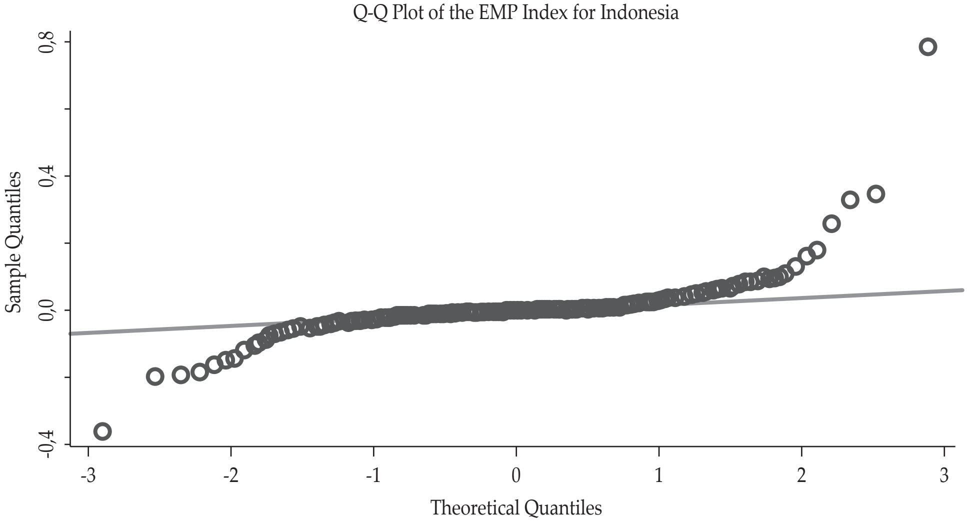
APPENDIX

Figure A.1.
Normal Q-Q Plots

This figure shows the normall Q-Q plots of the EMP series for Indonesia, Korea, Malaysia and Philippines.Since the point curves were away from the line at each end and they curve in opposite direction, EMP series for all four countries were not normally distributed and fat- tailed.



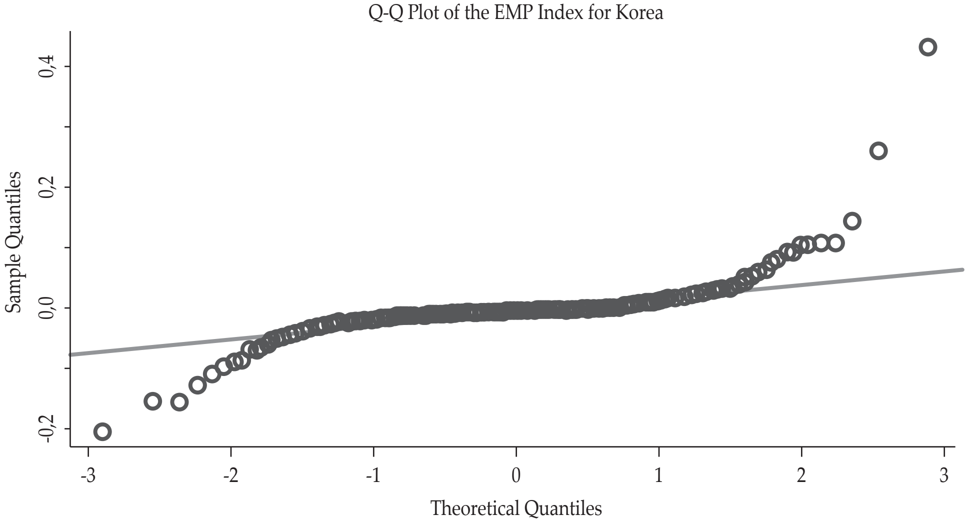
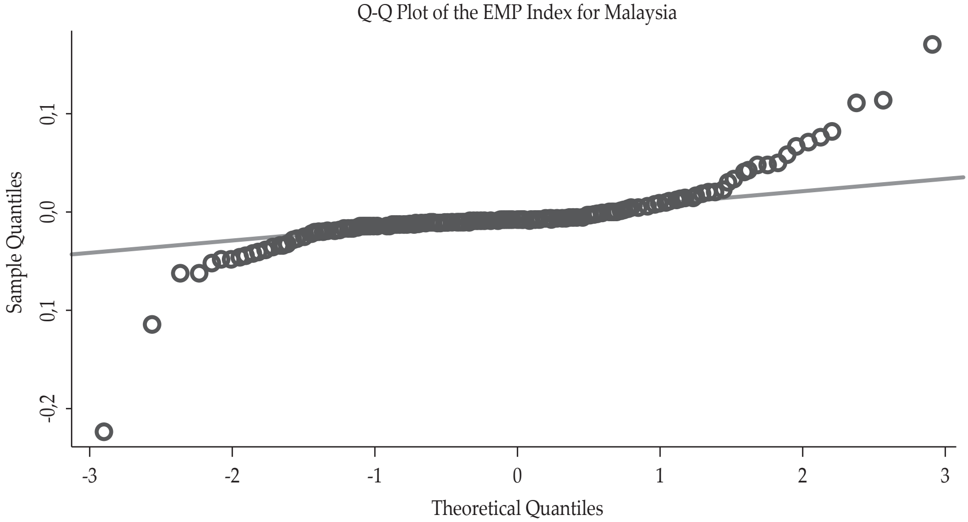


Figure A.1.
Normal Q-Q Plots (Continued)



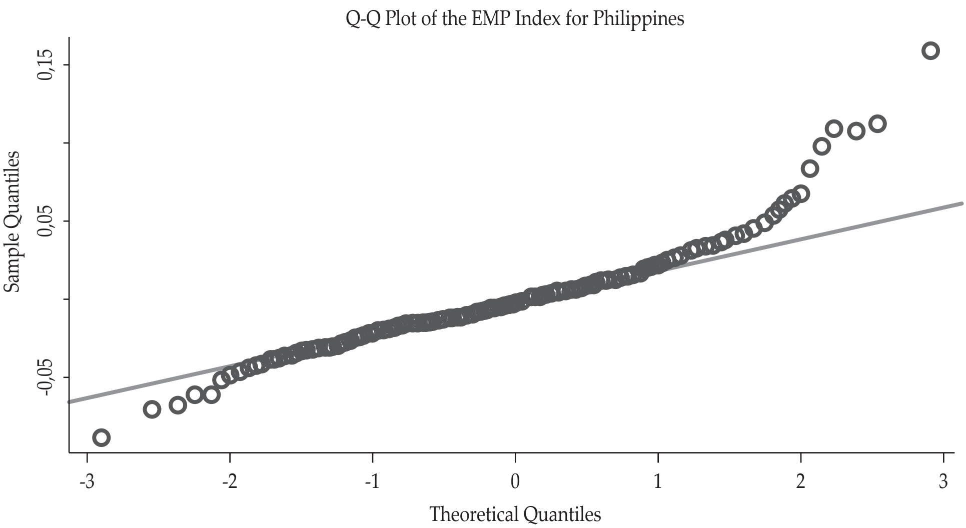


Table A.1.
Shapiro-Wilk Normality Test

This table reports the Shapiro-Wilk test statistic of EMP series for Indonesia, Korea, Malaysia and Philippines. Shapiro-Wilk test statistic is $W = \frac{\left(\sum_{i=1}^{n} a_{xi} x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i-\bar{x})^2}$, where x_i is ith order statistic, $\bar{x}$ is the sample mean, and $a_i = \frac{m^T V^{-1}}{(m^T V^{-1} V^{-1} m)^{1/2}}$ where m is expected values of the order statistic of independent and identically distributed random variables sampled from standard normal distribution, V is the covariance matrix of those order statistics.The null hypothesis of Shapiro-Will test is that the population is normally distributed. The * denote statistical significance at the 1% levels

	Indonesia	Korea	Malaysia	Philippines
W	0.5938	0.6695	0.8630	0.9179
p-value	0.0000*	0.0000*	0.0000*	0.0000*

The main objective of Monte Carlo exercise is to get optimal number of exchange market pressure, m** and define all the observations corresponding to the m** largest observations as periods of crisis. Through Monte Carlo Simulation exercise, the MSE of simulated optimal numbers of exceedances is computed and choose the optimum cutoff value with minimum MSE. The MSE of an estimator, $\hat{X}$ is

$$MSE(\hat{\vartheta}) = E[(\hat{X} - X)^2] = [E(\hat{X} - X)]^2 + Var(X)$$

where $\hat{X}$ represents the mean of S simulated observations. MSE combines both bias and inefficiency to capture the tradeoff elements. The first part of the decomposition measures the bias and the second part measures the inefficiency.

Monte Carlo simulations can be decompose in five steps (Longin and Solnik (2001) and Haile and Pozo (2008):

1. Simulate S time series containing n observations from student-t distributions with α degree of freedom, the α ranging from 1 to K. Simulation α is allowed to take values from 1 to 10 with increment of 0.1 and number of replications (S) equals 1000.
2. For different number of m of the extreme EMPs, a tail index $\gamma_s^h(m, \alpha)$ corresponding to the sth replication from the Student's t with α degrees of freedom is estimated.[19] Values of m can vary from 1% to 20% of n, where n is the sample size of the actual EMP data.
3. For a student-t distribution with k degrees of freedom and for each number n of extreme EMPs, MSE of the S tail index estimates, denoted by $(MSE((\xi_s(n,k))_{s=1,S})$ is computed.[20] The optimal m, denoted by m*(α), which minimizes MSE for the particular Student's t distribution with α degrees of freedom is selected. Optimum values of m* for different Student's t distributions are repeatedly selected.

[19] According to Blattberg and Gonedes (1974), the distribution with greater kurtosis (fatter tails) were adequately characterized by student (or t) distribution.

[20] As explained by Jansen and de Vries (1991), there is a U-shaped relation between $(MSE((\xi_s(n,k))_{s=1,S})$ and n, which expresses the trade-off between bias and inefficiency. For high values of n, the inclusion of many observations such that some do not belong to that tail but rather to the center of the distribution makes the bias part of the MSE dominate the inefficiency part. On the other hand, for low values of n, the inclusion of few observations makes the inefficiency part of the MSE dominate the bias part as the tail index is badly estimated.

4. Using each of K optimum values of m that are obtained in last step, the Hill index, $\gamma_s^h(m,\alpha)$ is estimated from actual EMP series. For all α from 1 to 10, the tail indices, γ^h, are estimated from actual EMP series.
5. Finally, we select one single number (m**) from the K optimum tail indices, m* for each EMP series such that the estimated tail index from the actual data is statistically the closet to the corresponding tail index of theoretical distribution.

Table A.2.
Crisis Observations in Indonesia Using EVT

This table reported the extreme 'tail'observations detected for Indonesia.

Monthly	1997M07	1997M08	1997M09	1997M10	1997M12	1998M01	1998M05
Quarterly		1997Q3		1997Q4		1998Q1	1998Q2
Monthly	1998M06	1998M12	1999M01	1999M08	1999M09	1999M11	2000M01
Quarterly	1998Q2	1998Q4	1999Q1	1999Q3		1999Q4	2000Q1
Monthly	2000M04	2000M05	2000M09	2000M10	2001M02	2001M03	2001M04
Quarterly	2000Q2		2000Q3		2000Q4	2001Q1	2001Q2
Monthly	2001M09	2001M10	2004M05	2005M08	2006M05	2008M10	2008M11
Quarterly	2001Q3	2001Q4	2004Q2	2005Q3	2006Q2	2008Q4	
Monthly	2009M02	2011M11	2012M05	2013M07	2013M08	2013M09	2013M11
Quarterly	2009Q1	2011Q4	2012Q2	2013Q3	2013Q3		2013Q4
Monthly	2014M09						
Quarterly	2014Q3						

Table A.3.
Crisis Observations in Korea using EVT

This table reported the extreme 'tail'observations detected for Korea

Monthly	1990M12	1991M03	1991M08	1992M06	1993M12	1996M06	1996M08
Quarterly	1990Q4	1991Q1	1991Q3	1992Q2	1993Q4	1996Q2	1996Q3
Monthly	1997M01	1997M03	1997M08	1997M09	1997M10	1997M11	1997M12
Quarterly	1997Q1		1997Q3			1997Q4	
Monthly	1998M02	1998M05	1998M08	1999M02	1999M07	1999M09	2000M10
Quarterly	1998Q1	1998Q2	1998Q3	1999Q1	1999Q3		2000Q4
Monthly	2000M11	2000M12	2001M03	2001M09	2001M12	2002M09	2003M03
Quarterly	2000Q4		2001Q1	2001Q3	2001Q4	2002Q3	2003Q1
Monthly	2003M10	2004M04	2007M08	2007M11	2008M03	2008M05	2008M08
Quarterly	2003Q4	2004Q2	2007Q3	2007Q4	2008Q1	2008Q2	2008Q3
Monthly	2008M09	2008M10	2008M11	2009M01	2009M02	2010M05	2010M11
Quarterly	2008Q3	2008Q4		2009Q1		2010Q2	2010Q4
Monthly	2011M09	2011M11	2012M05	2013M03	2013M05	2014M09	
Quarterly	2011Q3	2011Q4	2012Q2	2013Q1	2013Q2	2014Q3	

Table A.4.
Crisis Observations in Malaysia using EVT

This table reported the extreme ‘tail’observations detected for Malaysia

<table>
<tr><td>Monthly</td><td>1992M12</td><td>1997M07</td><td>1997M08</td><td>1997M09</td><td>1997M10</td><td>1997M12</td><td>1998M01</td></tr>
<tr><td>Quarterly</td><td>1992Q4</td><td colspan="3">1997Q3</td><td colspan="2">1997Q4</td><td>1998Q1</td></tr>
<tr><td>Monthly</td><td>1998M05</td><td>1998M06</td><td>2008M08</td><td>2008M09</td><td>2008M10</td><td>2009M01</td><td>2011M09</td></tr>
<tr><td>Quarterly</td><td colspan="2">1998Q2</td><td colspan="2">2008Q3</td><td>2008Q4</td><td>2009Q1</td><td>2011Q3</td></tr>
<tr><td>Monthly</td><td>2012M05</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Quarterly</td><td>2012Q2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Table A.5.
Crisis Observations in the Philippines using EVT

This table reported the extreme ‘tail’observations detected for the Philippines.

<table>
<tr><td>Monthly</td><td>1990M04</td><td>1990M08</td><td>1990M09</td><td>1990M11</td><td>1992M04</td><td>1992M05</td><td>1992M09</td></tr>
<tr><td>Quarterly</td><td>1990Q2</td><td colspan="2">1990Q3</td><td>1990Q4</td><td colspan="2">1992Q2</td><td>1992Q3</td></tr>
<tr><td>Monthly</td><td>1993M04</td><td>1993M05</td><td>1993M09</td><td>1995M02</td><td>1997M07</td><td>1997M08</td><td>1997M09</td></tr>
<tr><td>Quarterly</td><td colspan="2">1993Q2</td><td>1992Q3</td><td>1995Q1</td><td colspan="3">1997Q3</td></tr>
<tr><td>Monthly</td><td>1997M10</td><td>1997M12</td><td>1998M01</td><td>1998M04</td><td>1998M06</td><td>1998M08</td><td>1999M08</td></tr>
<tr><td>Quarterly</td><td colspan="2">1997Q4</td><td>1998Q1</td><td colspan="2">1998Q2</td><td>1998Q3</td><td>1999Q3</td></tr>
<tr><td>Monthly</td><td>1999M09</td><td>2000M05</td><td>2000M07</td><td>2000M09</td><td>2000M10</td><td>2001M04</td><td>2001M06</td></tr>
<tr><td>Quarterly</td><td>1999Q3</td><td>2000Q2</td><td colspan="2">2000Q3</td><td>2000Q4</td><td colspan="2">2001Q2</td></tr>
<tr><td>Monthly</td><td>2008M03</td><td>2008M05</td><td>2008M08</td><td>2008M10</td><td>2010M05</td><td>2013M05</td><td>2013M08</td></tr>
<tr><td>Quarterly</td><td>2008Q1</td><td>2008Q2</td><td>2008Q3</td><td>2008Q4</td><td>2010Q2</td><td>2013Q2</td><td>2013Q3</td></tr>
<tr><td>Monthly</td><td>2014M09</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Quarterly</td><td>2014Q3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>