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STOCK MARKET PERFORMANCE: FORETELLING AND CRISIS SIGNALLING?

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Abstract

Based on our empirical results, using the Extreme Value theory, we conclude that stock market performance, particularly in times of vulnerabilities, does contain some information which may signal an impending crisis. This signal can be within the same month up to between 1- 3 months ahead. We are, however, not arguing that policymakers must take into account asset prices in their policy decisions. On the contrary, we argue that policymakers may want to be proactive and react accordingly to lessen the likelihood and impact of potential crisis in the making.

Keywords: Extreme Value Theory, Financial Crisis, Stock Markets, Crisis Signalling

JEL Classification: G01, G15

STOCK MARKET PERFORMANCE: FORETELLING AND CRISIS SIGNALLING?

1. Introduction

There have been many studies on the performance of stock markets during normal times and during crises periods. For example, the impact of financial crises on the volatility of the stock markets (Schwert, 2011; Singhania and Anchalia, 2013). In the SEACEN economies, there are, however, not many studies on whether stock market performance is useful in signalling impeding financial crises. This paper, thus, intends to study the behaviour of stock markets in selected SEACEN economies to see whether it contains enough information to be identified with financial crises. This is done by comparing the epoch of financial "crises" as indicated by Extreme Values (EV) of the Exchange Market Pressure Index (EMP) with that of EV of the stock market returns. Stock market contagion is also investigated. While the study does provide some information on how stock markets behave around the normal and period of crises, it is not intended to inform on whether financial crises are the root cause of stock market turmoil or vice-versa.

2. Literature Review

It is generally agreed that most stock markets of SEACEN economies, like those of most emerging economies, have one time or other experienced large swings in stock prices. This disparate behaviour of stock prices has generated perturbing concerns for policy makers, central bankers included, concerning asset price bubbles. However, it is clear from the many studies of the stock markets that most of the time, the root cause of financial crises did not stem from the stock markets. Rather, empirical evidence seems to indicate that excessive volatility and shifts in stock prices were due to financial crises (Dwyer, 2009). This is not surprising given that stock market is often the very first to react to market news.

While there are not many studies on how stock market performance may inform financial crises, the cross-border transmission of stock market shocks, similar to crises contagion is well documented. Evidence is, however, inconclusive. Rijckeghem and Weder (1999) argue that the contagion effects have become more intensified recently through increasingly financial market linkages. For the Asian stock markets, Arshanapalli et al. (1995) found strong links with the US markets for post-October 1987. On the other hand, using multivariate Extreme Value Theory, Bekiros and Georgoutsos (2008) note that on the basis of extreme correlation (during financial crisis), Asia-Pacific equity markets do not belong to a distinct block of countries. In other words, there is no strong correlation. Others have found asymmetric relationship between the stock markets during different stages of crises. In the context of the subprime crisis, in a study of how economic news in the US affect emerging economies, Dooley and Hutchison (2009) found evidence for the decoupling–recoupling hypothesis. They found that in the early stages of the subprime crisis, emerging markets in general appeared to be largely insulated and decoupled but at the later stage, they face strong recoupling with the international financial system.

3. Methodology

Six active SEACEN stock markets, namely those of Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand are studied. All data from January 1999 to December 2013 are sourced from the Financial Statistics of the IMF. To identify 'crises' episodes, the Extreme Value Theory (EVT) is used to identify EV by empirically analysing the Exchange Market Pressure index (EMP) (see Appendix A). The findings of Siregar, Pontines and Nurulhuda (2012) indicate that the extreme values of EMP is able to track financial crises reasonably well. The stock market returns are also subject to the same methodology.[2] The dates for which the EV occur for both series are identified and then compared.

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2. Calculated as a percentage change over the 12 month corresponding period.

4. Identifying Extreme Values[3]

The conventional approach employed in the literature is that an Extreme Market Pressure is identified when a particular index exceeds some upper bound:

$$\text{Extreme Value} = \begin{cases} 1 & \text{if Index}_{i,t} > \beta\sigma_{index} + \mu_{\text{index}} \\ 0 & \text{otherwise} \end{cases} \qquad (1)$$

where: σ_{index} equals the sample standard deviation of the Index and μ_{index} is the sample mean of the Index. As noted, an Extreme Market Pressure is identified if the Index crosses a threshold, defined in terms of an arbitrary multiple of standard deviations above the mean. The problem with this threshold is that it conveniently assumes that the Index is characterised by a well-behaved standard normal probability density function. However, the normality assumption is at odds with the substantial literature that characterises the statistical probability distribution function of financial asset returns, which describe such series as being fat-tailed. As an alternative, Pozo and Dorantes (2003), Lestano and Jacobs (2007) and Pontines (2010) suggest for the use of the Extreme Value Theory in exploiting information in the tails of the distribution by locating the threshold that separates the normal values of the Index (corresponds to normal periods) from that of extreme values of the Index (corresponds to extreme pressure periods) without the need to set an arbitrary threshold value for the Index.

The estimation of the parameter (α), the tail index of the distribution of the Index is crucial as it determines the degree of tail fatness the distribution exhibits. The tail index measures the speed at which the distribution's tail approaches zero - the higher (α), the faster the speed and the less fat-tailed the distribution. In addition, the tail index (α) has the attractive feature that it is equal to the maximum number of existing finite moments in the distribution. Unfortunately, the estimation of the tail index is not a simple task, although there are a few available

3. This section is based on Siregar, Pontines and Nurulhuda (2012).

estimators in the literature. The most common of these is the Hill (1975) estimator, which is given as:

$$\gamma(k) = \frac{1}{k}\sum_{j=1}^{k}\ln(x(n-j+1)-\ln(x(n-k)) \quad (2)$$

We assume that there is a sample of n positive independent observations drawn from some unknown fat-tailed distribution. Letting the parameter (γ) be the inverse of the tail index (α), and $x(i)$ be the th-order statistic such that $x(i-1) \leq x(i)$ for $i = 2,\ldots, n$. k is the pre-specified number of tail observations. The choice of k is crucial to obtain an unbiased estimate of the tail index. The intuition behind this critical choice of k is that there is an uncomfortable variance and bias trade-off. If we employ a k that is too small, we are not using all of the tail observations, and would thus obtain an estimate of the tail index with a large variance. In contrast, if we employ a k that is large, we bias the estimate of the tail index by including observations in the sample from the centre of the distribution.

In an important paper, Huisman et al. (2001) introduces an estimator that overcomes the need to select a 'single' optimal k in small samples, by accounting for the bias in the Hill estimator. They showed that for values of κ smaller than some threshold k, the bias of the Hill estimate of γ increases almost linearly in k and can be approximated by:

$$\gamma(k) = \beta_0 + \beta_1 k + \varepsilon(k), \quad k = 1,2, \ldots \kappa \quad (3)$$

The above equation has to be estimated by weighted least squares (WLS) to deal with the heteroscedasticity in the error term $\varepsilon(k)$. The weight has $(\sqrt{1}, \sqrt{2}, \ldots, \sqrt{k})$ as diagonal elements and zeros elsewhere. The bias corrected estimate of γ is the intercept β_0 and the estimate of the optimal tail index α would be given by $\hat{\alpha} = 1/\beta_0$.

5. Findings

A visual inspection (see Graph 1 in Appendix B) shows that the EMP is closely correlated to stock market returns for all economies. As a rise in the EMP reflects strong selling pressure on the domestic currency and a negative index implies the opposite, it does appear that selling pressure is closely associated with negative return and vice versa for the sample estimated. In addition, judging from the correlation between EMP and stock market returns and among the stock market returns themselves, two conclusions are observed.

Firstly, the EV of EMP is able to capture significant events, including the 2008 financial crises. This study, using extended sample, concurred with the findings of Siregar, Pontines and Nurulhuda (2012). In addition to the global financial crisis, the Extreme Value Approach is able to capture the effect of the information technology (IT) sector slump in the US in early 2000 to mid-2001, the collapse in 2001 of Argentina's convertibility plan as well as some of the domestic political uncertainties in Indonesia in the aftermath of the 1997-98 Asian Crisis until mid-2002 and the late-2000 impeachment of former President Joseph Estrada in the Philippines. It is also able to capture the events in Eurozone area such as concerns over the Greek sovereign debt crisis and concern about the solvency of the Eurozone during 2011-2012.

Secondly, the association between the EV of EMP and stock market returns and that of the EV of stock market returns themselves become much stronger during the 2008 global financial crisis (see Table 1) as compared to the entire sample (1999.1-2013.12). This shows that the relationships are asymmetric across the two periods, indicating that the stock market returns appear to behave in a much similar fashion during period of crises.

Table 1
Cross-Border Correlations of Stock Market Returns
(Full Sample and Post-global Crisis)

	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
Indonesia	1.00 (1.00)					
Korea	0.53 (0.79)	1.00 (1.00)				
Malaysia	0.57 (0.76)	0.40 (0.66)	1.00 (1.00)			
Philippines	0.64 (0.67)	0.49 (0.62)	0.40 (0.59)	1.00 (1.00)		
Singapore	0.67 (0.72)	0.68 (0.80)	0.56 (0.74)	0.63 (0.74)	1.00 (1.00)	
Thailand	0.65 (0.84)	0.63 (0.69)	0.52 (0.66)	0.62 (0.72)	0.68 (0.79)	1.00 (1.00

Figures in parentheses refers to post-global crisis of sample size from 1998.8-2013.12.

Table 2 shows the episodes of occurrence of EV of both the stock market returns and the EMP. The Extreme Value Theory, in particular the Hill Estimator, requires the use of stationary and uncorrelated data. The ADF unit-root tests as well as from the alternative Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit-root tests confirm that both the EMP and the stock market returns are stationary *I(0)* for all economies (See Appendix C).

Table 2: Episodes of Occurrence of Extreme Values

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Indonesia	***EMP***	Sep	May	Feb			May	Jul	Jun		Oct		May	Sep	May	Jun
	Stock Market Returns	Jul	Feb, Sep	Sep	Jul			Aug	May		Mar, Oct			Jan, Sep	May	Aug
Korea	***EMP***										Aug		May	Sep		
	Stock Market returns	Feb, Sep	Apr	Feb, Sep	Apr, Dec	Sep	May	Mar, Oct	May	Jan, Nov	Jun	Feb, Oct	May	Feb, Sep	May	Jun
Malaysia	***EMP***			Mar				Dec			Aug		May	Sep	May	Jun
	Stock Market returns	Feb, Sep	Apr, Dec	Sep	May	Nov				Aug	Mar, Sep		May	Aug		
Philippines	***EMP***	Aug	Feb, Sep	Apr	Jul	Feb	Jan				Mar, Oct		May	Sep	May	May
	Stock market Returns	Aug	May	Mar, Oct	Jun						Jan, Oct		Nov	Sep		Jun
Singapore	***EMP***	Feb	Feb	Mar, Dec	Sep		Apr	Jan, Sep			Aug		May	Sep	May	May
	Stock Market Returns		Jan, Sep		Jun				May	Nov	Jun	Feb	May	Aug	May	Aug
Thailand	***EMP***	Sep	Jul	Mar				Mar			Jun			Sep	May	Jun
	Stock Market Returns	Jul	Feb, Sep	Jul	Sep		Jan	Mar	May	Nov	Jun			Jan, Sep	May	Jun

Given that there were more occurrence of EV in the stock market returns (this is expected given the volatility of the stock market returns), it is noted that EV of the stock market market returns are not always associated with extreme values of EMP. Logically, this indicates in all sense, provided that there is causation, EV of EMP does not always cause all of EV of stock market returns. Table 3 indicates the probability of EV of stock market returns associated with that of the EV of EMP, calculated as a ratio of number of occurrence of EV of stock market returns with that of EV of EMP over the total number of episodes of EV of stock market returns.

Table 3
Probability of Extreme Values of Stock Market Returns Associated with the Extreme Values of Exchange Pressure Index (EMP) */

Across Economies	Pre-global Crisis	Post-global Crisis
0 months	4.2%	44%
1-3 months	12.5%	12%
Within 3 months	16.7%	56%

Calculated as the ratio, in percent the number of occurrence of EV of stock market returns with that of the EV of EMP over the total number of episodes of EV of stock market returns. Pre-global crisis: 1999-2007, Post-global crisis, 2008-2013. In both periods, the total number of episodes of EV of stock returns >= the total number of episodes of EV of EMP.
*/ 0 = occurrence with the same month, 1-3 = EV of stock market returns precedes the EV of EMP within 1- 3 months.

From the Table above, it is noted that post-global crisis, there is a 44% chance of EV of the stock market returns occurring in the same month as EV of EMP compared to just 4.2% in the pre-global crisis period. This ratio increases to 56% when the window period is within 3 months as compared to 16.7% for the pre-global crisis period. Individually, for this window period, for some economies such as the Philippines and Thailand, this ratio is as high as 67-80%. However, a caveat worth considering is that given that we do not have daily data, if the occurrence is within the same month, it cannot be confirmed which series is the leading indicator. In this respect, the Granger Causality Test is done. From the results, it strongly indicates post-global crisis, the stock market returns Granger-cause the EMP but not the other way around (see Table 4).

Table 4
Granger Causality Tests

	EMP-> Returns		Stock market Returns -> EMP	
	6 lags	**3 lags**	**6 lags**	**3 lags**
Indonesia	0.63	0.76	1.72*m	3.33***
Korea	1.41	3.56**	5.94***	5.56***
Malaysia	0.73	1.05	1.74*m	2.03*m
Philippines	1.33	1.54	2.43**	1.00
Singapore	2.63**	0.30	2.00**	2.50**
Thailand	1.48	1.95	2.64**	5.47***

Post-global crisis (2008.8-2013.12). Null Hypothesis: X does not cause Y. *, ** and *** indicate rejection of the null hypothesis at 10, 5 and 1% respectively. *m indicates marginally significant at 10%.

6. Policy Implications

Based on the results, we can conclude that stock market performance does contain some useful information which may signal an impending crisis in the EMP. The signals can be any time within the same month or between 1- 3 months ahead. It is noted that the signals are asymmetric and significantly stronger during period of vulnerabilities. It is also during this period that the stock market returns tend to be more correlated than normal times.[4] In this sense, stock market performance can provide useful signals within a sufficient lead time for policy makers to act accordingly to lessen the likelihood or perhaps the impact of the impeding financial crises. Also, it may be worthwhile for policymakers to spend more time in identifying asset price bubbles.

Having said that, as far as central bankers are concerned, the general consensus regarding stock market performance is that unless they know the exact cause of stock price fluctuation, they should not intervene nor direct their policies to target these prices. Stock price movements are inherently much affected by non-fundamental economic elements such as psychological factors. However, what we are arguing here is not whether central bankers should take into account prices explicitly when setting monetary policies. On the contrary, we are certain that in times of vulnerabilities in particular, policy makers, central bankers included, could improve their effectiveness - lessen the likelihood of economic instability - by taking stock market performance into consideration.

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4. But this could also mean that the markets have become more integrated and regionalised in recent times. The degree of correlation has been influenced heavily by the degree of financial integration. For example, as Chowdhury (2004) find that in countries where there are restrictions on cross-country investing, there is decoupling of the stock markets. Financial integration gives rise to the tendency for prices of financial assets to converge, resulting in the Law of One Price (LOOP) (Marshall, 1947 and Cournot, 1971), that is risk-adjusted returns of identical assets should be comparable across regions and globally. Thus, one would expect a much higher cross-border correlation between the stock markets.

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Appendix A[5]

Exchange Market Pressure Index (EMP)

In this paper, we employ the exchange market pressure index adopted by Eichengreen, Rose and Wyplosz (ERW) (1995, 1996) by taking a weighted average of the changes in exchange rates, international reserves and interest rates. This allows us to completely capture successful as well as unsuccessful currency pressures. More recent constructions of indices such as by Kaminsky et al. (1998), Kaminsky and Reinhart (1999), while following the ERW (1995, 1996) very closely, however, excludes the interest rate differentials in their original construction of the indices. The exchange market pressure index of Eichengreen, Rose, and Wyplosz (ERW) (1995, 1996) uses all three variables of the EMP index relative to a reference country. The US is used as our reference country. The EMP index using this method is expressed as:

$$EMP_{i,t} = \frac{1}{\sigma_e}\frac{\Delta e_{i,t}}{e_{i,t}} - \frac{1}{\sigma_{res}}\left(\frac{\Delta res_{i,t}}{res_{i,t}} - \frac{\Delta res_{US,t}}{res_{US,t}}\right) + \frac{1}{\sigma_i}(i_{i,t} - i_{US,t}) \tag{1}$$

where $EMP_{i,t}$ is the exchange rate market pressure index for country *i* in period *t*; $e_{i,t}$ the units of country *i*'s currency per U.S. dollar in period *t*; σ_e the standard deviation of the relative change in the exchange rate($\frac{\Delta e_{i,t}}{e_{i,t}}$); $res_{i,t}$ the gross foreign reserves of country *i* in period *t*; and σ_{res} is the standard deviation of the difference between the relative changes in foreign reserves in country *i* and the reference country (US)$\left(\frac{\Delta res_{i,t}}{res_{i,t}} - \frac{\Delta res_{US,t}}{res_{US,t}}\right)$; $i_{i,t}$ the nominal interest rate for country *i* in period *t*; $i_{US,t}$ the nominal interest rate for the reference country (U.S.) in period *t*; σ_i the standard deviation of the nominal interest rate differential $(i_{i,t} - i_{US,t})$.

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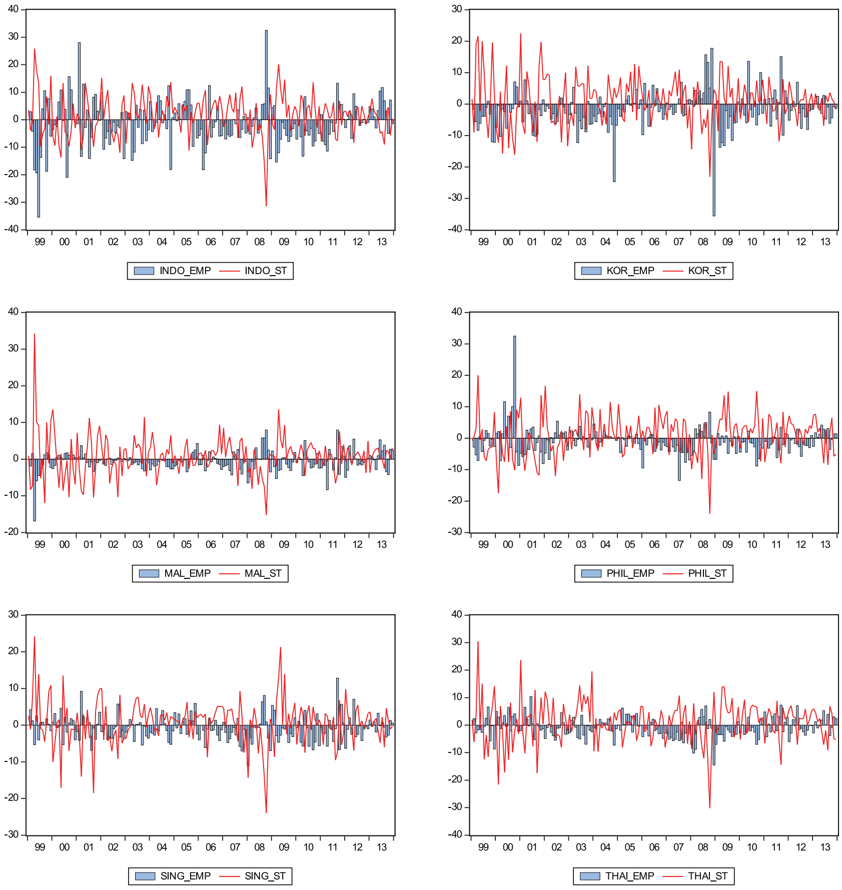
5. This Section is based on Siregar, Pontines and Nurulhuda (2012).

As earlier emphasised, the EMP index increases with a depreciation of the domestic currency, a loss of international reserves and a rise in the domestic interest rate. A rise in the index reflects stronger selling pressure on the domestic currency. Similarly, when the index becomes negative, it signals rising buying pressure on the local economy. In addition, the breakdown of the EMP components may also reveal the policy preferences of the local central bank/monetary authority. Frequent adjustments in the interest rate or/and buying/selling of the foreign exchange reserves could be argued as evidences of 'against (or with) the wind' exchange rate policy of the local central bank.

In order to capture the tail mass or extreme values, the so-called tail index (α) has to be estimated, and as earlier mentioned, we use the Hill estimator for this purpose. The Hill estimator proceeds by ordering the values of the EMP index from lowest to highest denoted by $x(i)$. Although asymptotically unbiased, the Hill estimator is biased in relatively small samples. In accordance with the suggestion of Huisman et al. (2001), to deal with the estimation of the tail index with a small sample size, we use Equation (3) in estimating a weighted least squares (WLS) regression for the EMP index for each individual economy, after computing the γ (inverse of α) for a range of values of k. The essence is to identify the 'extreme right-tail' observations from an ordered distribution of the EMP index as the number and incidence of extreme market pressure episodes that individual countries experienced are determined in the right-tail distribution. Accordingly, Diebold, Schuermann and Stroughhair (2000) suggest, (also similarly employed by Pozo and Dorantes (2003) and Lestano and Jacobs (2007)), that recursive residuals be derived from the weighted least squares regression to diagnose structural changes, which will guide us in the selection of the optimal k.

Appendix B

EMP Index (_EMP) and Stock Market Returns (_ST)



Appendix C

Unit Root Tests

Stock Returns	ADF test without trend	ADF test with trend	KPSS test without trend	KPSS test with trend
Indonesia	-10.64***	-10.62***	0.06	0.06
Korea	-12.46***	-12.44***	0.06	0.03
Malaysia	-11.82***	-11.78***	0.03	0.03
Philippines	-12.19***	-12.26***	0.21	0.07
Singapore	-11.66***	-11.64***	0.09	0.04
Thailand	-12.97***	-12.93***	0.04	0.04

*, ** and *** indicate rejection of the null hypothesis at 10, 5 and 1% respectively.

Unit Root Tests
Full Sample (1999.1-2013.12)

EMP Index	ADF test without trend	ADF test with trend	KPSS test without trend	KPSS test with trend
Indonesia	-11.47***	-11.52***	0.103	0.07
Korea	-11.71***	-11.92***	0.294	0.05
Malaysia	-10.55***	-10.62***	0.151	0.05
Philippines	-10.48***	-10.54***	0.226	0.09
Singapore	-13.43***	-13.44***	0.22	0.10
Thailand	-10.22***	-10.19***	0.22	0.18*

*, ** and *** indicate rejection of the null hypothesis at 10, 5 and 1% respectively.