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How does crisis affect efficiency? An empirical study of East Asian markets

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Abstract

Much research has been undertaken in the Efficient Market Hypothesis (EMH) over the preceding two decades. With Asian countries emerging as a global powerhouse in terms of regional economics, the interest in their stock markets has picked up recently. Asian markets traditionally comprised of many emerging markets are generally assumed to be more volatile and speculative in nature. Based on this crux, we focus specifically on the response of these markets efficiency to major crisis. In recent years, the Asian markets have experienced a phenomenal boom in attracting foreign capital inflow, with Singapore evolving into a global financial hub in terms of banking and financial services. Scepticism and cautious nature raises the question of whether these stock markets are efficient enough for further investment and development. Our study is unique in nature, as we focus on the efficiency of these market in response to crisis periods, comparing it with their pre-crisis period, both in shorter term of 1 year as well as longer term of 5 years post and pre crisis period. Taking Malaysia, Indonesia, Singapore and South Korea owing to their economic and financial development, we use MF-DFA to derive efficiency measure for comparative analysis with its own past. The findings put forth a notion of generally a deteriorating and negative impact of the Asian financial crisis, while the sub-prime crisis impact varies based on the economic structure of the economies. The findings concur with the mainstream literature and similar studies for other countries and region.

JEL classification: C22; E44

Keywords: East Asian; Efficiency; Multifractal; Stock markets

1. Introduction

In the modern history, there have been two main economic cataclysms to the East Asian region. Firstly, the East Asian financial crisis of 1997, which began with the fall of the Thai baht, led to the downfall of several East Asian economies. Secondly, the global crisis of 2008, which caused stock markets to plummet and forced several economies into recession. It is interesting to note the difference between these two crises. While the Asian crisis had severely devastated economies, countries such as Indonesia, Korea, Thailand and Malaysia quickly bounced back post crisis. Park and Lee (2001) explain that owing to favourable fundamentals, the countries were able to recover swiftly. However, Stiglitz (2000) argues that the core of the 1997 crisis lies with financial and capital market liberalization without proper regulatory framework.

On the other hand, the global crisis, which was brought to East Asia through increased integration with major global financial centres owing to liberalization of capitals accounts and an increase in foreign investments, saw a greater interdependence between East Asian countries and other foreign markets.

The stock market plays a prominent role in the economic development of a country. Not only does it encourage savings and investments but also enhances corporate governance and

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social responsibility. A stock market, despite its relative riskiness as a mode of investment, provides great opportunities for local and global diversification through effective and efficient asset allocation (Samaratunga, 2008).

Discussing the impact crises have on stock markets, a key aspect that needs to be addressed, is the efficiency of the stock market. The case for efficiency arises with the liberalization of capital market prior to the crises. Retaining conventional neoclassical models, capital market liberalization should lead to markets that are more efficient. In particular, emerging markets post liberalization become more attractive to foreign investors for diversification purposes, and thus are able to increase liquidity and informational transparency leading to greater market efficiency. The premise of an efficient market lies in the Efficient Market Hypothesis (EMH) pioneered by Fama (1965). It statuses the concept of random walk in stock returns, as it allows us to formulate the rational expectation model and test the weak form market efficiency. This form of efficiency states that the current stock price is reflective of all information in the past prices (Arshad, Rizvi, Ghani, & Duasa, 2015).

Worthington and Higgs (2006) examined the weak-form efficiency of 10 emerging and 5 developed markets in Asia using serial correlation coefficient and runs tests and found no traces of random walk behaviour in the emerging market stocks (in China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan and Thailand), thus were marred with inefficiency. A similar study by Claessens, Dasgupta, and Glen (1995) tested for return anomalies and predictability using the Lo-MacKinlay statistic and several other statistical methodologies, found the stock markets of 20 emerging markets to be inefficient. Hoque, Kim, and Pyun (2007) examined the weak-form efficiency of eight emerging Asian stock markets for pre, post Asian crisis periods, employing two new variance ratio tests—Wright's rank and sign and Whang—Kim subsampling tests, as well the Lo—MacKinlay and Chow—Denning tests. They found no significant effect on the degree of efficiency. Six of the markets (Hong Kong, Indonesia, Malaysia, Philippines, Singapore and Thailand) remained inefficient even after the Asian crisis. On a similar note, Kim and Shamsuddin (2008), using multiple variance ratio tests based on the wild bootstrap and signs did not find a significant change in efficiency with the impact of the Asian financial crisis.

Based on the above studies, the crux of this paper is to examine the nature of East Asian stock markets pre- and post-crises, focussing on the efficiency aspect. We look at the impact the Asian Financial crisis of 1997 (July 1, 1997 to June 1, 1998) and the global crisis of 2008 (September 1, 2008 to May 1, 2009) has on the stock market's efficiency. Our study takes a sample of four countries, viz. Malaysia, Singapore, Indonesia and South Korea covering short-term (1 year) and long-term (5 year) periods before and after crisis. The segregation in one year and five year is to investigate on whether deviation in the stock markets efficiency is due to a temporary shock from the crisis, or a more fundamental shift in the efficiency level.

We select the countries based on their pecuniary development stage, market size and in particular exposure to both crises. Furthermore, they are selected owing to their position as tiger economies. Malaysia and Indonesia are part of the Tiger Club Economies, which follow the same model as the Four Asian Tigers, of which Singapore and South Korea are part. While other East Asian countries could be included, we focus on Malaysia, Indonesia, Singapore and South Korea owing to the direct impact of the Asian Financial crisis, making them significant in our study as opposed to other East Asian countries, which had a more indirect relationship. Thailand is not selected owing to significant data gaps, which would provide bias results. This study revolves around both the Asian financial crisis and the global crisis, hence the selection criteria were based on the significant involvement of East Asian markets for both crises.

The significance of selecting East Asia lies behind its nascent prominence in the global arena, noticeable by rapid expansions in trade and financial flows across borders. East Asia contributes towards 40% of the world's GDP growth. Much of this accelerated growth is attributed to significant emphasis on intra-industry trade, allowing for a FDI influx over the past several years, only affected during the various crisis periods, i.e. 1997 Asian crisis, 2000 dot com crisis, and the recent 2008 global crisis (Lipsey & Sjöholm, 2010). Furthermore, a global shift from west to east is being witnessed increasing the potential of emerging markets to develop and prosper. This inflow of substantial FDIs and the emerging nature of East Asian stock markets, which are more susceptible to volatility, beg the question of whether or not the stock markets are efficient.

Furthermore, leafing through literature on the Asian financial crisis it is clearly seen that the impact of the crisis on the efficiency of the stock market has received very little attention (see Lim, Brooks, & Kim, 2008; Cheong, Nor, & Isa, 2007 and Kim & Shamsuddin, 2008). This study contributes to existing literature by firstly, examining the impact of the crisis on the stock markets, through its efficiency. Secondly, we employ a relatively recent methodology in econophysics, the Multifractal Detrended Fluctuation Analysis (MF-DFA) to rank the efficiency of the stock markets. Thirdly, as discussed by Antoniou, Ergul, and Holmes (1997) it is necessary to examine efficiency at different stages of development to reflect changes in market regulations, hence, we examine the efficiency at post- and pre-stages of both crises.

The traditional approach to arguing for weak-form efficiency is return independence, often measured by correlation (see Allen, Otchere, Senbet, 2011). However, this is mainly suitable for developed securities markets, which assume that the prices are not exposed to substantial upward trends and are more liquid. More appropriate approaches include the unit-root analysis (Annuar & Shamsher, 1993), probability distribution functions (Gabaix, Gopikrishnan, Plerou, & Stanley, 2003; Lee & Lee, 2007), correlation functions (Podobonik, Grosse, & Stanley, 2002), and network analysis (Jeong, Tombor, Albert, Oltvai, & Barabási, 2000). In the case of detecting whether evolving markets are weak-form efficient, a

significant contribution comes from Zalewska-Mitura and Hall (1999) who evaluated evolving weak-form market efficiency on developed and developing stock markets.

Several pioneering researches focus on significant ways of determining weak form efficiency such as a time-varying parameter model with GARCH effects (see Arouri, Dinh, & Nguyen, 2010, Arouri, & Nguyen, 2010 and Fontaine & Nguyen, 2006).

Another popular method is the De-trended Fluctuation Analysis (DFA) derived from econophysics, proposed by Peng et al. (1994). They based their proposed methods on a plethora of evidence (Kwapien, Oswiecimka., & Drozdz, 2005; Mandelbrot, 1972; Oswiecimkaa, Kwapien, Celinska, Drozdza, & Rak, 2005; Pasquini & Serva, 1999) that finds stock market data to be multi-fractal in nature. Based on the multi-fractural nature of stock market in particular for developing markets, this paper uses the proposed methodology of Peng et al. (1994); MFDFA. The MFDFA is often used to analyse long-range autocorrelations and describe the fractal properties and is considered to be one of the best ways of measuring efficiency.

Succeeding the introduction, we discuss the data and methodology followed by the empirical analysis and finally a conclusive interpretation of the results as well as drawing some tentative policy conclusions.

2. Data and methodology

Our dataset comprises 5 years post and pre crisis daily stock market data for broad market indices for each of the four East Asian economies Singapore, South Korea, Indonesia and Malaysia. The rationale for choosing broad market indices is to capture the maximum market, since the broad market indices under study from the family of Morgan Stanley Composite Indices (MSCI) captures 80%−85% of market constituents. The country level indices used are MSCI Singapore Index, MSCI Malaysia Index, MSCI Indonesia Index and MSCI Korea Index, all of which are denominated in US dollars. Some financial details on the selected stock market indices can be found in Appendix A.

Table 1 below provides a snapshot of the descriptive statistics for the stock returns of these markets over the whole sample period. We restrict here to full sample period as to provide a brief overview and not taper away from our core objective. From the table we can see that throughout the sample period, Korea has the highest mean and standard deviation, indicating a much higher level of volatility than the other countries. Generally the stock markets show a relatively moderate kurtosis and skewness over the whole sample period, with the exception of Malaysia, representative of the illiquid nature of the market.

Table 1
Descriptive statistics of sample countries.

	Malaysia	Singapore	Indonesia	Korea
Mean	0.03%	−0.02%	0.04%	0.07%
Std. Dev.	0.019	0.014	0.022	0.027
Kurtosis	41.219	2.812	7.811	2.464
Skewness	0.952	0.229	0.421	0.269

The two primary crises that this study focuses on is the Asian specific, Asian Financial Crisis of the 1997−1998 and the sub-prime crisis of 2007−2008, which resulted in the global economic slowdown. The crisis dating has been extracted from International Monetary Fund's (IMF) and National Bureau of Economic Research (NBER) annual reports on global economic outlook. The Asian Financial crisis of 1997 lasted from July 1, 1997 to June 1, 1998 and the global crisis of 2008 from September 1, 2008 to May 1, 2009.

The methodology used in our study is classified under the emerging field of econophysics, where studies have developed new methods to test market efficiency by revealing any long-range dependence on the prices. One of the recent methods proposed is by Peng et al. (1994) who detect the long range dependence using de-trended fluctuation analysis (DFA). It was further developed and applied by Jiang and Zhou (2007) in analysing Asian stock markets where they concluded these markets to be highly efficient with the scale exponents of large volatility being close to 0.5. Kwapien et al. (2005) and others have argued that despite the application of DFA, the financial markets tend to be multi-fractal in nature. This school of thought has given rise to application of multifractal de-trended fluctuation analysis (MF-DFA) in studying stock markets, which is capable of studying the multipoint correlation of a non-stable series. Zunino et al. (2008) found that using MF-DFA allowed for an inefficiency ranking and Onali and Goddard (2009) reported evidences of multi-fractality and departure from random walk behaviour as statistically significant while testing the Italian stock market. Arshad and Rizvi (2015) have studied the East Asian markets across business cycle, and found that the markets tend to be more efficient in economic booms as compare to preceding busts.

2.1. Multifractal Detrended Fluctuation Analysis

In the attempt to understand the efficiency of East Asian stock markets when faced with crises, we employ Multifractal Detrended Fluctuation Analysis (MF-DFA) on our original return series. The MF-DFA is credited for being proficient in measuring the efficiency as it allows us to serially rank the individual efficiency of the market. Moreover, it is apt in determining the level of inefficiency in a market. A brief glimpse into available literature illuminates on the existence of changing efficiencies with the impact of crises (see Lim et al. 2008). Borrowing from Kantelhardt et al. (2002), the technical details of MF-DFA are summarized below:

The first step of the analysis begins with a correlated time series (signal) $\{u_i, i = 1,\ldots, N\}$, where N is the size of the series, the corresponding profile is determined by integration:

$$dfY(k) = \sum_{i=1}^{k}[u_i - (u)], \quad k = 1,\ldots,N, \tag{1}$$

Next, after the determination of the profile, the $Y(k)$ is categorized into non-overlapping windows of equal lengths, s. In our study, we use a window of 4 days. However, it should be

stated that the N does not need to be the integer multiple of s. To avoid any significant loss of data, the series *[y (k)]* should be divided from the opposite end (Bai & Zhu, 2010), leaving us with 2N_s sub-intervals.

To examine the local trend of each window $v = 1, \ldots \ldots,$ 2Ns, the least square fit of the data is considered, in which the de-trended time series is denoted by $Y_s(i)$, and represented as the difference between the original time series and the fits:

$$Y_s(i) = Y[(v - N_s)s + 1] - p_v(i) \tag{2}$$

For $v = 1,\ldots,$ N_s, and

$$Y_s(i) = Y[N - (v - N_s)s + 1] - p_v(i) \tag{3}$$

For $v = Ns + 1,\ldots,$ 2Ns.

In this case, p(i) is the fitting polynomial in the v_{th} window. The time series is subtracted in order to obtain the de-trending, hence causing the methods to differ in their capacity to remove trend from the data. In the mth order of MF-DFA, trend of order m and in the profile $m-1$ in the original record are removed, allowing an assessment of the different order results of the MF-DFA. Since we are using a polynomial fit of order 3, we denote the algorithm as MF-DFA-3.

Subsequently, the variance for both of the 2Ns of the de-trended time series Ys(i) is assessed by averaging over all data point i in the vth window

$$F_s^2(v) = \frac{1}{s}\sum_{i=1}^{s}(Y_s(i))^2 \tag{4}$$

By averaging over all segments, we obtain the qth order fluctuation function:

$$F_{q(s)} = \left\{\frac{1}{N_s}\sum_{v=1}^{N_s}\left[F_s^2(v)\right]^{q/2}\right\}^{1/q} \tag{5}$$

Starting from the beginning and starting from the end.

$$F_{q(s)} = \left\{\frac{1}{N_s}\sum_{v=N_s+1}^{2N_s}\left[F_s^2(v)\right]^{q/2}\right\}^{1/q} \tag{6}$$

Any real value can denote the order q. Due to the divergent exponent, the value h(0) for $q = 0$ cannot be determined. Alternatively, we employ a logarithmic average procedure. For $q = 2$, the standard DFA procedure is retrieved.

Lastly, for scaling behaviour determination of the fluctuation, we analyse log–log plots of F(q)s versus s for each value of q. The $F_q(s)$ increases for large values of s if the series u_i are long-range correlated, as a power-law. More detailed explanation on power law is found in Horvatic, Stanley, and Podobnik (2011).

$$F_q(s) \sim s^{h(q)} \tag{7}$$

Nonetheless, if the time series is stationary, the profile defined in Eq. (1) will be a fractional Brownian motion (fBm). Thus, $0 < h(q = 2) < 1$ for these processes, and $h(q = 2)$ is identical with the Hurst parameter, H. Conversely, if the original signal is a fBm, the profile will be a sum of fBm, so $h(q = 2) > 1$. In this case, the relationship between the exponent $h(q = 2)$ and H is $H = h(q = 2) - 1$. Thus, the exponent (q) is usually known as the generalized Hurst exponent.

3. Empirical analysis

We initiate our analysis from identifying the apparent crossover of each curve for our data set, followed by the calculation of slope of the generalized Hurst exponents for short and long term as presented in Table 2 (only the slope for post Asian financial crisis period is presented as sample). It can be observed that change of generalized Hurst exponents of two sub-series depends on q as it varies from −4 to 4. This provides evidence of the apparent multifractal nature of the market returns. From Table 2, a moderate change in generalized Hurst exponents h(q) when q varies from −4 to 4 for both $S < S^*$ and $S > S^*$. This change in H(q) implies that the multifractality characteristic of the markets becomes weaker and also reflecting the markets as becoming relatively more efficient.

The multifractal analysis is conducted using a $q = 4$, in light of the recent studies in Rizvi, Dewandaru, Bacha, and Masih (2014), Arshad et al. (2014) and Jiang and Zhou (2007) who have delved into the determination of the apparent q based on the divergence of the integrand for large m_a. (For a detailed discussion on determination of 'q' see Jiang and Zhou (2007), Zhou, Sornette, and Yuan (2006) and Rizvi et al. (2014)).

In line with the earlier theory outlined in literature review, for a market to be efficient, all kind of fluctuations should

Table 2
Generalized Hurst exponents for short term and long term −4 to 4.

	Malaysia		Singapore		Indonesia		Korea	
	Short term	Long term	Short term	Long term	Short term	Long term	Short term	Long term
−4	0.579	0.605	0.628	0.670	0.669	0.617	0.744	0.393
−3	0.567	0.613	0.598	0.648	0.634	0.626	0.717	0.385
−2	0.558	0.631	0.573	0.622	0.592	0.636	0.688	0.381
−1	0.547	0.661	0.552	0.593	0.544	0.645	0.656	0.380
0	0.529	0.694	0.533	0.564	0.491	0.650	0.622	0.382
1	0.500	0.717	0.512	0.537	0.439	0.649	0.588	0.387
2	0.460	0.721	0.488	0.515	0.390	0.643	0.553	0.393
3	0.419	0.711	0.459	0.498	0.346	0.632	0.521	0.399
4	0.382	0.695	0.428	0.486	0.308	0.619	0.491	0.404

Table 3
Efficiency Measure "D" for sample countries.

Malaysia	Short term	Long term
Asian financial crisis		
1 year pre	0.0984	0.1502
1 year post	0.1610	0.5048
5 year pre	0.0758	0.1356
5 year post	0.2260	0.1906
Subprime crisis		
1 year pre	0.0562	0.1299
1 year post	0.1257	0.1689
5 year pre	0.1222	0.0970
5 year post	0.1446	0.0766
Singapore	**Short term**	**Long term**
Asian financial crisis		
1 year pre	0.0997	0.0921
1 year post	0.1769	0.3760
5 year pre	0.0956	0.1415
5 year post	0.1075	0.0983
Subprime crisis		
1 year pre	0.0602	0.1118
1 year post	0.1139	0.2656
5 year pre	0.0914	0.0246
5 year post	0.1255	0.1049
Indonesia	**Short term**	**Long term**
Asian financial crisis		
1 year pre	0.1804	0.1181
1 year post	0.3412	0.3721
5 year pre	0.2908	0.0648
5 year post	0.1334	0.1250
Subprime crisis		
1 year pre	0.1488	0.1249
1 year post	0.0843	0.1217
5 year pre	0.1652	0.0318
5 year post	0.1502	0.1175
South Korea	**Short term**	**Long term**
Asian financial crisis		
1 year pre	0.1261	0.1015
1 year post	0.1168	0.0915
5 year pre	0.0853	0.0563
5 year post	0.0997	0.1387
Subprime crisis		
1 year pre	0.1186	0.1127
1 year post	0.0996	0.1639
5 year pre	0.0461	0.1275
5 year post	0.1183	0.0989

follow random walk behaviour. This translates into h(q)'s related to different q's are equal to 0.5. For our analysis, we focus on short and long term components, for this we define market deficiency measure as:

$$D = \frac{1}{2}(|h(-4) - 0.5| + |h(4) - 0.5|) \quad (8)$$

In eq. (8) scale exponents h(4) are used for denoting the small and large price fluctuations. For a market to be efficient, the value of D has to be close to 0, whereas a value of deficiency indicates a less efficient market. Our focus of the study is on the general efficiency of the market; hence the empirical analysis will focus on D in short term and long term, and not indulge in small or large fluctuation.

From Table 3 below, we see a rather interesting trend developing. For most of the countries, the efficiency seems to be greater in pre-crisis periods than post crisis. This is in line with Lim et al. (2008) who found in the case of the 8 Asian markets impacted by Asian financial crisis of 1997 to have had a decreased efficiency post crisis, compared to before the crisis.

Our findings tend to concur with the earlier studies in broad terms, but provide a few interesting insights into the shorter horizon and longer horizon behaviour. While Hoque et al. (2007) found no improvement in the degree of efficiency in pre-crisis and post-crisis period for Asian countries; our findings differ on the shorter period scale. While the year post crisis, definitely efficiency deteriorated as compared to the preceding period, the longer span of five years show that it is not much different from the 5 years preceding the crisis except for Malaysia. Malaysia tends to show a deteriorating efficiency of the stock markets during the period. This can be intuitively argued from the response strategy of Malaysia. While Singapore, Korea and Indonesia followed the conventional strategies and bailouts, Malaysia opted for capital controls, and a drastic shift to fixed exchange rate regime. The drastic policy change affected the confidence of investors in the stock market and took a long time to return. Johnson and Mitton (2002) argue the negative impact of capital controls on market discipline, and visibility of political patronage benefits impacted the micro level structure of the market.

Lim (2008) also highlights the negative impact of the Asian crisis over seven of the eight economic sectors in the Malaysian stock market. The nascent stage of the markets in terms of development can be attributed for the loss in efficiency, as Kim and Shamsuddin (2008) argue that the developed stock markets of Singapore and Korea, were less impacted, while the markets of Indonesia and Malaysia are inefficient in crisis-period. At the same time, there was found evidence that the financial liberalizations following Asian crisis improved market efficiency. This financial liberalization and its positive impact of the upswing in market measures is visible in the improving numbers of Indonesian market over the longer 5 year period post crisis. The Indonesian government following the IMF instructions liberalized the markets, attracting huge capital influx and liquidity into the market in the long run. This has been studied by Rejeb and Boughrara (2013) who argue emerging markets are characterized by a greater efficiency in recent years post liberalization. They base their argument through empirical analysis of impact of financial liberalization on the degree of informational efficiency in emerging stock markets while considering three types of financial crises, i.e. banking, currency and twin crises.

The result generally holds in terms of the recent sub-prime crisis, but with slight differences in the case of Korea and Indonesia. The Indonesian market seems to stay unaffected from the crisis, in terms of the efficiency measure. This is in line with a recent study by Rizvi et al. (2014) who conclude that Indonesian markets show a steady improvement in efficiency measures to a level where in some periods it surpasses some major developed markets. This can be explained by the large population and the increasing savings and income of the

local population. Nearly 60% of the real GDP of Indonesia is contributed from domestic consumption and savings, one of the highest in the world. While in the case of Korea, the shorter time period of one year post crisis, the stock markets seem to show no signs of effect, but the efficiency seems to reduce over the longer 5 year period. This may be owing to the smaller population size as compared to Indonesia, and secondly a heavy reliance on the western consumer markets for Korean companies. The financial crisis and the ensuing global economic slowdown, seems to impact the markets in Malaysia in both short and long term, which is expected owing to the exposures undertaken by global portfolio managers in these capital markets. With credit crunch in the western markets, the contagion was expected in these two markets, thus creating liquidity issues. The negative impact of decreasing liquidity and efficiency has also been discussed by Chordia, Roll, and Subramanian (2008). Our findings of efficiency study of these markets also conform to the recent Arshad and Rizvi (2015) for the East Asian markets.

The results of this study are in consideration to those of Rejeb and Boughrara (2013), where they assessed the impact of financial liberalization on the degree of informational efficiency on emerging stock markets under the consideration of financial crises. In their paper, using a treatment effects model with time-varying parameters, they found efficiency to be greater in recent years, which is concurrent with the present study. Another similar study (Rejeb and) focuses on the structural changes in emerging market volatility. The researches firstly determine structural breaks and then compare with the dates of financial crises to understand the effects of volatility spillovers and contagion. Their results concurred with the current findings of financial shocks transmitting from one market to another during the periods of crises.

The results from this paper are concurrent with those found in Arshad et al. (2015). They investigated the weak-form efficiency, using MF-DFA, of OIC member stock markets during different business cycles. Their results indicated improving efficiency over the past decade. Similarly, Rizvi and Arshad (2014) did a similar study on the efficiency of East Asian markets during different business cycles and found that volatility for all investors tend to be lower in every succeeding boom. Furthermore, their data revealed that long-term volatility impacts the long term efficiency significantly.

4. Conclusion

Delving into the analysis of efficiency of stock markets provides vital insight for the regulators and global investors and has implications for investment strategies and theory for academic literature. After every crisis, literature sprouts on the empirical understanding of the nexus between crisis and the stock market efficiencies. This research adds to this growing body, by studying a different tangent, where we incorporate methodology from physics to answer the all-important question regarding the behaviour of weak form efficiency of the East Asian markets in the shorter run of 1 year and longer time span of 5 years post crisis, as compared to pre-crisis.

The results of our research put forth a notion of generally a deteriorating and negative impact of the Asian financial crisis, on East Asian markets. But differing behaviours are witnessed based on the terms of the market structure in light of liberalizations versus capital controls, and the structure of economy, inward looking or outward looking. This is in line with the recent work of Cajueiro, Gogas, and Tabak (2009) who found a positive impact of financial liberalization on the market efficiency. The improving efficiency of the East Asian market in the wake of global financial crisis is a good indicator for officials as greater efficiency can translate to an increase in investments.

This paper is not without its limitations, and one such limitation is the effect of different trading days. As this paper is an introductory analysis on efficiency, it does not take into account different trading days across stock markets. It would benefit future studies to factor in different holidays across countries in their analysis.

4.1. Policy implications

In regards to policy implication, an efficient market is important as it can play an important role in the development of the economy, via resource allocation and capital formation. A liberalized and efficient stock market plays a pivotal role in increasing savings and investment, which are essential for economic development and stability in the wake of any crises.

National as well as global investors may use the relationship amongst our sample countries to predict the efficiency of emerging markets to invest in profitable stock markets in East Asia, a region in spotlights given its fast developing environment. Our results suggest better market conditions post liberalization programs, which in turn requires more attention from policy makers. It would be in their best interest to improve the quality of key factors to allow for better market efficiency. Arouri et al. (2009) describes these key factors as financial infrastructure (market regulation, accounting standards, and investments laws), information quality and quantity and investor financial knowledge. This would eliminate the barriers that inhibit convergence to market efficiency.

From an international investor perspective, the equity market, by allowing diversification across a variety of assets, helps reduce the risk the investors must bear, thus reducing the cost of capital, which in turn spurs investment and economic growth.

Appendix A.

Financial statistics of sample countries.

	GDP growth																						
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Malaysia	8%	9%	9%	10%	10%	7%	−7%	6.%	9%	0.5%	5%	6%	7%	5%	5%	6%	5%	−1%	7%	5%	6%	5%	6%
Korea	5%	6%	8%	9%	7%	5%	−5%	11%	9%	4%	7%	3%	5%	4%	5%	5%	3%	1%	6%	4%	2%	3%	3%
Indonesia	7%	7%	7%	8%	7%	4%	−13%	1%	5%	4%	4%	5%	5%	6%	5%	6%	6%	5%	6%	6%	6%	5%	5%
Singapore	7%	11%	11%	7.%	7%	8%	−2%	6%	9%	−1%	4%	4%	9%	7%	9%	9%	2%	−1%	15%	6%	3%	4%	3%
	Stock market size − Market capitalization (%)																						
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Malaysia	159	329	267	251	305	93	137	184	125	129	123	153	152	126	145	168	81	127	166	137	156		
Singapore	94	219	182	168	156	106	110	230	159	131	111	236	243	249	187	196	94	162	157	112	143		
Korea	30	35	42	33	23	8	32	81	31	41	41	48	56	80	83	100	49	93	100	83	97		
Indonesia	9	21	27	33	40	13	23	46	16	14	15	23	29	28	38	49	19	33	48	44	43		
	Stock market liquidity − Stock turnover ratio (%)																						
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Malaysia	28	98	60	36	66	76	31	40	45	18	23	34	33	27	32	53	33	33	27	32	29		
Singapore	29	90	61	43	29	50	51	67	52	47	51	53	32	40	62	122	102	103	83	75	43		
Korea	114	172	173	99	111	186	174	320	377	359	337	236	169	210	173	202	181	238	169	195	139		
Indonesia	41	41	29	25	41	71	41	46	31	39	49	35	43	54	44	64	71	83	48	37	23		

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