Stock return weak-form efficiency of ASEAN stock markets

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Abstract: This paper investigates the weak-from efficiency of five ASEAN stock markets. It applies the automatic portmanteau test and the automatic variance ratio test to moving sub-sample windows of stock market returns. The empirical results show that the Thai and Singaporean stock markets are weak-form efficient for the period investigated (1999-2015). The other stock markets except for Malaysia shows improvement in efficiency post the global financial crisis of 2007. The findings reveal evidence that supports the adaptive market hypothesis and confirms the positive impact of the ongoing financial liberalization processes in the ASEAN region.

I. Introduction

The efficient market hypothesis (hereinafter EMH) is a corner stone theory in finance, which attracted lots of attention by academics and practitioners over last 40 years. The EMH states that a market is informationally efficient if stock prices *fully reflect* all available information to all market participants (Fama, 1970). It follows that market prices adjust instantaneously in response to new information. Therefore, price changes (or returns) are unforecastable.

In the literature of the EMH testing, there are surprisingly large numbers of empirical studies which investigate the efficiency of stock prices in the weak form. Authors have attempted to answer question: is it possible to predict return using historical information of stock? Various approaches have been proposed to answer this question. Among these approaches, a wide range of statistical tests are used to track the autocorrelations of stock returns over a number of lag period based on

argument that the weak-form efficiency implies uncorrelated successive returns. For testing whether stock return sequences are correlated, the variance ratio (VR) test of Lo and MacKinlay (1988) has emerged as the standard tool (see survey paper by Lim and Brooks, 2011). The VR test is based on the property that the variance of a multi-period return is the sum of single-period variance return when a stock price are uncorrelated. It follows that the variance of k-holding period return $r_{k,}$ must be k time variance of one-holding period return r_1 if market is efficient. Nevertheless, a possible problem of the VR statistics is that the autocorrelations of different signs can be compensated (Griffin, 2010). This problem can be effectively complemented by employing the Q test which use a weighted sum of square of return autocorrelations as a natural measures of return predictability.

This study examine the weak-form EMH focusing on ASEAN stock exchanges - a market of interest for many finance practitioners and scholars. In the recent years, the region has experienced growth rates that are the envy of other countries. As a group, ASEAN have a large internal market of 9% of world population (600 million people), with a rapidly expanding middle class. The region represents dynamic economies with high growth and developing financial markets witnessing significant increases in trading volume. With multi-faceted economies, cultural diversity and large populations, the potential of region is hard to ignore. After the Asian financial crisis in 1997 and the Global Financial Crisis in 2008, a series of reforms have been introduced in ASEAN financial markets in order to improve stock market efficiency (Guidi and Gupta, 2011). Despite that, it is not clear to date how these policies affect the incorporate - information process of regional stock markets. In addition, the ASEAN Economic Community (AEC) is decided to launch in 2015 to promote ASEAN economic integration and centrality with the goal of

establishing a single market and a production base. Substantial progress was deployed in each member state from 2010 to liberalize the flow of capital from country to country and integrate the national banking sectors. Thus, understanding the impact of the amendment of many domestic laws on market efficiency is a critical condition for investors from all member states to have confidence to allocate investments across ASEAN stock exchanges.

Though some empirical studies regarding to weak-form EMH have been carried in this region with different sample periods, methods and data frequencies, however, the achieved results are conflicting in some cases and out of date in the other cases. For further detail, prior research by Kim and Shamsuddin (2008) and Guidi and Gupta (2011) found the weak-form efficiency in Singaporean and Thailand markets; while research by Lai et al (2002); Lima and Tabak (2004); Hoque (2007); Lento (2007); Yu et al (2013) against this conclusion. In the case of Indonesia, Malaysia and the Philippines, most of extant research agree that these markets are inefficient until 2010. However, no study has been conducted in these markets since then. Furthermore, previous studies focus on testing all-or-nothing notion of absolute market efficiency therefore their outcomes are only indicate efficient level at the time of the respective studies. As a sequence, the findings from these studies may be subject to data-snooping bias.

Being aware the gap of literature and the problems of previous studies, this paper focus on examining the weak-form efficiency of ASEAN stock markets using updated data and up to date methodology. The findings of study makes at least three contributions to the literature:

First, and most important, we show the efficient evolvement of individual stock exchanges using two recently developed data-driven tests which can provide exact and objective results. It is worth noting that a major shortcoming of standard VR and Q tests is the arbitrary selection of

the holding period k (for VR test) and the lag order p (for Q test). This can lead to conflicting results when the different values of p and k are used. To address this problem, our research employ the automatic portmanteau Box–Pierce (AQ) test and the Wild-Bootstrapped automatic variance ratio (WBAVR) test, which optimally choose p and k based on the dataset and then can prevent the potential conflicting results. According to recent literature (see, for example, Charles et al. 2011), these tests have superior statistical properties and therefore they will provide a more rigorous analysis than other tests applied in prior research.

Second, these two tests will be used to examine updated data of returns via moving-sub sample windows. This testing process will enable the paper to trace the evolvement of markets' efficiency over the whole period investigated and obtain inferential results which are robust to possible structural changes or influential outliers (Kim et al, 2011). Consequently, the findings from analysis are free of data-snooping bias and provide a general view of efficiency level of ASEAN stock exchanges over time. Under the moving-sub sample windows framework, the paper also offers additional evidence related to Lo's (2004) adaptive market hypothesis (AMH) which argues that efficiency level changes over time and dynamic market conditions govern the degree of stock market efficiency.

Last but not least, the paper delivers evidence related to the impact of financial liberalization to the efficiency of ASEAN stock markets over time and policy implication for member states.

The rest of the paper is organized as follows: The next section looks at data and methodology. The third section discusses the empirical results and their implications. Conclusions are drawn in the final section.

II. Detail of Data and Testing Methodology

II.1. Detail of Data

In this paper, the stock portfolios from five founding members of the ASEAN block are considered. Stock market indices are used as proxies for comprehensive and well-diversified stock portfolios. All data are collected from Thomson Financial's Datastream for the period from 31st August 1999 to 28th August 2015, including 4174 daily and 835 weekly observations. The weekly data are associated with Wednesday. For empirical analysis, the log returns are derived from the stock price indices denominated in local currency: $r_t = \log(\frac{P_t}{P_{t-1}})$ where P_t is the closing price of index on day t.

The details of descriptive statistics for daily returns are reported in Table 1. From descriptive statistics and results of the ARCH LM test, it can be seen that all log return series are highly non-normal with a strong conditional heteroscedasticity as might be expected from daily stock returns. The mean equity returns have been positive for the period of analysis, although they are fairly small. The highest daily return was 11% for Thailand stock index while the lowest was about -16% for the same index. The minimum of Kurtosis of 5.44 indicates that all returns distribution are fat-tailed. With the exception of the Philippines, the skewness of all stock returns are negative indicating that the asymmetric tail extends more towards negative values than positive ones.

Table 1: Summary statistics of data on daily returns

	Singapore	Thailand	Indonesia	Malaysia	The Philippines
Sample	4174	4174	4174	4174	4174
Mean	0.00007	0.00027	0.00049	0.00017	0.00028
Min	-0.09	-0.16	-0.11	-0.1	-0.13
Max	0.08	0.11	0.08	0.05	0.16

Skewness	-0.27	-0.7	-0.63	-0.75	0.3
Kurtosis	5.44	9.54	6.56	10.29	16.33
ARCHLM tests lag 5	686.2 (0.00)	686.2 (0.00)	357.55 (0.00)	254.17 (0.00)	102.44 (0.00)

Notes: P-values are in ()

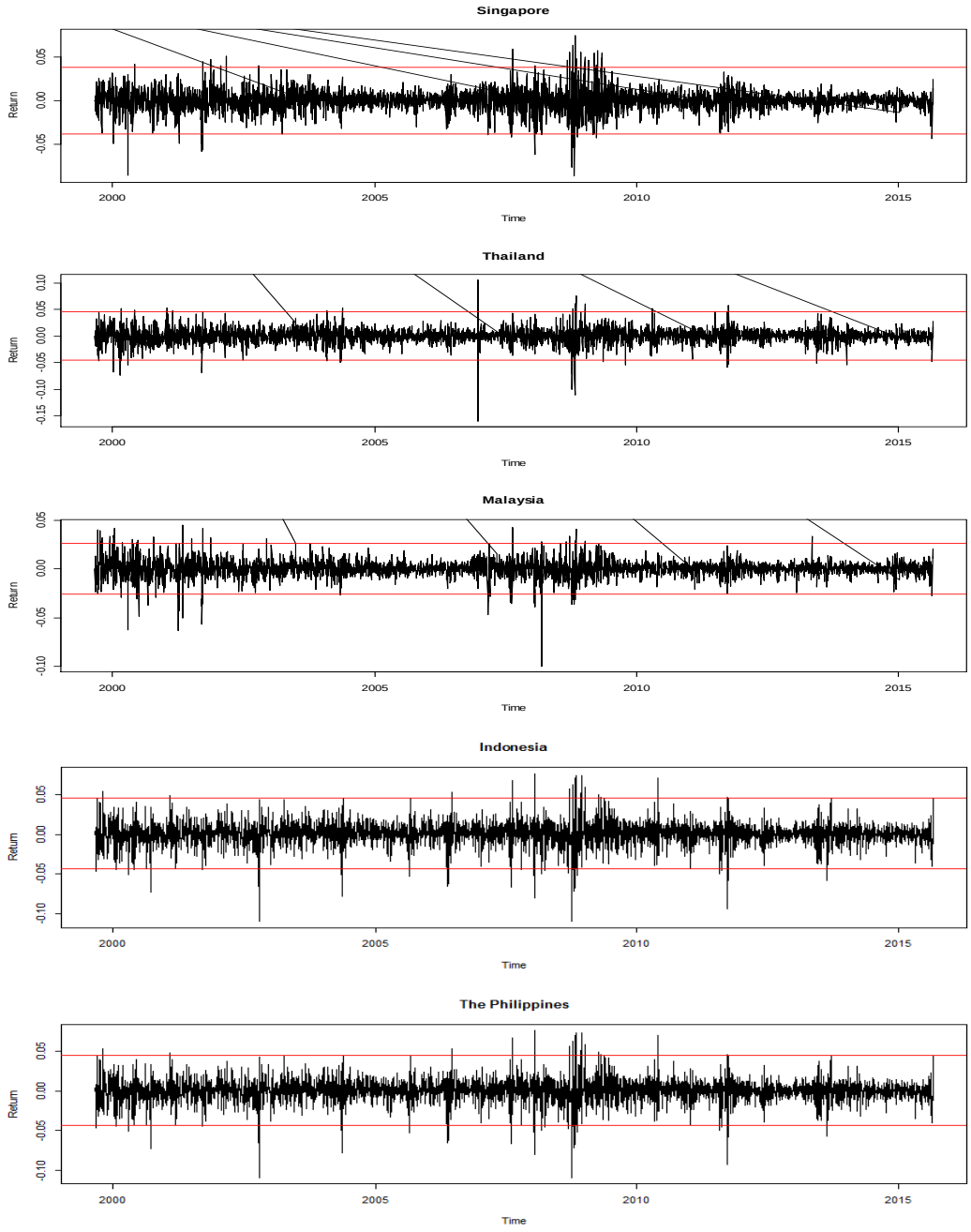


Figure 1. Time plots of log daily return for studied markets

Figure 1 presents the time series plots of daily log returns for all markets. The horizontal lines in each graph indicate (Q1-3IQR, Q3+3IQR)

where Q1 is the first quartile, Q3 is the third quartile, and IRQ is the inter-quartile range (Q3 – Q1). This is a popular criterion to detect extreme outliers based on the box plot. It is obvious from Fig. 1 that all investigated markets show extreme outliers around 2008 indicating high degrees of volatility in connection with the GFC. Outliers occurred in Thailand market in 2009, 2011 and 2012 which are related to political unrest. For weekly data, the detailed results are not reported as they are found to be qualitatively similar to those of daily data.

II.2. Testing Methodology

In order to evaluate the efficiency of market, the stock returns will be investigated under the Martingale Differences Hypothesis (MDH). According to the MDH, if the price of a stock is a martingale then successive price changes are unpredictable and their autocorrelations over time are zero ($\rho_j = 0$ for all j). Even though, a martingale process would allow the conditional variance of the price change to be predictable from past variance. It is, therefore, suited for financial time series.

Regarding to methodology for testing the MDH, the Automatic portmanteau Box-Pierce (AQ) test and Wild Bootstrap Automatic variance ratio (WBAVR) test will be deployed over moving-sub sample windows.

Automatic portmanteau Box-Pierce (AQ) test

The portmanteau Box and Pierce's (1970) Q_k statistic is one of the earliest auto-correlation based tool for testing the null hypothesis H_0 where the first p autocorrelations of a time series are jointly zero. Though numerous improvements have been proposed over the years, the arbitrary selection of the lag order p remains a main obstacle in empirical finance research. To address this limitation, Escanciano and Lobato (2009) propose the AQ test with a data-driven procedure to choose the optimal value of p.

The AQ test statistic is defined as:

$$AQ = Q_p^* = T\sum_{j=1}^{p}\tilde{\rho}_j^2$$

where $\tilde{\rho}_j^2 = \frac{\hat{\gamma}_j^2}{\hat{\tau}_j}$ with $\hat{\gamma}_j^2 = \frac{1}{T-j}\sum_{t=1+j}^{T}(r_t - \bar{r})(r_{t-j} - \bar{r})$ representing the estimator for the auto-covariance of r_t and $\hat{\tau}_j = \frac{1}{T-j}\sum_{t=1+j}^{T}(r_t - \bar{r})^2(r_{t-j} - \bar{r})^2$ representing the auto-covariance of r_t^2.

The AQ statistic asymptotically follows the Chi-squared distribution with one degree of freedom. Hence, for the significance level α, the test for the null hypothesis of serial uncorrelatedness is rejected in favour of the alternative hypothesis of at least one of autocorrelation is non-zero, if

$$AQ > X_{1-\alpha,1}^2$$

where $X_{1-\alpha,1}^2$ is the α-quantile of the chi-squared distribution with 1 degree of freedom.

By summing the squared autocorrelation, the AQ statistic is designed to detect departures from zero-autocorrelations in either direction and at all lags. Therefore, it has power against abroad range of alternative for testing the MDH. However, selecting number of autocorrelation ***p*** requires some care – if too few are used, the presence of higher-order autocorrelation may be missed; if too many are used, the test may not have much power due to insignificant higher-order autocorrelations (Campbell et al., 1997). In an effort to choose the optimal lag order ***p***, Escanciano and Lobato (2009) propose a fully data dependent procedure as following:

$$\tilde{p} = \min\{k: 1 \le k \le d, L_p > L_h, h = 1,2,\dots,d\}$$

where

- $L_p = Q_p^* - \pi(p,n,q)$;
- $\pi(p,n,q) = p * \log(n)\ if\ \max_{1\le j\le d}\sqrt{n}|\tilde{p}| \le \sqrt{q * \log(n)}$;
- $\pi(p,n,q) = 2p$ if otherwise.

- ***d*** is an arbitrarily fixed upper bound, this number plays no role for inference (Esciano and Lobato (2009) recommend d=25,50,75);
- ***h*** is the number of lags to be tested;
- ***q*** is some fixed positive number, Esciano and Lobato (2009) recommend q=2.4 for finite sample;

Esciano and Lobato (2009) claim that this selection rule allows a compromise between Akaike's information criterion which is ideal when the serial correlation is presented in high order autocorrelation, and the Bayesian information criterion, which is ideal when the serial correlation is present in lower order autocorrelation.

Wild Bootstrap Automatic variance ratio (WBAVR) test

Under the null hypothesis of the MDH, Choi (1999) proposes automatic variance ratio (AVR) test that is defined as:

$$AVR(\hat{k}) = \sqrt{T/\hat{k}} * [(VR(\hat{k}) - 1]/\sqrt{2} \xrightarrow{d} N(0,1)$$

with the VR is calculated as $VR(k) = \frac{Var(r_k)}{k*Var(r_1)} = 1 + 2\sum_{i=1}^{k-1} \frac{k-i}{k} \rho_i$

According to this definition, the unknown sampling distribution of the *AVR*(*k*) statistic is considered as asymptotic approximation toward normal distribution. However, this approximation is problematic when sample size is small. Kim (2009) investigates the size and power properties of the AVR test and discovers that the AVR test suffers from serious size distortion in small samples when the return is conditionally heteroscedastic. He, thus, proposes the wild bootstrap method of Mammen (1993) to improve performance of the test. Evaluating this method by a Monte Carlo study, Kim (2009) finds that when using the wild bootstrap, the automatic variance ratio test shows no size distortion, and it has substantially higher power than its competitors such as the wild bootstrap

version of the Chow–Denning test (Kim, 2006) and the power-transformed joint test of Chen and Deo (2006).

The wild bootstrap method includes in three stages:

1. With the original series, form a bootstrap sample of T return observations $r_t^* = \theta_t r_t$, where θ_t is a random sequence with $E(\theta_t) = 0$ and $E(\theta_t^2) = 1$;
2. Calculate $AVR^*(\hat{k})$ of r_t^*
3. Repeat step 1 and step 2 **B** times to produce the bootstrap distribution of the AVR statistic$\{AVR(\hat{k}, j)\}_{i=1}^{B}$.

The above procedure is applied to an asymptotically pivotal statistic (here is AVR), and it will approximates its sampling distribution under H_0 since r_t^* is a uncorrelated sequence conditional on r_t.

In implementing the wild bootstrap, a number of bootstrap replication and a specific form of θ_t should be chosen. Kim (2006) notes that other choices provided qualitatively similar small sample results. In this paper, we follow Kim (2006) using the standard normal distribution, although two-point distributions may be used instead (see, for example, Mammen, 1993). The number of bootstrap replication **B** is set to 2000.

To test for the null hypothesis H_0 against the two tailed alternative, the 100(1-α)% wild bootstrap confidence interval is calculated as the $0.5\alpha^{th}$ and $(1\text{-}0.5\alpha)^{th}$ percentiles of the bootstrap distribution $\{AVR(\hat{k}, j)\}_{i=1}^{B}$. If the value of the observed statistic $AVR(\hat{k})$ is inside the confidence band, then the MDH is accepted at α significance level. The acceptance of the null hypothesis is used as evidence of the weak-form efficiency in investigated market. It should be emphasized that this bootstrap confidence interval has been proposed as a superior alternative to the asymptotic method in many applications (see, for example, MacKinnon, 2002).

Moving-sub sample windows

Since Kim et al. (2011) report that moving-sub sample windows approach allow to achieve results which are robust to outlier and structural changes, it is interesting to apply this method to obtain more exact and robust results. In this study, the WBAVR and AQ tests will be deployed over the whole dataset using a two-year window length for daily data and a five-year window length for weekly data. The robustness of test results is checked under one-year and three-year window for daily data and four-year and six-year window for weekly data. The results from different window lengths show the similar characteristics. So only the results of two-year daily window and five-year weekly window will be reported.

Taking a two-year window for daily data as an example, the moving-subsample windows method is deployed in the following steps:

- First, the WBAVR and AQ statistics are computed for the period from 31/8/1999 to 31/8/2001.
- Then we move to the window that covers the period from 1/9/1999 to 1/9/2001 and compute the WBAVR and AQ statistics for this period.
- This process is continued to the end of the data set and we can obtain daily measure of return predictability to August 2015.

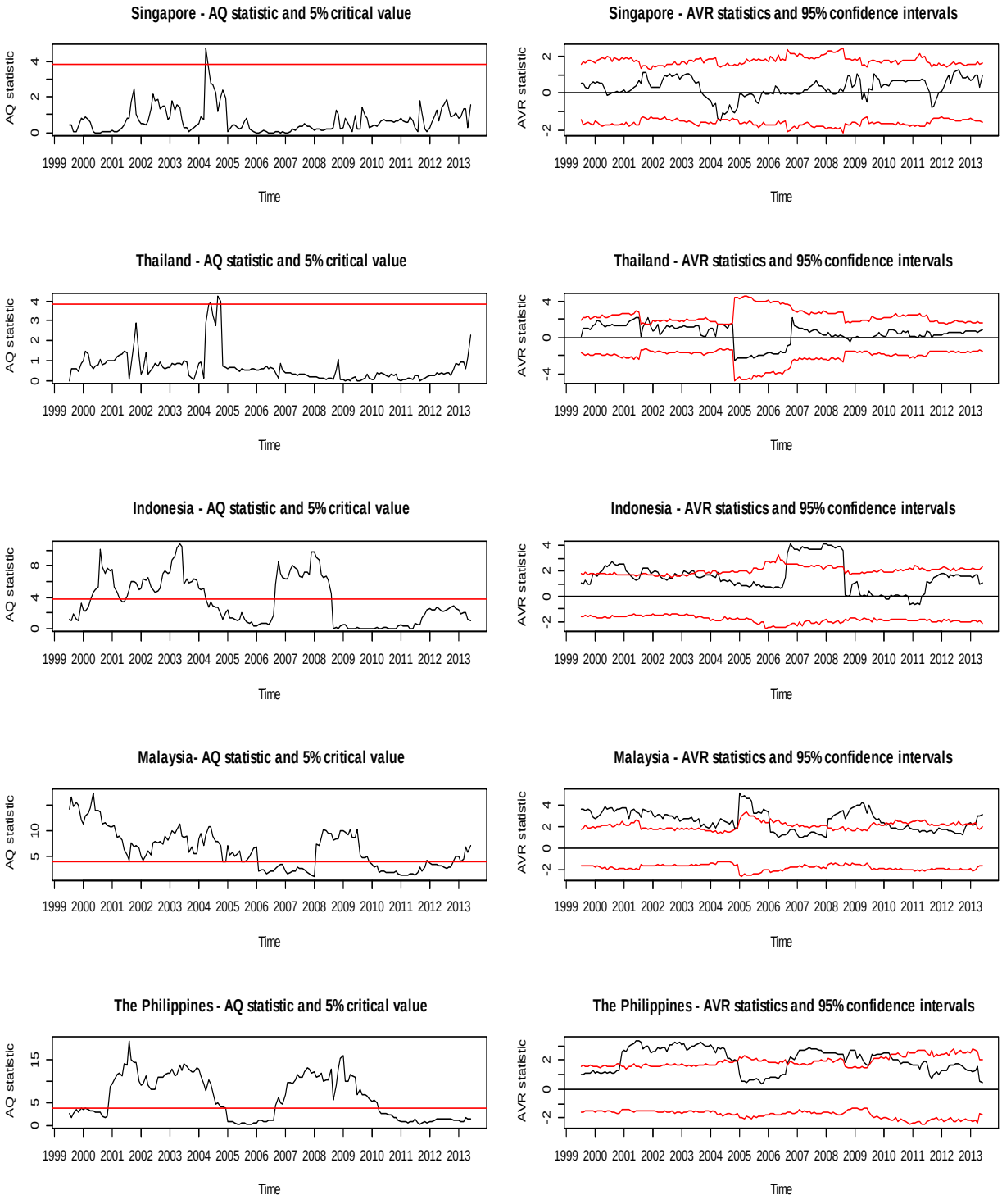
In this analysis, the width of the 95% confidence interval (CI) of the WBAVR statistics is employed as a measure of uncertainty associated with return predictability. A wider interval of confidence indicates a higher degree of the associated uncertainty.

III. Empirical results and Policy Implications

III.1. Empirical results

Figure 2 reports results of the WBAVR and AQ tests using daily data over a two-year subsample window. The vertical axis shows values of the test statistics and the horizontal axis is marked with dates of time windows. The 5% critical value is plotted for the AQ test, and the 95% confidence interval is plotted for the AVR test. Graphically, the higher value of the AVR (in absolute value) and AQ statistics, the higher return predictability and the stronger evidence against the weak-form market efficiency. The null hypothesis of zero serial correlation is rejected at 5% level of significance when the AQ statistics go over 5% critical value (3.84) or the AVR statistics go outside 95% confidence bound.

According to Fig. 2, there are obvious changes in the degree of market efficiency over the course of fifteen years since both statistics show fluctuation. The most remarkable result emerges from the figure is a common tendency of improving efficiency over time across investigated markets. For all markets, degrees of autocorrelations are higher before the GFC, especially high in 2008, even though, they become significantly lower after this event. This implies that the regional markets' efficiency have significantly improved since the GFC.



Notes.
The horizontal line for Q test is 5% critical value (3.84).
The Q test statistics above this line indicates rejection of the martingale hypothesis at 5% level of significance.
The black line in the graph plots the AVR statistics and the red lines represent the 95% confidence intervals. The AVR test statistics lie out of these two lines indicate rejection of the martingale hypothesis at 5% level of significance.

Figure 2. Automatic Q and Automatic variance ratio test for daily data

For Group 1 markets, [1]a quick glance at Fig. 2 reveals that the WBAVR statistics of Singaporean and Thailand markets remain inside confidence band for the whole sample period. Correspondingly, the AQ statistics are lower than 3.84 except for two years 2004 and 2005. Since the WBAVR test have higher power than the AQ test in many linear and non-linear models (Charles et al, 2011), the MDH is not likely to be rejected for these two years. As a result, it can be concluded that the markets of Singaporean and Thailand are efficient overall.

For Group 2 markets, the AQ and WBAVR statistics show a high level of return predictability over the first four years of 21st century. The similar level is also evident around the GFC, however, after the GFC, both statistics reveal a much lower degree of return predictability. Among this group, Indonesian stock exchange has emerged as the least affected by the GFC since this market turned back to efficiency in 2009 while the other markets cannot attain of the efficient level until the next year (2010). In another perspective, Malaysian stock exchange shows the highest degree of inefficiency within the period explored. This stock exchange exhibit deviations from the MDH in most of the time with the exception from 2006 to 2008 and from 2010 to 2012. Furthermore, both statistics also uncover the fact that the Malaysian market exhibits the signal of inefficiency from 2013 to the end of the studied stage while the markets of Indonesia and the Philippines, by contrast, have functioned efficiently since returning to efficient status.

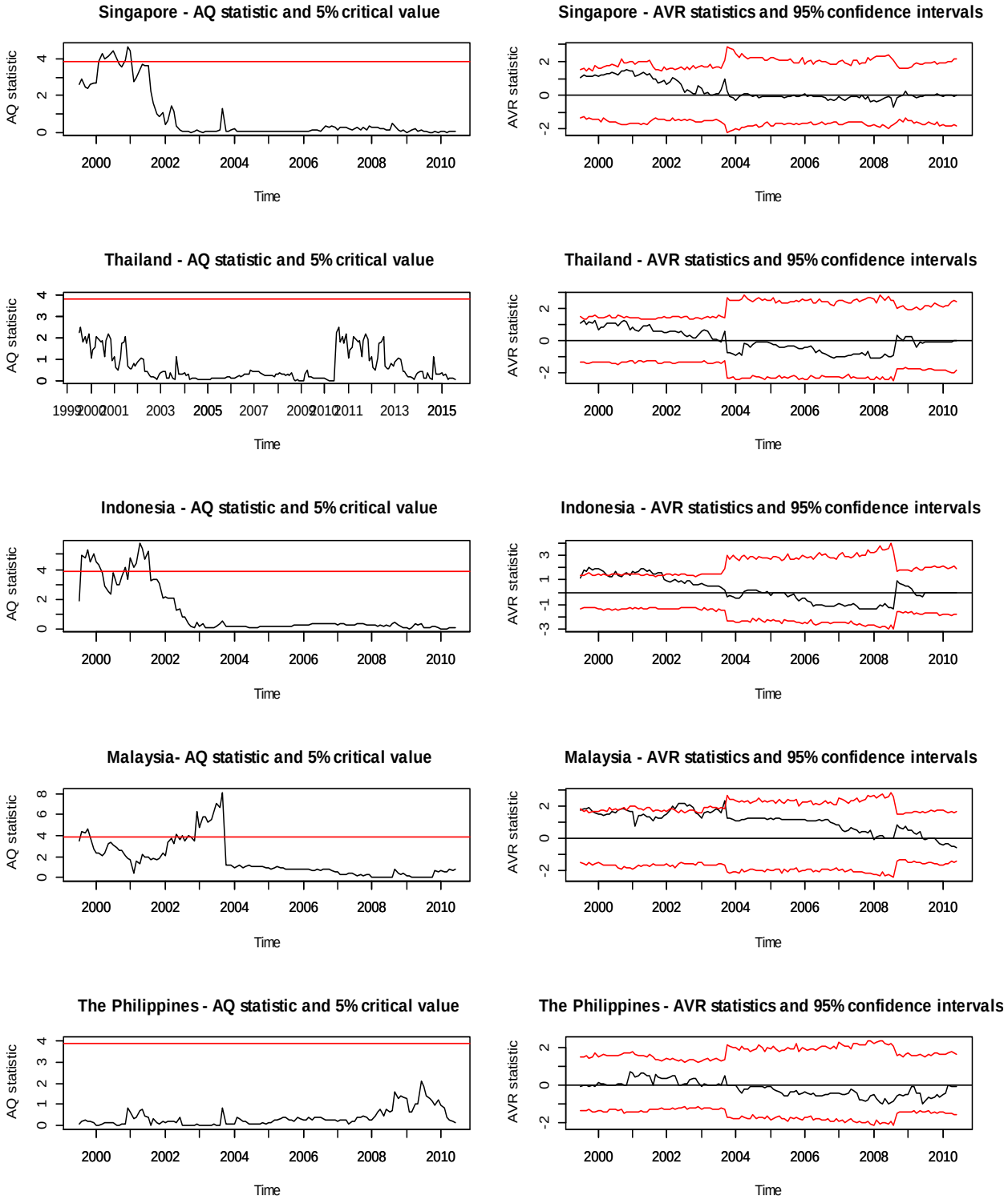
[1] To be convenient in comparing and figuring out the common tendency between the studies, the markets in this study are divided into Group 1, which includes Singaporean and Thailand markets, and Group 2, which includes Indonesian, Malaysian and the Philippines markets. These two group markets are based on the results of previous studies which reveal that Singaporean and Thailand markets became efficient after the Asian financial crisis while Malaysian, Indonesian and the Philippines markets showed no sign of efficiency (for example, see Kim and Shamsuddin, 2008).

Paying attention to the range of WBAVR's confidence band which represents uncertain level of return predictability, it is noticeable that the bands range approximately from -2 to 2 over normal times but are wider during the crisis time (2006 to 2008) in all markets. This reveals a high degree of uncertainty in the ASEAN stock markets during the crisis. In the post crisis period, all stock markets remain at much lower volatility level except for the Philippine's market. In the exceptional case, stock market reaches the highest level of volatility at the end of the investigated period.

Lo (2004)'s adaptive market hypothesis (AMH) states that the degree of efficiency varies continuously over time because of changes in market conditions as well as the psychology of market participants. Timmermann (2008) attributes these changes in efficiency to incomplete learning effects, structural changes in the return generating process and exogenous events. With this in mind, this empirical analysis traces the time variation predictability of ASEAN markets to validate Lo's (2004) hypothesis. As highlighted in Fig.2, the changing of WBAVR and AQ values over time obviously illustrate the time-varying nature of the predictable patterns in the dataset. Of Group 1 markets, two stock returns are not predictable for most of the sample periods, though there are sometimes evidence of local predictability. The graph of Group 2 markets demonstrates that return predictability are possible during periods of the GFC and 2000-2004 but not possible in other time. These results are a prominent evidence in support of the time varying efficient perspective of the AMH. On accounting of the fact that stock market crash in 2008 is caused by investors' panic with link to US sub-prime mortgage, it precisely represents extreme event that change market conditions. The results of better efficiency after the GFC of Group 2 markets, therefore, also confirm that changing market ecologies is a significant factor for return predictability. From the standpoint of behavioural finance, it reflects

investors' under-reaction or overreaction to news in Group 2 markets. Kim et al (2011) report empirical evidence in that American stock return predictability is directed by changing market conditions. Our study results show the similar evidence for Malaysian, Indonesian and the Philippines markets.

Aside from graphing the time varying autocorrelations, a meaningful comparative analysis to validate the AMH is conducted by computing the number of insignificant rolling windows over full sample period. If the markets are efficient for the complete period, the ratio should be below 5%. Consequently, if the AMH is true and the stock exchanges become inefficient on occasion depending on market conditions, this ratio should be substantially higher than 5%. This is hinged on the presumption that each successive case is independent, which may be debatable. In this analysis, the ratios for the WBAVR test are 0.59% for Singaporean market, 2.38% for Thailand market, 64.2% for Malaysian market, 54.7% for the Philippines market and 33.3% for Indonesian market while the corresponding figures for the AQ test are 0.59%, 1.78%, 66.07%, 54.76% and 41.07%, respectively. These figures verify the AMH in Group 2 markets. Additionally, it reconfirms the highest degree of market inefficiency of Malaysian stock exchange as shown before.



Notes.

The horizontal line for Q test is 5% critical value (3.84).

The Q test statistics above this line indicates rejection of the martingale hypothesis at 5% level of significance.

The black line in the graph plots the WBAVR statistics and the red lines represent the 95% confidence intervals. The WBAVR test statistics lie out of these two lines indicate rejection of the martingale hypothesis at 5% level of significance.

Figure 3. Automatic Q and Automatic variance ratio test for weekly data

Figure 3 reports the analysis of weekly returns using a five-year window length. Similar to the daily data, the weekly data show the time-varying nature of predictability and the tendency of higher efficiency over time in all investigated markets. These features are largely consistent with those observed from Fig.2. In addition, there are some notable features which emerge from weekly data:

For Group 1 markets, there are no significant differences between the analysed outcomes from daily data and those from weekly data in terms of efficiency, although the size of the latter group was smaller. Both statistics reveal a small degree of return autocorrelations from 1999 to 2015 and this degree decreases gradually over time. Consequently, Singaporean and Thailand markets showed the martingale behaviour overall.

For Group 2 markets, the results from weekly data are incompatible with those from daily data. To provide more detail, the efficiency of the Philippines stock exchange is generally accepted by two tests for the whole sample when analysing weekly data. But for daily data, both tests indicate a rejection of the MDH before and during the 2008 crisis; though from 2009 onward, they reveal the martingale behaviour. The similar divergence between two data sets is also evident in Indonesian stock exchange. While the weekly data provides evidence in favour of efficiency before, during and after global crisis, the corresponding daily data reject the MDH around 2008 and from 2000 to 2004. The most conflicting results occur in the case of Malaysian stock market. Using daily data, the tests' results indicate that Malaysian market is inefficient in most of the analysed period excluding two short-lived periods of efficiency (2006-2008 and 2010-2012). The results from weekly data, however, show the opposite results: Malaysian market is efficient before, during and after crisis with only a short-lived inefficient time from 2002 to 2004.

Despite the lack of consistency, the difference between daily and weekly results of the Group 2 markets are somewhat expected. Kim and Shamsuddin (2008) cope with the same situation and they argue that this contradiction happens because of slow price adjustment in response to a shock, which might be explained by regulatory constrains such as the system of stock price limits and the extent of domestic financial market liberalization.

Given the outcome from daily data are based on a larger sample size, results from this dataset are definitely more powerful than those from weekly data. Therefore, it may be concluded that Group 2 markets are inefficient before and during the crisis and have become efficient after that. From these final results, it is interesting to compare the obtained outcomes with those from past studies. In term of level of efficiency, the outcomes of this study agree with finding from prior study of Lim, Brooks and Kim (2007) where Singapore market is the most efficient market in the region, follow by markets of Thailand, Indonesia, the Philippines and Malaysia. Regarding to the EMH, the finding of efficiency for Singaporean and Thailand markets differs from some published papers (Lento, 2007; Hoque et al, 2007), even though it is consistent with results of Kim and Shamsuddin (2008) and Guidy and Guta (2013). For Group 2 markets, past studies generally found inefficiency before 2010: see Lai et al (2002); Hoque et al (2007); Lento (2007); Kim and Shamsuddin (2008); Guidy and Guta (2013). In this study, the achieved evidence points to the same results. Moreover, new evidence is in support of efficiency of Group 2 markets from 2010 onward. Two striking discoveries in this Group from daily dataset are: 1) Malaysian stock exchange has revealed the signal of inefficiency from 2013 to the end of the studied period and 2) At the same time the Philippines market has been at high level of uncertainty. It is suspected that these new findings are due to number of reasons including

the use of more segregated data, superior statistical tests which are robust to outlier as well as structural changes, and updated data.

III.2. Interpretation and Policy Implications

From the previous analysis, some policy implications can be discerned as following:

Firstly, it is worth noting that there have been several changes in the regulatory framework, microstructure and technology which potentially improve market efficiency in ASEAN region over last one and a half decade. ***From regulatory framework perspective***, one countable major change is that after the 1997 Asian financial crisis, most of ASEAN countries introduced more efficient domestic regulatory framework in an attempt to better monitor financial sector activities (Guidi and Gupta, 2011[2]). With a better regulatory environment, it is likely that the stock exchanges become more efficient over time. Another major change is that during the 2000s, ASEAN equity markets have experienced a rapid growth in the number of listed companies, capitalization and liquidity (Guidi and Gupta, 2012). This rapid growth and the corresponding reform of regulatory systems may have contributed to reduce the systematic divergence of stock price from the fundamentals resulting in more efficient markets. Last but not least, in 2010, ASEAN Finance Ministers Meeting decided a roadmap for financial integration with the ultimate goal of greater economic integration among ASEAN countries by 2015. Yee and Hong (2013) report that a series of actions has been taken to facilitate the access of investors in to the markets, such as: reducing friction of moving

[2] According to Guidy and Gupta (2011), after the 1997 Asian Crisis, ASEAN countries established financial institutions to monitor and improve efficiency of financial activities. In Singapore, the institution is managed by the Monetary Authority of Singapore (MAS). In Thailand, the Bank of Thailand (BoT) is responsible for the duty while in Indonesia, the corresponding institutions are the Bank of Indonesia (BoI) and the Indonesian Capital Market and Financial Institutions Supervisory Agency. In Malaysia, the responsible unit is Central Bank of Malaysia (BNM) and in the Phillippines, it is Central Bank

funds into and across the markets, providing secure ownership rights, ensuring protection of investors and even facilitating the exit of funds. These relaxations on financial regulation of all states over a range of domestic and foreign investors may help to improve the efficiency of ASEAN stock markets. ***From microstructure and technology change perspective***, new trading platforms and direct market access (DMA) which allow algorithmic trading were introduced in Singapore (2012), in Thailand (2009), in Indonesia (2010), in Philippines (2010) and in Malaysia (2012). Meanwhile, an ASEAN Trading Link has been offered to connect seven stock exchanges in six ASEAN countries and provide a single point access. This trading link and the application of algorithmic trading are expected to provide easier access to liquidity, further accelerate the efficiency of ASEAN markets. Along with those policies, the tick size [3]is also cut in all markets investigated. Singapore is the first stock exchange conducting this measure in 1994, 2007 and 2011. It is then followed by Thailand (2001), Indonesia (2007), Malaysia (2009), and the Philippines (2010). Angel (1997) reports that tick size reduction does not only reduce time spent bargaining, enforce time and priority in a limit order book, but also provide incentives for investors to supply liquidity by submit limit order. Consequently, tick size reduction will certainly help increase liquidity of markets which may lead to improvement of market efficiency.

A tendency of better efficiency in all regional stock markets over past fifteen years, especially after 2009 as pointing out in previous section is strong evidence which reveals that the ongoing liberalization processes and removal of restrictions to trading activity have played their role in the nature of ASEAN stock markets. This appears to be well supported by Kim and Signal's paper (1997) which investigated effect of financial liberation

[3] The tick size is minimum price variation to allow stock price change.

on Asian stock market efficiency and found that liberation generally improve the degree of efficiency. From this result, ASEAN policy makers are advised to speed up their existing liberalization process.

Secondly, it should be noted that after the Asian financial crisis, ASEAN governments took an obtrusive approach in the execution of their mandates with respect to regulating and developing the capital markets, in an effort to support stable market development (Guidi and Gupta, 2012). However, the inefficiency of Indonesian, Malaysian and the Philippines markets during the pre-crisis (2000-2004) as showing in above analysis suggests that the approach of Group 2 governments may not be effective in this period. In the next inefficient period of these markets, the rejection of the MDH around 2008 seems to be an effect of market sentiments during the crisis or influential outliers occurred as a result of the GFC. It, therefore, can be inferred that the approach also did not work in this time.

Thirdly, as reported by 2013 IMF's Malaysia Financial sector stability assessment, in 2011, the security commission of Malaysia launched a second ten-year Capital Market Masterplan (AMP2) which outlines strategies to further develop the capital market and support the establishment of a robust culture of governance. Despite this, the inefficiency of Malaysian stock market since 2013 suggests that the implementation of AMP2 have little impact on market efficiency at the first stage. Hence, the Malaysian policy makers are called for presenting more efficient regulatory framework to better monitor financial sector activities.

Finally, the high uncertainty problem of the Philippines should be of interest not only to practitioners and scholars; but also to regional policymakers, because as of November 2014, the Philippines was considered as the best equity market performers among ASEAN countries with a stock market index return of 24 percent year-to-date (Reny .E.P, 2014). According to "An overview of IFRS adoption in ASEAN", until

2013, the Philippines is the only country in ASEAN which does not apply International Financial Reporting Standards (IFRS) for its stock market. Consequently, IFRS could be interpreted as a reason for high uncertainty level of Philippines stock exchange. This is endorsed by research of Lambert et al. (2006) which found that IFRS has certain impact on the informational efficiency. Consequently, to address this uncertainty problem, the Philippines policy makers are recommended to adopt IFRS and introduce further reforms regarding to improving regulatory framework as well as increasing standards of transparency.

IV. Conclusion

This paper examines the weak-form efficiency of five ASEAN stock markets. We use daily and weekly measures of return for the period from 1999 to 2015. The results are based mainly on daily observations and the WBAVR test. Weekly data and the AQ test are employed in an effort to have a robustness check of the results.

Generally, a common tendency of better efficiency in all analysed stock exchanges over time is found. This indicates that liberalization processes have positively influence on the efficient nature of ASEAN stock markets. Additionally, it is also found that market efficiency varies between ASEAN countries. For the high level of liquidity markets of Singapore and Thailand, evidence in favour of efficiency is validated for the whole period investigated. For other markets, signals of inefficient pricing are detected from 2000 to 2004 and during the GFC; despite this, no inefficient signal is evident after the crisis except for Malaysian stock exchange. This finding suggests that: Firstly, the obtrusive approach taken by the Group 2 governments after Asian financial crisis did not function well from 2000 to 2004 and during the GFC. Secondly, the experience of the GFC as well as the improvements in legal framework and removal restriction deploying by ASEAN countries to prepare for AEC have

significant impact on efficient nature of these regional stock exchanges, especially for the Indonesian and the Philippines stock markets. In the case of Malaysian market, the inefficiency from 2013 points out that the AMP2 plan of this country's security commission has not reached expected outcome and should be monitored carefully to reach its goal.

This study also offers vital evidence for uncertainty degree of ASEAN stock exchanges. It is discovered in both groups that a high degree of volatility emerged during crisis period in both daily and weekly data. This implies that a financial crisis can be forecasted based on level of volatility of stock markets. As the analysis found, Philippines market has presently been at the highest level of uncertainty since 1999. It is consequently recommended that the Philippines policy makers should immediately execute necessary reforms to depress the volatility level of stock exchange and prevent a potential financial crisis in future.

Regarding the AMH of Lo (2004), the paper has managed to provide additional support for the hypothesis. We found evidence that: (1) Return predictability of ASEAN markets fluctuates over time. (2) Efficiency in the Group 2 markets shows to be governed largely by changing market conditions.

In short, this paper has figured out efficiency level of five ASEAN stock markets as well as a positive influence of liberalization progress in region until August, 2015. However, the liberalization progress is moving forward and the efficiency degree may change over time. Thus, a possible future extension of this study is to apply Anatolyev (2009)'s procedures to monitor the impact of liberalization together with the change of efficiency as new observations arrive.

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