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Additional evidence against the Weak–form of the Efficient Markets Hypothesis: the Indonesian Stock Exchange

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ABSTRACT

Using several non-parametric and parametric econometric methods, we test for the weak form efficiency of the Indonesian stock market; one of the promising emerging markets of the world. Analyzing daily data from 1983 to 2007, we find that Indonesian market is not weak form efficient. This is yet another financial market where stock prices can be predicted from information in the past stock prices.

JEL: G10, G15
Keywords: Efficient Markets Hypothesis, Emerging Markets

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INTRODUCTION

The earlier tests of the weak form of the Efficient Market Hypothesis (EMH) have showed that future returns cannot be predicted by past returns. Fama's (1991) extensive study covered the predictability of returns to the predictability of dividends, to the forecastibility of firm size and the seasonality of returns. Following Fama (1991), numerous studies have tested the validity of the EMH on developed markets. As data becomes available, studies on emerging markets emerged.

Earlier empirical examinations of the EMH were mainly based on serial correlations and runs tests, with more recent tests of market efficiency have used variance ratio tests. The latest tests have relied on Augmented Dickey-Fuller, unit root and Johansen's cointegration. Using tests based on variance estimators, Lo and MacKinlay (1988) have rejected the random walk hypothesis. Lee (1992), also working with variance ratio tests, found that the random walk model provides appropriate characterization of weekly return series for the majority of developed countries. These findings were confirmed by Choudhry (1994), Chan et al. (1997), Huang (1995) and Worthington & Higgs (2004).

Opposite results were reported by Al-Loughani and Chappel (1997). They have determined that the FTSE 30-share index does not follow a random walk. Groenewold (1997), who worked with data from Australia and New Zealand, concluded that past returns help to explain current returns in each country, but that the proportion of variation explained is still small.

Since the late 1980s, emerging markets have attracted considerable attention (Poshakwale (1996), Moustafa (2004), Tas and Dursonoglu (2005)). Most of these studies have also resulted in conflicting results. Urrutia (1995) tested the efficient market hypothesis for Argentina, Brazil, Chile, and Mexico. The random walk hypothesis was rejected for all four markets when the variance ratio tests were used, while runs tests were not able to reject the EMH. Employing the Ljung-Box Q, the runs and unit root-tests, Chang et al. (1996) and Chang and Ting (2000) observed that the Taiwan stock market was weak-form efficient.

To sum-up, Table 1 shows that most empirical studies of developed markets support the random walk hypothesis and that these markets are at least weak-form efficient. A similar conclusion cannot be made in the case of emerging stock markets. Mixed results from the literature on emerging stock market efficiency are not surprising, as emerging stock markets are generally less efficient than developed markets. In comparative terms, while the developed markets, with well-established institutions, are characterized by a high level of liquidity and trading activity, substantial market depth and low information asymmetry, emerging markets exhibit more information asymmetry, thin trading and shallow depth; often because of their weak institutional infrastructure.

The remainder of this manuscript includes four sections. Section 1 introduces Indonesia, the Jakarta stock exchanges and summarizes the studies published about the efficiency of the Indonesian market. Section 2 presents the data and the methodology. Section 3 discusses our findings**.**

Table 1. Summary of Selective Empirical Studies on Weak-Form Efficiency in Developed and Emerging Stock Markets

Plus (+) sign indicates that the random walk hypothesis is not rejected, minus (-) sign indicates that the random walk hypothesis is rejected, and plus and minus signs together +(-) indicates the mixed results of rejecting the random walk hypothesis. Panel A shows the studies on developed markets and Panel B shows the studies on Emerging stock markets.

Study	Market	Sample	Results
Panel A: Developed markets			
Lo & MacKinlay (1988)	U.S.	1962-1985	-
Lee (1992)	U.S.,10 developed countries	1967-1988	+
Choudhry (1994)	U.S, U.K., Canada, France, Japan, Italy, Germany	1953-1989	+
Huang (1995)	9 Asian stock markets	1988-1992	+(-)
Al-Loughani & Chappel (1997)	U.K.	1983-1989	-
Chan, Gup & Pan (1997)	18 international stock markets	1961-1992	+
Groenewold (1997)	Australia, New Zealand	1975-1992	+(-)
Cheung & Coutts (2001)	Hong Kong	1985-1997	+
Worthington & Higgs (2004)	16 European markets	1987-2003	+
Lima & Tabak (2004)	Hong Kong, Singapore	1992-2000	+(-)
Panel B: Emerging markets			
Laurence (1986)	Singapore, Malaysia	1973-1978	-
Barnes (1986)	Malaysia	1974-1980	+
Butler & Malaikah (1992)	Kuwait, Saudi Arabia	1992-1998	-
Parkinson (1987)	Kenya	1974-1978	-
Dickinson & Muragu (1994)	Kenya	1979-1988	+
Urrutia (1995)	Argentina, Brazil, Chile, Mexico	1975-1991	+
Poshakwale (1996)	India	1987-1994	-
Chang et al. (1996)	Taiwan	1967-1993	+
Antoniou et al. (1997)	Turkey	1988-1993	-
Karemera et al. (1999)	15 emerging stock markets	1986-1997	+
Ojah & Karemera (1999)	Argentina, Brazil, Chile, Mexico	1987-1997	+
Chang & Ting (2000)	Taiwan	1971-1996	+
Abeysekera (2001)	Sri Lanka	1991-1996	-
Mobarek & Keasey (2002)	Bangladesh	1988-1997	-
Abraham et al. (2002)	Kuwait, Saudi Arabia, Bahrain	1992-1998	+(-)
Appiah-Kusi & Menyah (2003)	11 African stock markets	1989-1995	+(-)
Gilmore & McManus (2003)	Czech Republic, Hungary, Poland	1995-2000	-
Smith & Ryoo (2003)	Greece, Hungry, Poland, Portugal, Turkey	1991-1998	+(-)
Hassan et al. (2003)	Kuwait	1995-2000	-
Moustafa (2004)	The United Arab Emirates	2001-2003	+
Worthington & Higgs (2004)	Czech Republic, Hungary, Poland, Russia	1994-2003	+(-)

Abrosimova et al. (2005)	Russia	1995-2000	+
Akinkugbe (2005)	Botswana	1989-2003	+
Khaled & Islam (2005)	Bangladesh	1990-2001	-
Tas & Dursonoglu (2005)	Turkey	1995-2004	-
Hassan et al. (2006)	7 European emerging stock markets	1988-2002	+(-)

THE JAKARTA STOCK EXCHANGE AND THE EMH IN INDONESIA

The Jakarta Stock Exchange

The Republic of Indonesia proclaimed its independence from the Netherlands in August of 1945. The country transformed from virtually no industry in 1965 to the production of steel, aluminum, and cement by the late 1970s. Indonesia is now a major exporter of oil, responsible for about six percent of the total from petroleum exporting countries. The country's industrial transformation is due, in part, to the development of the Jakarta Stock Exchange.

Bursa Efek Jakarta, or Jakarta Stock Exchange (JSX), is located in Jakarta, the capital of Indonesia. Established in 1992 (as it exists in its present form), the stock exchange had an informal existence since the beginning of the 19th Century. The JSX was officially launched in 1912, under the authority of the Dutch colonial government. Like many exchanges around the world, it closed during World War I and World War II. In 1977, thirty years after World War II, the exchange was reopened under the management of Ministry of Finance. On July 13, 1992, the stock exchange was privatized and turned into a limited liability company using the local name of PT Bursa Efek Jakarta. At this time "Bapepam"[2] became the capital market watchdog. In the years that followed, as the JSX and Indonesian financial sectors developed, the volume of transactions and the number of companies listed increased and the market experienced a large bull run in 1990. On July, 1992, the exchange was privatized. On March 22, 1995, JSX opened the Jakarta Automated Trading System (JATS). Table 2 presents the major events characterizing the JSX history.

As shown in Table 2, the market has experienced major structural changes. Because these changes have the potential for affecting market efficiency, the sample period is thus divided into several sub-periods of different market environments. These periods are presented below.

Period 1: Privatization

The privatization of the Jakarta Stock Exchange became a reality in July 1992. In the 1990s, privatization was a key component of structural reform programs in both developed and developing economies. The aim of these programs was to achieve higher microeconomic efficiency and foster economic growth. These programs were also introduced to help reduce

[2] According to the Law of the Republic of Indonesia concerning the Capital Market, guidance, regulation, and day-to-day supervision of capital market is provided by Bapepam (a government organization) in order to implement an orderly, fair, and efficient capital market activities and protect the interests of investor and public.

public sector borrowing requirements through a reduction in subsidies. As the exchange was privatized on 07/13/1992, our analyses will compare the distribution of returns before (PRIVATEB) and after the privatization period (PRIVATEA). To eliminate bias due to the impact of the event, the data will end 10 days prior to the event and resume 10 days after.

Period 2: JATS

On March 22, 1995, the JSX launched the Jakarta Automated Trading System (JATS). The upgrade to an automatic trading system is often believed to be an important step in the support of an exchange mission to become a competitive venue. The introduction of the JATS will be used to divide data, as done previously, for the privatization of the exchange. JATSB refers to the period before the introduction of a new trading system and JATSA refers to the period after the introduction. As mentioned above, in order to eliminate bias, due to the impact of the introduction of the JATS, data will end 10 days prior to the event and resume 10 days after.

Table 2:Jakarta Stock Exchange Historical Development

This table illustrates the major development of Jakarta Stock Exchange from 1912 until now

1912	The first Stock Exchange in Indonesia is built in Batavia (currently known as Jakarta) by the Dutch East Indies.
1914 – 1918	The Batavia Stock Exchange is closed during the World War I.
1925 – 1942	The Batavia Stock Exchange is re-opened, and new stock exchanges are established in Semarang and Surabaya.
Early 1939	Due to political issues, the stock exchanges in Semarang and Surabaya are closed.
1942 – 1952	During World War II, the Jakarta Stock Exchange (JSX) is closed.
1952	JSX is re-opened. The only product traded in the Exchange is the Indonesian Government bond.
1956	Due to the nationalization of several Dutch's companies by the Indonesian Government, the JSX became stagnant.
1956 – 1977	During this period the JSX is inactive.
1977	The JSX is re-activated. PT Semen Cibinong is the first issuer listed in the JSX.
1977 – 1987	The exchange is growing. Twenty four companies are now listed.
1987	The Indonesian Government enacted regulations to simplify the process of going public and to attract foreign investors.
1988 – 1990	The banking sector and capital markets are deregulated and the JSX is welcoming foreign investors.
June 2,1988	Indonesia Parallel Bourse started to operate.
Dec-88	Additional regulations to bring positive images and growth are introduced.
16-Jun-89	The new Surabaya Stock Exchange (SSX) started to operate. It is managed by the Surabaya Stock Exchange Inc.
13-Jul-92	The JSX is privatized. This date is still celebrated as the anniversary of Jakarta Stock Exchange.
22-May-95	The JSX introduced the computerized Jakarta Automatic Trading System (JATS).
10-Nov-95	The Government of Indonesia issued Regulations No. 8 to provide better legal foundation for investors and to protect the investing public.

07/22/1995	On July 22, 1995, the market successfully merged with the as Indonesian Parallel Exchange.
2000	A new trading system is introduced in Indonesia's Capital Market.
2002	The JSX started to implement a remote trading system.
2007	Surabaya Stock Exchange was merged with the Jakarta Stock Exchange. As a result, JSX changed its name into the Indonesia Stock Exchange.

Period 3: Merger 1995

In July 22, 1995, the Indonesian Parallel Bourse merged with the Surabaya Stock Exchange. The merger was intended to help accelerate economic development in Indonesia and was part of a long-term plan to create a more efficient and transparent capital market. For Indonesia, an efficient capital market was a crucial step toward helping the economy move from a banking-dominated economy to a system in which the capital market would serve as the major source of funding for economic development. In this study, the 1995 merger is also used to divide the data. MEGERB refers to the period before the merger and MERGERA refers to the period after the merger. Again, data will end 10 days prior to the event and resume 10 days after in order to eliminate biases

Period 4: Asian crisis

In Indonesia, the Asian crisis started later than in the other contaminated countries. The rupiah did not come under attack until August of 1997 when the managed floating exchange regime was replaced by a free-floating exchange rate arrangement. Despite this change and the intervention of the IMF, the rupiah continued to drop. The rupiah and the Jakarta Stock Exchange reached an historic low in September of 1997, as companies that had borrowed in dollars had to face the higher costs imposed upon them by the rupiah's decline. By mid-1998, the country was on the road of recovery when Habibie replaced Suharto as President. To analyze the impact of the Asian crisis on market efficiency, the sample was further divided into two sub periods. The first period ends in 08/01/1997; it represents the period before the crisis (ASIANB). The second period starts after 07/01/1998; it is the period after the crisis (ASIANA). We attempt to control for the event bias by eliminating data too close to the event. As done previously, we select a window of 10-days.

Evidence of the EMH in Indonesia

The EMH as introduced by Fama (1991); is tested for the JSE for the whole sample and each of the sub-periods described above. As far as the EMH is concerned, studies undertaken so far have shed some lights on the Asian Pacific area. Studies, however, have not yet focused exclusively on Indonesia. As shown below, most studies used Association of Asian Nations (ASEAN countries include Indonesia, Malaysia, Philippines, Singapore, and Thailand) or focused on the political struggles that have characterized Indonesia during the 1980s and 1990s.

Praphan and Sharma (2002) have investigated the role of select macroeconomic variables, i.e., GNP, the consumer price index, the money supply, the interest rate, and the exchange rate on the stock prices in five ASEAN countries. They found long and short term relationships between stock prices and these macroeconomic variables. Click and Plummer (2005) considered the degree to which the five stock markets in the original ASEAN-5 are correlated. Their empirical

findings have suggested that the ASEAN-5 stock markets are co-integrated and, therefore, are not completely segmented by national borders. **Manning (2002)** used different estimation approaches to show that equity markets in South East Asia are converging during the 1990s.

Indonesia political struggles have led to several studies. Wang (2000) addressed the benefits and risk of foreign investment in Indonesia. Wang's (2000) findings have revealed that the large orders placed by foreign institutional investors improve local market depth and liquidity. Fisman (2001) reported that firms connected to President Suharto experienced large losses, as Suharto's health was deteriorating. Leug and Oberholzer-Gee (2006) have reported that firms with strong political connections are less likely to have publicly traded foreign securities. Wang (2006) has documented a strong relationship between foreign equity trading and market volatility in Indonesia and Thailand.

As far as we know, Indonesia has been included in several studies about market efficiency. A focus on Indonesia itself, however, has not yet been published. Griffina, Kellyb, and Nardaric (2008) have proposed to incorporate measures of both public and private information to investigate the efficiency of 55 individual equity markets, including Indonesia. Evidence from their study has revealed that markets with high levels of investors' protection react to earnings events more than markets with lower levels of investors' protection. They have also examined the speed at which public information is incorporated into prices and found that many emerging markets are remarkably efficient at incorporating information. Dvorak (2005) has shown that clients from local brokerage firms have a short lived information advantages over clients from global firms. Clients from global brokerage firms, however, are better at picking long-term winners. Findings from multiple variance ratio tests reported by Kim and Shamsuddin (2008) have indicated that the Hong Kong, Japanese, Korean and Taiwanese markets have been efficient in the weak-form. The markets of Indonesia, Malaysia and Philippines have shown no sign of market efficiency, despite financial liberalization measures implemented since the eighties.

Lim, Brooks and Hinich (2008) have examined the weak-form efficiency of 10 Asian emerging stock markets. Their statistical results revealed that all of the returns series contain predictable nonlinearities even after removing for serial correlations. Hoque, Kim and Pyun (2007) have revisited the random walk hypothesis for eight emerging equity markets in Asia: Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. The hypothesis was tested with variance ratio tests, Wright's rank and sign tests, Whang–Kim subsampling tests and the conventional Lo–MacKinlay and Chow–Denning tests. They found that, with the exceptions of Taiwan and Korea, the stock prices of the Asian countries studied do not follow a random walk. They have also reported that the opening of the eight stock markets to foreign investors following the Asian financial crisis in 1997, has not significantly altered the mean-reversion patterns of stock prices vis-à-vis the market efficiency hypothesis. Finally, Ghosh, Swati and Revilla (2008) have explored the relative efficiency of the same stock markets using newly available data on transactions costs and the quality of the informational environment of stock markets. They have found that some institutional arrangements, such as the availability of stock lending, short selling-and the openness of markets are associated with lower transactions costs.

Although some of the characteristics of Indonesia are shared with its neighbor countries, Indonesia is quite unique. First, Indonesia is ASEAN's biggest economy. Second, political changes in Indonesia have extended far beyond legal and institutional reforms experienced by most neighboring countries. Third, corruption has always been more extensive in Indonesia than in most other emerging countries.

Studies assessing the efficiency of the Indonesian exchange are quite important. Looking back at the Asian crisis, we found general agreements that Indonesia, South Korea and Thailand were the countries most affected by the crisis. A better understanding on how efficient these markets have been before and after the Asian crisis will shed some light on the EMH and the impact of crisis on financial markets efficiency. Further, as discussed in the following section, Indonesia went through substantial changes since the 1990th. Again, a better grasp on how efficient these markets have been before and after these changes should enhance our understanding of the EMH.

DATA & METHODOLOGY

Data

The Jakarta Stock Price Index (JSX) is a modified capitalization-weighted index, an index similar to a general market capitalization index with one main difference. In a modified capitalization-weighted index, the largest stocks are capped to a percent of the weight of the total stock index and the excess weights are redistributed equally amongst the other stocks. The JSX was introduced April 1, 1983. At that time, the index equals 100, and the number of stocks listed was 13.

Methodology

A relationship between subsequent price movements supports the idea that markets are inefficient. Indeed, if historical data can successfully be used to predict future prices, the argument that the market is predictable, and hence inefficient, has some credibility. Therefore, the issue is to see whether the stock market is predictable or not by detecting some type of relationship between successive stock returns. To achieve this objective, this study uses several non-parametric and parametric econometric methods. The non-parametric tests include the Anderson-Darling test and the Run test. The parametric tests consist of the serial autocorrelation tests, unit root tests and ARIMA. These tests are reviewed below.

Non-parametric tests

Anderson-Darling

The Anderson-Darling statistics converts the data into a uniform distribution and examines if the transformed data conformed to uniformity. Specifically, the test statistic "A" evaluates whether R_{mt} comes from a distribution with a cumulative distribution function F. "A" is defined as follows:

$$\boldsymbol{A^2 = -N - S} \quad (2)$$

$$\textbf{with } \boldsymbol{S = \sum_{t=1}^{N} \frac{(2t-1)}{N} [\ln F(R_{mt}) + \ln(1 - F(R_{m+1-t}))]} \quad (3)$$

In the above formulas, t is the time index, N the number of observations and F the cumulative Normal distribution.

The test is a variation of the Kolmogorov-Smirnov test. It gives more weight to the tails of the distribution and uses a specific distribution in calculating the critical values. This procedure has the advantage of allowing a more sensitive test.

Run Test

The Wald Wolfowitz Run Test assesses the randomness of a series. A run is defined as the repeated occurrence of the same value. Stock price runs can be positive, negative, or analogous to each other. Under the null hypothesis that successive outcomes of a series are independent, the total expected number of runs is normally distributed. The Run test compares the actual number of runs to the expected number of runs using following equation (Campbell et al., 1997):

$$\boldsymbol{m = \frac{N(N+1) - \sum_{i-1}^{3} n_i^2}{N}} \quad (4)$$

Where m is the expected number of runs, n_i is total numbers of changes of each category of signs. The other symbols are as defined above. For a larger number of observations, the expected number of runs m is approximately normally distributed with a standard deviation σ_m:

$$\boldsymbol{\sigma_m = \left[\frac{\sum_{i-1}^{3} n_i^2 \left[\sum_{i-1}^{3} n_i^2 + N(N+1)\right] - 2N\sum_{i=1}^{3} n_i^3 - N^3}{N^2 (N-1)}\right]^{\frac{1}{2}}} \quad (5)$$

Parametric tests

Serial Autocorrelation tests

The autocorrelation function (ACF) test is examined to identify the degree of autocorrelation of the JSX time series. The test measures the correlation between the current and lagged observations of the time series of stock returns, defined as:

$$p_k = \frac{\sum_{t=1}^{n-k} (R_{mt} - \overline{R})(R_{mt+k} - \overline{R})}{\sum_{t=1}^{n} (R_{mt} - \overline{R})^2} \quad (6)$$

where *k* is the number of lags, R_{mt} as defined above and $\overline{R}$ the average returns.

Two important statistics are customarily used for estimating the autocorrelations, the standard error test and the Ljung and Box (Q_{LB}) test. In this study, we rely on the Ljung and Box test:

$$Q_{LB} = n(n+2)\sum_{k=1}^{m}\frac{\rho^2(k)}{(n-k)}, \sim \chi^2_m \quad (7)$$

where ρ(*k*) is the estimated autocorrelation coefficients, *k* is a given lag; *k* takes the values of 1 to 12 lags and *n* is the sample size. If the calculated value of Q_{LB} exceeds the critical value of χ^2 (*m* degrees of freedom), then at least one value of ρ(*k*) is statistically different from zero.

Unit Root

Time series characterized as white noise, random walk, martingale and fair game support the EMH. In this case, prices must be equal to the Samuelson's fair game theory or martingale difference. Samuelson (1965) modeled this property of prices as the random walk:

$$R_{mt} = R_{mt-1} + \varepsilon_t \quad (8)$$

and a random walk with drift:

$$R_{mt} = \mu + R_{mt-1} + \varepsilon_t \quad (9)$$

Random walks also exhibit Markov and martingale properties. A Markov property occurs when the information needed for determining the probability of a future value of the random variable, is already contained in the current status of that variable. A martingale property is the conditional expectation of a future value of the random variable. The positive drift (called sub-martingale) in random walk happens when *α* is greater than zero. Negative drift (called super-martingale) exists when *α* is less than zero. If *α* is equal to zero, the process is a normal random walk. A martingale property is defined as:

$$R_{mt} = R_{mt-1} + \alpha + \varepsilon_t \quad (10)$$

If the stock prices follow a random walk, then price changes are white noise. Therefore, testing whether returns are white noise is equivalent to the test of random walk in stock prices. As mentioned, generally, if stock prices and returns are not predictable then these time series have the properties of martingale, fair game, random walk and white noise implying the validity of EMH.

The most commonly used test to examine the existence of a unit root is the Augmented Dickey-Fuller (ADF) test. A series with unit root is non-stationary indicating non-random walk. For a series generated by an autoregressive process of order one, AR(1), the most commonly used test to examine the existence of a unit root is the Dickey-Fuller test (Dickey & Fuller, 1981). The

Augmented Dickey-Fuller (ADF) test includes additional lagged difference terms, to account for the correlations of the error terms. The ADF unit root test is based on the following equations:

$$\Delta R_{mt} = \gamma R_{mt-1} + \sum_{i-1}^{q} \rho_i \Delta R_{mt-i} + \varepsilon_t \quad n_i \tag{11}$$

$$\Delta R_{mt} = \mu + \gamma R_{mt-1} + \sum_{i-1}^{q} \rho_i \Delta R_{mt-i} + \varepsilon_t \tag{12}$$

$$\Delta R_{mt} = \mu + \alpha_i t + \gamma R_{mt-1} + \sum_{i-1}^{q} \rho_i \Delta R_{mt-i} + \varepsilon_t \tag{13}$$

where μ is a constant, α the coefficient on a time trend, q the number of lagged terms, *i* is the lag order of the autoregressive process.

ARIMA

The weak-form efficiency implies that we cannot predict prices from their historical values. The Autoregressive Integrated Moving Average (ARIMA), known as the Box-Jenkins methodology, is one of the most popular forecasting methods used by financial economists. In an ARIMA (p,d,q) models, p is the number of autoregressive terms, d is the number of non-seasonal differences, and q is the number of lagged forecast errors. The model is written as follows:

$$R^{*}_{mt} = \theta + \alpha_1 R^{*}_{mt-1} + \alpha_2 R^{*}_{mt-2} + .. + \alpha_p R^{*}_{mt-p} + \beta_0 u_t + \beta_1 u_{t-1} + \ldots + \beta_q u_{t-q} \tag{14}$$

where R^{*}_{mt} denote the *d* difference of a time series, p identifies the AR(p) process and u_t ,u_{t-1} .... u_{t-q} are the q current and past white noise error terms.

In order to determine the proper model, the *q, d,* and *p* values are determined using correlograms and partial correlograms, R-squared, Adjusted R-squared, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC).

EMPIRICAL EVIDENCE

Returns Characteristics

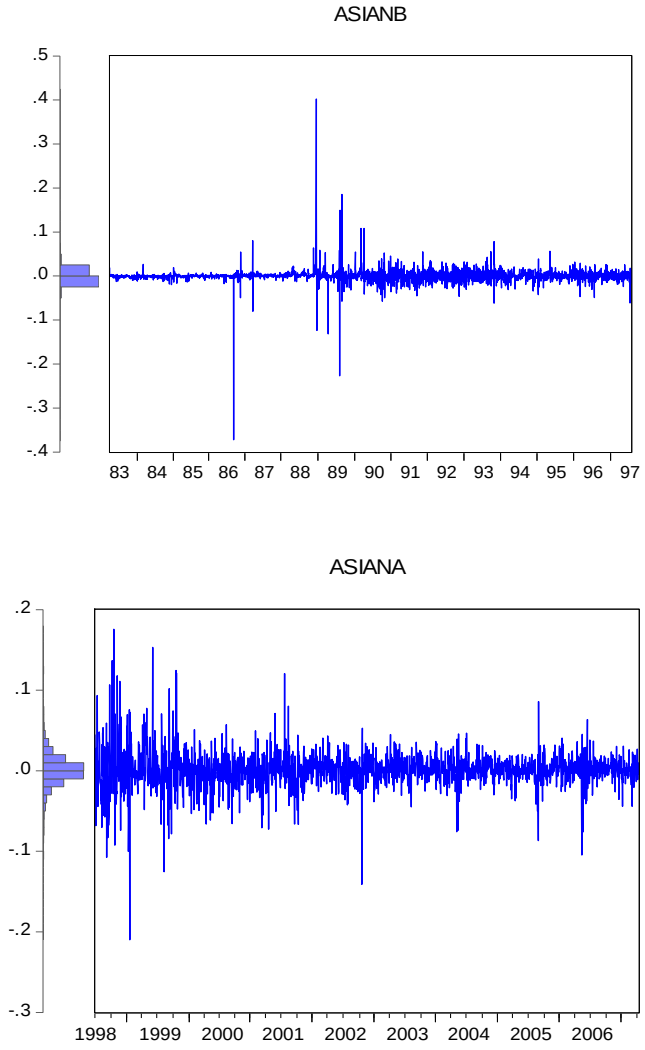
Figure 1 (Panels A, B, C and D) shows the indices price movements for the entire period and for each sub-period studied. Each figure presents the time plots of daily log returns for the Indonesian market. All indices series are calculated using the continuously compounded formula of Brooks (2004) presented below:

$$R_{mt} = \ln\left(\frac{PI_i}{PI_{i-1}}\right) \times 100 \quad (1)$$

where R_{mt} is the market return during period t, PI_i is the price index during period t, PI_{i-1} is the price index during period t-1 and *ln* is the natural log.

Figure 1: Jakarta Stock Exchange: Returns distribution

PRIVATEB refers to the period before the stock exchange privatization; PRIVATEA refers to the period after the privatization; JATSB refers to the period before the introduction of the JATS; JATSA refers to the period after the introduction of the JATS; MERGERB refers to the period before merger; MERGERA refers to the period after the merger, ASIANB refers to the period before the Asian crisis, and ASIANA refers to the period after the crisis.



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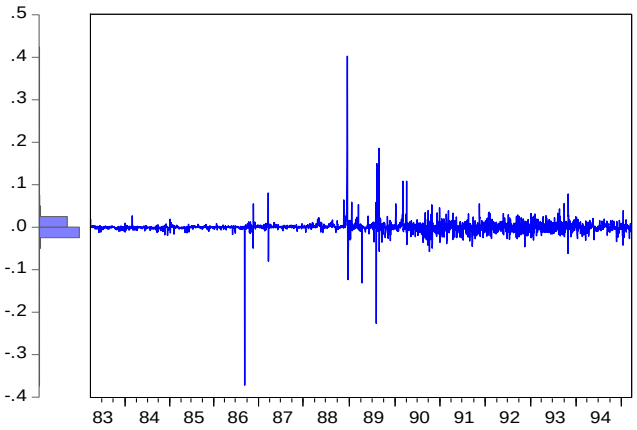
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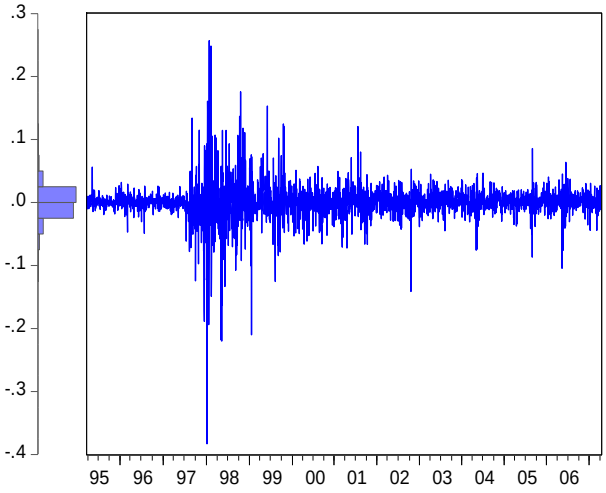
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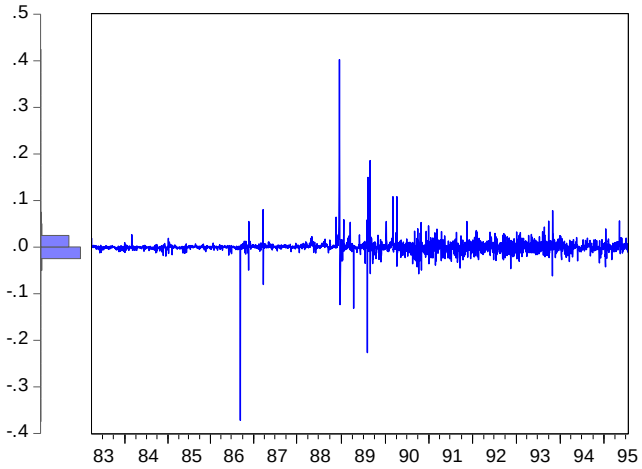
MERGER1B



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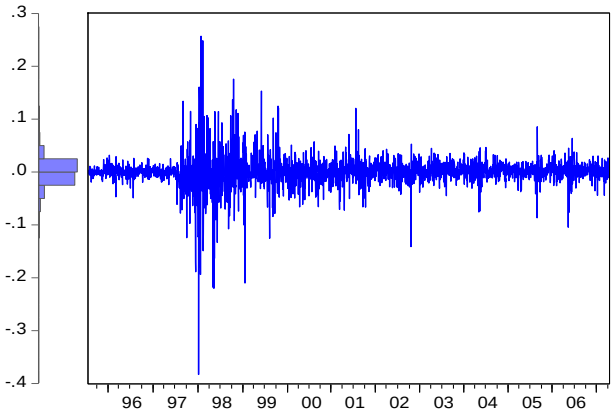

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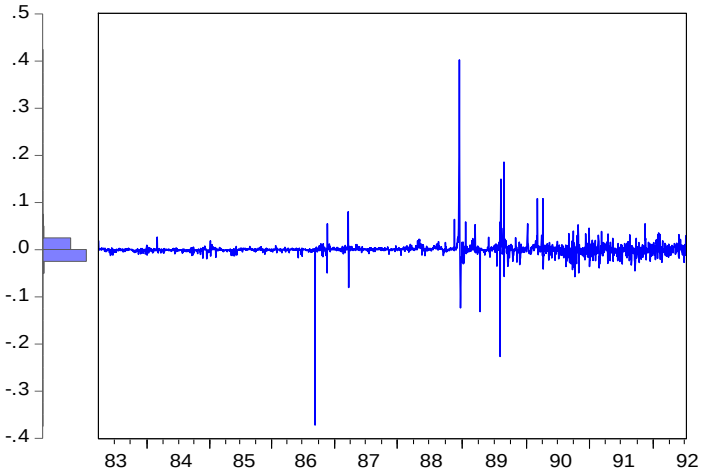

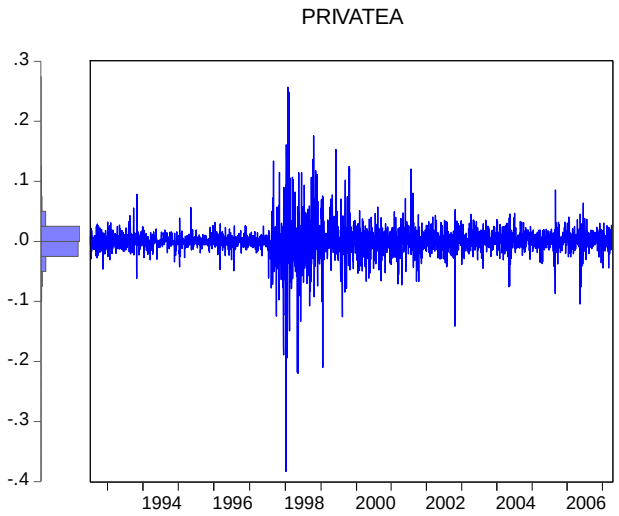

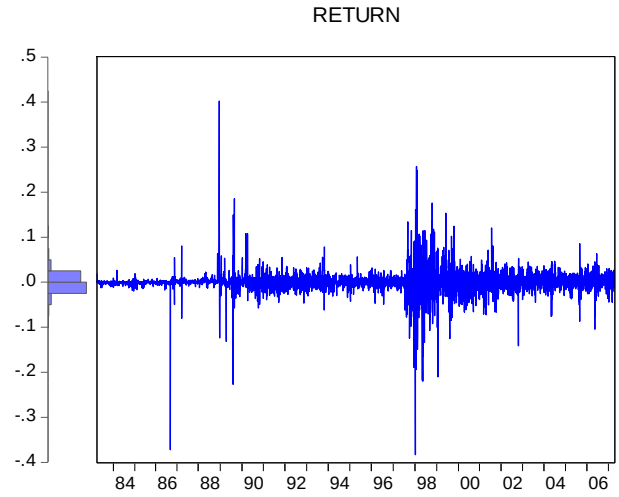

Panel A reveals several spikes in the observations, i.e. 1985, 1988, 1989, 1990. Panel A also shows an increase of volatility after 1990. Panels B, C, D and E indicate that data are dominated by episodes of sharp increases in volatility after the events identified previously. The returns' volatility increases to a higher level after the privatization, after the merger, after the introduction of JATS, and after the Asian crisis. The graphs also illustrate that stock market volatility changes over time. The macroeconomic events studied provide information about the volatility of both future expected cash flows and future discount rates.

Table 3 illustrates that the frequency distribution of the return series is not normal. The skewedness coefficients for the series PRIVATEB, JATSB, MERGERB and ASIANB are all higher than one, a value generally taken to be fairly extreme. Further, although in a Gaussian

distribution, one would expect to have a kurtosis coefficients around 3, all the coefficients presented in the table are significantly higher showing that the series exhibits leptokurtic distributions. Finally the p-value given next to the Jarque-Bera (JB) goodness-of-fit test shows that the hypothesis of non-normality cannot be rejected.

Table 3:Returns characteristics

Std refers to the standard deviation, JB refers to the Jarque–Bera test of goodness-of-fit measure and N is the sample size. Our analyses compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA), (2) before the introduction of JATS trading system (JATSB) to the period after (JATSA), (3) before the exchanges merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the end of the crisis period (ASIANA).

Variable	Mean	Std	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera	Sample size N
RETURN	.000123	.0233	-.3831	.4024	-0.5524	62.51	869974 (p=0000)	5892
PRIVATEB	.000188	.0185	-.3720	.4024	1.6622	200.74	3693189(p=0000)	2266
PRIVATEA	.000008	.0258	-.3831	.2568	-1.0370	34.05	146371(p=0000)	3626
JATSB	.000210	.0172	-.3720	.4024	1.6041	206.10	5040136(p=0000)	2931
JATSA	.000003	.0280	-.3831	.2568	-0.9965	30.08	91015(p=0000)	2961
MERGERB	.000265	.0171	-.3720	.4024	1.6096	208.23	5287747(p=0000)	3012
MERGERA	-.00000	.2568	-.383	.028	-.98	29.4	84368(p=0000)	2880
ASIANB	.000281	.0162	-.3722	.4024	1.5781	218.80	6821458(p=0000)	3513
ASIANA	.000904	.0227	-.2099	.1757	0.0144	13.91	10667(p=0000)	2151

Anderson-Darling tests

Results of the Anderson-darling tests are reported in Table 4. In the table, the first column, "Adj. Value", depicts the asymptotic test statistics adjusted for parameter uncertainty and the second column reports the *p*-value.

Table 4: Anderson Darling goodness-of-fit

Adj. value is the Anderson–Darling adjusted value and Prob. the probability. Our analyses compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA), (2) before the introduction of JATS trading system (JATSB) to the period after (JATSA), (3) before the exchange merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the end of the crisis period (ASIANA).

Variable	Adjusted value	Probability
RETURN	447.8999	0.0000
PRIVATEB	179.8030	0.0000
PRIVATEA	179.8030	0.0000
JATSB	321.1462	0.0000

JATSA	145.6351	0.0000
MERGERB	324.6389	0.0000
MERGERA	138.9662	0.0000
ASIANB	333.4743	0.0000
ASIANA	46.15119	0.0000

Results show that the frequency distribution of the daily returns series of Indonesia does not fit a normal distribution. The results are similar for the whole period and for all sub-periods studied. The findings studied are consistent with the results reported by Groenewold (1994), Laurence (1986), Poshakwale (1996) and more recently by Mollah (2006). Findings are similar for New Zealand (Groenewold, 1997), India (Poshakwale, 1997), Bangladesh (Mobarek et al, 2005), Kuala Lumpur and Singapore (Laurence, 1986).

Run Test

Results from the Run tests are presented in Table 5. Most results are in-conclusive; the Z-statistics are mostly negative but not significant.

Table 5: **Wald Wolfowitz Runs Test for the randomness**

"-/+" the number of negative/positive returns; Run the number of runs and "ztest" is the z statisti. It is equal to the actual number of runs in the pattern, minus the expected number of runs in the pattern, divided by the standard deviation of the expected number of runs. In our analyses we compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA), (2) before the introduction of JATS trading system (JATSB) to the period after (JATSA), (3) before the exchanges merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the period the crisis (ASIANA). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

Count	Return	PrivateB	PrivateA	JatsB	JatsA	MergerB	MergerA	AsianB	AsianA
-	3163	1373	1322	1712	1450	1747	1324	1987	1288
+	2729	893	1264	1218	1511	1264	1556	1526	1092
Run	2537	921	1601	1225	1311	1259	1248	1473	984
Ztest	-.095	-.108	.168	-.100	-.081	-.102	-.091	-.105	-.119

In conducting this research on market efficiency, we use run tests as a framework for verification of the weak-form efficiency, as was done for the U.S. and other countries' stock markets in the

study by Kennedy (1977), Cooper (1982), Chiat and Finn (1983), Wong and Kwong (1984), Yalawar (1988), Ko and Lee (1991), Butler and Malaikah (1992), and Thomas (1995). These studies found typically that in most markets, the null hypothesis is not rejected. The findings about Indonesia, however, do not permit the corroboration or rejection of the efficient market hypothesis regardless of the sub-periods studied.

Serial Autocorrelation tests

Results of the Serial Autocorrelations tests are presented in Table 6.

Table 6: Serial Autocorrelation tests

This table provides the results of the sample autocorrelation coefficients and the Ljung-Box statistics for the daily returns on the indices for the JSX for the sample period 04/04/1983-04/13/2007. All returns are continuously compounded; ρ_k is the sample autocorrelation coefficient at lag *k*. *Q*(1) through *Q*(12) are the Ljung-Box statistic identifying the presence of first and twelfth-order autocorrelation. Under the null hypothesis of no autocorrelation, it is distributed as χ^2 with 1 and 12 degree of freedom, respectively. Values in parentheses are *p*-values. Our analyses compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA),(2) before the introduction of JATS trading system (JATSB) to the period after (JATSA), (3) before the merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the end of the crisis period (ASIANA). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Return	PrivateB	PrivateA	JatsB	JatsA	MergerB	MergerA	AsianB	AsianA
ρ1	0.161***	0.275***	0.124**	0.24***	0.131***	0.241***	0.13**	0.24***	0.11***
ρ2	0.056**	0.157**	0.023	0.143***	0.022*	0.144**	0.022	0.138*	0.024*
ρ3	-0.032*	0.01	-0.046	0.019	-0.052**	0.019	-0.052**	0.015*	0.009*
ρ4	-0.037*	-0.052**	-0.032	-0.047**	-0.033**	-0.047*	-0.033	-0.048	-0.001
ρ5	-0.011	-0.034**	-0.004	-0.029**	-0.004	-0.028*	-0.004	-0.027	0.007
ρ6	-0.067**	-0.061**	-0.069**	-0.053**	-0.073**	-0.051*	-0.074**	-0.045*	-0.025*
ρ7	0.012	-0.019	0.022	-0.01	0.021	-0.008	0.02	-0.007	-0.006
ρ8	-0.01	0.01	-0.017	0.018	-0.021	0.018	-0.021	0.016**	0.029**
ρ9	0.037*	-0.009	0.051*	0.004	0.049**	0.003	0.049*	0.003	-0.009
ρ10	0.078**	0.001	0.103**	0.007	0.104***	0.006	0.105**	0.006**	0.063**
ρ11	0.041**	0.015	0.049**	0.014	0.051**	0.015	0.051*	0.016**	0.027**
ρ12	-0.006	0.069*	-0.029	0.067**	-0.033**	0.069**	-0.034*	0.071*	0.012*
Q1	151.89***	171.37***	55.995***	168.98***	50.526***	174.27***	48.758***	203.29***	26.247***
Q2	170.09***	227.07***	57.973***	229.16***	52.014***	236.19***	50.188***	270.05***	27.511***
Q3	176.28***	227.3***	65.706***	230.21***	59.967***	237.25***	57.963***	270.84***	27.687***
Q4	184.19***	233.36***	69.401***	236.59***	63.218***	243.77***	61.097***	279.11***	27.692***
Q5	184.89***	235.97***	69.446***	239.13***	63.262***	246.1***	61.154***	281.76***	27.791***
Q6	211.7***	244.29***	86.953***	247.4***	79.036***	253.82***	76.948***	288.97***	29.095***

Q7	212.61***	245.07***	88.739***	247.67***	80.292***	254.02***	78.127***	289.14***	29.162***
Q8	213.2***	245.32***	89.741***	248.67***	81.577***	255.05***	79.373***	290.02***	31.01***
Q9	221.07***	245.49***	99.199***	248.72***	88.634***	255.08***	86.358***	290.05***	31.204***
Q10	256.87***	245.49***	137.97***	248.85***	121.06***	255.19***	118.29***	290.18***	39.83***
Q11	266.79***	246.02***	146.66***	249.4***	128.87***	255.86***	125.77***	291.13***	41.376***
Q12	266.98***	256.7***	149.82***	262.72***	132.14***	270.17***	129.14***	308.81***	41.666***

***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

Findings show that the daily series of the JSE exhibit substantial correlations, sometimes reaching more than 25%. This finding is similar for the daily series PRIVATEB, PRIVATEA, JATSB, JATSA, MERGERA, MERGERB, ASIANB and ASIANA. The results of the Ljung-Box statistics show that returns for most lags, are non-zero at the 1%, 5% and 10% significance levels. Significant positive autocorrelations are detected at lag one for all return series and all sub-periods. Significant positive autocorrelations are also identified for lag 2 and even lag 3. Positive autocorrelations indicate predictability of returns and potential evidence against market efficiency. The Q_{LB} statistics also provide evidence of possible dependence in the first and higher moments of the return distributions. The statistics indicate that the null hypothesis of no autocorrelations is rejected for all returns at lag 1 through 12 at the 1% level of significance. The non-zero autocorrelations clearly suggests that all return series do not follow a random walk, the JSE is not weak-form efficient. Our results are consistent with previous findings in emerging markets reported by Harvey (1995), Poshakwale (1996), Mobarek and Keasey (2002) and Hassan et al (2006).

Unit Root

The results of the ADF with and without intercepts and time trends are presented in Table 7.

TABLE 7: Unit Root tests

This table reports the results of the Augmented Dickey-Fuller unit root test. The optimal lag length for the ADF is selected with the Schwartz Info Criterion and maximum lag is set to 36. The statistic applies to regression (8) without constant and time trend, for regression (9) with constant but without time trend and for regression (10) with constant and time trend. Regression are tested in levels and first and second differences. Our analyses compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA), (2) before the introduction of JATS trading system (JATSB) to the period after (JATSA), (3) before the exchanges merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the end of the crisis period (ASIANA). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

PANEL A		Return	PrivateB	PrivateA	JatsB	JatsA	MergerB	MergerA	AsianB	AsianA
Level	None	-22.52***	-22.97	-17.20***	-30.35***	-47.70***	-30.73***	-47.06***	-28.60***	-41.47***
	Intercept	-22.52***	-22.98	-17.20***	-30.35***	-47.69***	-30.78***	-47.06***	-28.61***	-41.51***

	Intercept & Trend	-22.53***	-22.98	-17.23***	-30.35***	-47.73***	-30.79***	-47.11***	-28.62***	-41.51***
First Difference	None	-26.03***	-21.56	-17.20***	-22.02***	-25.91***	-22.28***	-25.58***	-21.53***	-20.61***
	Intercept	-26.03***	-21.56	-17.20***	-22.01***	-25.91***	-22.27***	-25.58***	-21.53***	-20.60***
	Intercept & Trend	-26.03***	-21.55	-17.23***	-22.01***	-25.90***	-22.27***	-25.58***	-21.53***	-20.60***
Second Difference	None	-29.23***	-20.98	-28.54***	-22.32***	-22.08***	-22.67***	-21.77***	-24.18***	-20.71***
	Intercept	-29.23***	-20.98	-28.53***	-22.325***	-22.07***	-22.66***	-21.77***	-24.18***	-20.70***
	Intercept & Trend	-29.22***	-20.97	-28.53***	-22.321***	-22.07***	-22.66***	-21.76***	-24.17***	-20.70***

PANELB Akaike criterion		Return	PrivateB	PrivateA	JatsB	JatsA	MergerB	MergerA	AsianB	AsianA
Level	None	4.4936	-5.22	4.7076	3.8661	4.8833	3.8473	4.9079	3.7406	4.4667
	Intercept	4.4939	-5.23	4.7081	3.8667	4.8840	3.8478	4.9086	3.7410	4.4664
	Intercept & Trend	4.4942	-5.22	4.7084	3.8673	4.8831	3.8483	4.9082	3.7414	4.4672
First Difference	None	4.5199	-5.17	4.7076	3.9071	4.8997	3.8878	4.9243	3.7757	4.5030
	Intercept	4.5202	-5.17	4.7081	3.9078	4.9004	3.8885	4.9250	3.7762	4.5040
	Intercept & Trend	4.5206	-5.17	4.7084	3.9085	4.9010	3.8891	4.9257	3.7768	4.5049
Second Difference	None	4.5935	-5.08	4.7376	3.9973	4.9882	3.9719	5.0130	3.8623	4.5960
	Intercept	4.5939	-5.08	4.7382	3.9980	4.9888	3.9726	5.0137	3.8629	4.5969
	Intercept & Trend	4.5942	-5.08	4.7388	3.9987	4.9895	3.9733	5.0147	3.8635	4.5979
PANEL C **Schwartz criterion**		Return	PrivateB	PrivateA	JatsB	JatsA	MergerB	MergerA	AsianB	AsianA
Level	None	4.5050	-5.21	4.7247	3.8702	4.8853	3.8513	4.9100	3.7476	4.4693
	Intercept	4.5064	-5.21	4.7270	3.8729	4.8880	3.8538	4.9127	3.7498	4.4717
	Intercept & Trend	4.5078	-5.21	4.7289	3.8755	4.8899	3.8563	4.9144	3.7519	4.4752
First Difference	None	4.549	-5.13	4.7247	3.9442	4.9322	3.9240	4.9576	3.8163	4.5455
	Intercept	4.5510	-5.13	4.7270	3.9469	4.9349	3.9267	4.9604	3.8186	4.5491
	Intercept & Trend	4.5525	-5.13	4.7289	3.9497	4.9377	3.9294	4.9632	3.8209	4.5527
Second Difference	None	4.6323	-5.01	4.7651	4.0551	5.0453	4.0305	5.0715	3.9154	4.6626
	Intercept	4.6338	-5.01	4.7674	4.0579	5.0480	4.0331	5.0743	3.9177	4.6662
	Intercept & Trend	4.6352	-5.01	4.7696	4.0606	5.0508	4.0358	5.0771	3.9200	4.6698

Evidence indicates that the null hypothesis of a unit root is rejected at the 1% level for the whole sample and for all sub-periods. Thus, in Indonesia, stock price indices are stationary processes that are inconsistent with the efficient market hypothesis. These results show the presence of profitable arbitrage opportunities.

ARIMA

Results of the Autoregressive Integrated Moving Average are summarized in Table 8. The *q*, *d*, and *p* values determined using Adjusted R squared, Akaike Information Criterion (AIC) and

Schwarz Information Criterion (SIC) ended up between zero, two and one. The model chosen therefore is an ARIMA (0,2,1) with relatively low AIC, SIC on the one hand and the highest Adjusted R squared (between 34% and 65%) on the other.

Table 8: Autoregressive Models

AR refers to the autoregressive term; MA to moving average term; The Akaike Information Criterion (AIC) is computed as: $\mathrm{AIC} = -2l/T + 2k/T$ where l is the log likelihood; the Schwarz Criterion (SC) is an alternative to the AIC that imposes a larger penalty for additional coefficients: $\mathrm{SC} = -2l/T + (k\log T)/T$. Our analyses compare the distribution of returns (1) before the stock exchange privatization (PRIVATEB) to the period after the privatization (PRIVATEA),(2) before the introduction of JATS trading system (JATSB) and to the period after (JATSA), (3) before the exchanges merger (MERGERB) to the period after the merger (MEGERA) and (4) the period before the Asian crisis (ASIANB) to the end of the crisis period (ASIANA). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Coefficient	MA(1)	Adjusted R-squared	Akaike criterion	Schwarz criterion
Return	0.000145	-0.997***	0.6510	5.0521	5.0543
PrivateB	6.19E-05	-0.997***	0.3116	4.0707	4.0758
PrivateA	3.48E-05	-0.99***	0.4287	4.7389	4.7423
JATSB	-4.81E-07	-0.99***	0.3430	3.9309	3.9350
JATSA	7.06E-05 -	0.997***	0.4246	4.9013	4.9054
ASIANB	3.15E-05	-0.991***	0.3430	3.8081	3.8116
ASIANA	-5.95E-07	-0.99***	0.437381	4.4800	4.4853
MERGERB	5.46E-05	-0.99***	0.3428	3.9123	3.9163
MERGERA	0.000119	-0.99***	0.4250	4.9257	4.9298

As the random Walk is similar to the ARIMA (0, 1, 1), the JSE cannot be modeled as a random Walk, the JSE does not seems to be weak-form efficient. For the JSE, the ARIMA (0,2,1) captures the evolution of the series of returns; i.e. the JSE adequate model contains 0 (zero) autoregressive (*p*) parameters and one moving average (*q*) parameters which was computed for the series after it was differenced twice. As reported previously, the results are similar for all the sub-periods under investigation.

CONCLUSION

This study examines the random walk hypothesis and tests the weak-form of market efficiency for the Jakarta Stock Exchange (JSE) using daily data from the period 1983-2007. This time period was divided into several sub-periods corresponding to the most significant events that have characterized the JSE. This division is aimed at determining if the Indonesian exchange exhibits a trend towards efficiency. Specifically, we analyze data before, and after: privatization of the market, the merger with the Surabaya Stock Exchange, the modernization of the exchange, and the Asian crisis.

Our study relies on a triangulation econometric approach. It uses parametric and non-parametric tests which consist of normality tests, Anderson Darling tests, run tests, serial autocorrelation tests, Augmented Dickey Fuller unit root tests and Box Jenkins ARIMA tests. Each test was performed using the whole sample and the data from each of the sub-periods of different market environments.

Most of our findings indicate that the Jakarta Stock Exchange cannot be characterized as a weak-form efficient stock market and our results also show the presence of profitable arbitrage opportunities. First, findings suggest that the return distribution does not fit a normal distribution. Second, findings point to significant correlations between the returns. Third, the unit root tests reveal that stock price indices are stationary processes. Fourth, the series can be modeled using an autoregressive model. Similar findings were found for all the sub-periods studied. From these, we conclude that the JSE is another emerging stock market that lacks efficiency.

Indeed, a financial market is efficient if the prices of the traded assets represent the best possible forecasts of their discounted future returns, consisting of dividends and capital gains. According to the EMH, asset prices follow random walk changes. This implies that assets prices must be uncorrelated with past, and/or present, prices. Consequently, it should not be possible for anyone to reap speculative profits, on a systematic and regular basis, using past prices. The results of our study call into question the empirical validity of the EMH for the JSE. This paper consequently cautions portfolio managers against treating Indonesian stock prices as rational reflections of fundamental values.

The inefficiency of the Indonesian stock market compels us to wonder about the quality of the Indonesian financial system, the structure and functionality of the country's financial institutions and markets. This, in turn, prompts us to speculate that the Indonesian financial policies and regulations, such as those concerning liberalization, deregulation and privatization, have not yet been able to produce an efficient market. The implication being that the benefits of a well-functioning stock market have not yet been realized in the Indonesian economy.

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