



**UNIVERSITI PUTRA MALAYSIA**

**NONLINEARITY AND THE RANDOM WALK BEHAVIOUR OF EAST  
ASIAN STOCK PRICES**

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**NONLINEARITY AND THE RANDOM WALK BEHAVIOUR OF EAST ASIAN  
STOCK PRICES**

**By**

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
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June 2007

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This study examines the price behaviour of East Asian stock markets and individual stocks listed on the Bursa Malaysia in the light of random walk hypothesis by utilizing the new and powerful statistical tool, namely the Brock-Dechert-Scheinkman (BDS) test and Hinich Bispectrum test. This study emphasizes three main objectives. Firstly, this study examines the random walk behaviour and nonlinearity of East Asian stock indices and individual stock return series traded on Bursa Malaysia. Secondly, to ensure the consistency of the results, this study break the full sample period into 5 sub-periods with respect to the financial liberalization and the 1997 Asian financial crisis as the break points to observe whether these two issues will prevent the stocks from randomly pricing or vice versa. Lastly, this study also addresses the issue of whether market size influences the stock price behaviour by comparing the results of large-capitalization stocks and small-capitalization stocks. The following reveal the findings of this study. The econometric investigations (results of BDS) reveal that all the East Asian stock indices and individual stocks listed in the Bursa Malaysia do not follow a random walk process over the full sample period from January 1985 through December 2005. Besides



that, the Hinich Bispectrum results reveal that nonlinearity exists in the East Asian stock prices and individual stock prices traded in the Bursa Malaysia. Through the sub-periods analysis, empirical evidence from this study suggests that 1997 Asian financial crisis prevents stock price from following a random walk process. This result comes from the SST (Singapore) and several individual stocks in which pocket of efficiency found before the occurrence of the Asian financial crisis but disappear during and after the crisis period. Lastly, although the analysis on individual stock does not provide any support that market size will influence the stock price randomness, analysis of the East Asian stock indices provide a useful comparison in which, Japan stock market is efficiently performed provide a strong support that market size is a matter of the randomness of the stock prices.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KETIDAKLINEARAN DAN PROSES PERGERAKAN RAWAK HARGA  
PASARAN SAHAM ASIA TIMUR**

Oleh

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Kajian ini meneliti tindak balas harga pasaran saham Asia Timur dan saham individu disenarai di papan utama Bursa Malaysia dalam konteks hipotesis pergerakan rawak dengan menggunakan alat statistik baru bernama ujian Brock-Dechert-Scheinkman (BDS) dan ujian Hinich Bispectrum. Kajian ini mengutamakan tiga objektif. Pertama, kajian ini meneliti sama ada pulangan pasaran saham Asian Timur and saham individu disenarai di Bursa Malaysia bertindak balas secara rawak atau tidak. Pada masa yang sama, kajian ini juga memberi tumpuan sama ada pulangan saham bertindak secara tidak linear. Kedua, untuk memperolehi keputusan yang lebih konsisten, kajian ini membahagikan sampel data kepada lima sub sampel yang lebih kecil dengan mengambil kira liberalisasi kewangan and krisis kewangan pada tahun 1997 sebagai faktor pembahagian. Tujuan utama pembahagian ini adalah untuk mengkaji sama ada liberalisasi dan krisis kewangan akan mempengaruhi harga saham daripada mengikut proses pergerakan rawak atau sebaliknya. Akhirnya, kajian ini juga meneliti sama ada saiz pasaran boleh mempengaruhi harga saham daripada mengikut proses pergerakan rawak dengan membandingkan keputusan saham yang mempunyai pasaran modal tinggi

dan pasaran modal rendah. Berikut merupakan keputusan yang diperolehi. Penyelidikan ekonometrik (keputusan ujian BDS) mencadangkan semua hasil pulangan index pasaran saham Asia Timur dan saham individu diseranai di Bursa Malaysia tidak mengikut proses pergerakan rawak dari jangka masa Januari 1985 hingga Disember 2005. Di samping itu, keputusan Hinich menunjukkan ketidaklinearan wujud dalam pulangan index Asia Timur dan saham individu. Hasil penyelidikan juga mencadangkan krisis kewangan 1997 mempengaruhi harga saham daripada mengikut proses pergerakan rawak. Bukti keputusan ini datang dari index Straits Times Singapore dan beberapa saham individu Bursa Malaysia di mana kecekapan pasaran saham dikesan sebelum berlakunya krisis kewangan tetapi tidak selepas berlakunya krisis kewangan. Akhirnya, walaupun analisis saham individu tidak memberikan sebarang bukti bahawa saiz pasaran mempengaruhi proses pergerakan rawak harga saham, tetapi, analysis terhadap index saham Asia Timur mempamerkan perbandingan yang berguna, di mana pasaran saham Jepun beroperasi dengan cekap dan ini membuktikan bahawa saiz pasaran merupakan faktor penting yang mempengaruhi pergerakan harga saham.

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The contribution of them had helped me make this thesis possible.

Methew Vun



I certify that an Examination Committee has met on 25 June 2007 to conduct the final examination of Methew Vun Kien Chung on his Master of Science thesis entitled “Nonlinearity and the Random Walk Behaviour of East Asian Stock Prices” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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**METHEW VUN KIEN CHUNG**

Date: 20 JULY 2007



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## **CHAPTER I**

### **INTRODUCTION**

#### **An Overview**

Stock market is an important institution of a country's financial system in which reflects a country's prosperity and prospects. The world's stock exchanges provide both individuals and institutions to purchase and sell securities or stocks. These trading provide investment opportunities and portfolio allocation for both individual and institutional investors. From the producers or companies side, stock markets are important institutions for them to raise capital or funds to expand their operations and productions. In short, the stock markets provide signals for lending, borrowing and portfolio allocation. The active transactions of stocks and securities in the stock markets are extremely important for the allocation of scarce resources to achieve the highest productivity.

Since stock trading is crucial for both individual and institutional investors, understanding the stock price fluctuations play an important role in economic policy, corporate investments and financing strategies. A company that issue security will use the security price as a guide to expand their plans and operations. On the other hand, investors will use the security prices to make decision of their investment strategies and portfolio allocation. Thus, the ability to forecast the stock market movement and the stock returns accurately had gained serious consideration from investment communities and financial economists. Generally, there is a long standing empirical problem whether the historical prices and all available information of a security can be used to make



meaningful prediction for the future price movements of a security. As a result, investors aimed to exploit these information especially the historical prices for the purpose of predicting future price movements by the hope to gain a better return, especially the group of technical analysts. These groups of analyst believe that history tends to repeat itself and past patterns of price behaviour in individual securities will tend to recur in the future. As a result, they believe that an extra return can be obtained through proper analysis onto the historical prices of a security.

### **Efficient Market Hypothesis**

The efficient market hypothesis (EMH) introduced three decades ago had attracted the interest of investors, academicians and market regulators to examine the forecast ability of the stock market price and return movements. Roughly speaking, the term market efficiency of a stock market explains the relationship between the stock prices and information.<sup>1</sup> The issue of efficiency is of great significance to both local and international investors.<sup>2</sup> Bachelier (1900) notes that the past, present and even discounted future events are reflected in market price, but often show no apparent relation to price changes. In relation with the above statement, Fama (1970) has been the first developed the efficient market hypothesis. As noted by Fama (1970), a market in which prices always fully reflect all available information is called efficient. In his discussion, Fama (1970) divides the efficient market hypothesis into three forms:

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<sup>1</sup> The information that investors and stock analysts concern including the historical prices of the securities, economic performances, government policies, public available information and the internal information.

<sup>2</sup> An efficient financial market can benefit both traders and investors, in which when stock prices fully reflect all available information; this will guide decisions regarding financial and economic decisions in which include lending, borrowing and portfolio allocation. On the one hand, Hubbard (2000) asserts that market efficiency can enhance liquidity and risk sharing services of stock markets.

1. The weak-form efficiency which postulates that all the past prices or return is fully reflected in the stock prices.
2. The semi-strong form market efficiency postulates that all publicly information is fully reflected in the stock prices,<sup>3</sup> and
3. The strong-form market efficiency which postulates that all information including publicly available and internal information is fully reflected in the stock prices.

Thus, the market efficiency hypothesis examines whether the stock prices exhibit any patterns which allow the future prices to be predicted from the historical information and hence, for investors to earn a better or abnormal returns. In fact, for a market to be efficient, such patterns should not exist since information is fully reflected in the stock prices. In other words, the expected returns of any speculative strategies should be zero. Antoniou *et al.* (1997) state that, efficiency implicitly assumes that investors are rational, where rationality implies risk aversion, unbiased forecasts and rapidly response to information. Hubbard (2000) defines the efficient market as a theory of market pricing behaviour that applies rational expectations to the pricing of the securities. Thus, in short, for a market to be efficient, few conditions must be satisfied. Firstly, there must have a large number of profit maximizing participants analyze and value securities in which each independent of other. Secondly, new information regarding the securities comes in a random fashion. Lastly, investors adjust prices rapidly to reflect the effect of new information.

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<sup>3</sup> The publicly available information is such the announcement of annual earning, stock splits and etc.



## Random Walk Hypothesis

In the academic literature and most of the financial economics text books, much research endeavour has been devoted over the years to investigate the market efficiency, ranking from developed countries such as United States (U.S), United Kingdom (U.K) and etc. (See for examples, Fama, 1965 and 1970; Al-Loughani and Chappell, 1997; Zhu, 1998; Opong *et al.*, 1999 and etc.) to emerging stock markets<sup>4</sup> (See for examples Lim, 1981; Barnes, 1986; Annuar and Shamser, 1993; Fawson *et al.*, 1996; Antoniou *et al.*, 1997; Cheung and Coutts, 2001; Ryoo and Smith, 2002; Chaudhuri and Wu, 2003; Lim *et al.*, 2003 and 2004; and Lim and Liew(2004); Tas and Dursunoglu, 2005 and etc.). The increasing of this body of literature is due to the interest of the investors, financial analysts and economists on the predictability of stock prices. Investors especially the technical analysis groups believe that historical information act as a useful tool for them to predict the future movements of stock prices since history tends to repeat itself. However, if the efficient market hypothesis of the stock returns hold, nobody can predict the future prices and eliminated the aim to earn abnormal returns.<sup>5</sup>

Within the efficient market hypothesis framework, the random walk theory of stock prices has been widely employed to test the efficiency of stock market. Random walk model was first developed by Bachelier (1900) in which the author asserts that successive price changes between two periods are independent. Islam and Khaled (2005)

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<sup>4</sup> The emerging stock markets under consideration for most of researchers are Asia, Latin America and Middle East countries.

<sup>5</sup> Abnormal returns are computed as difference between the return on a security and its normal return.



define that, when any random components in the changes of a stock are not correlated and such unpredictability of stock price is known as 'random walk'. In other words, the random walk theory postulates that the future price movements cannot be predicted from historical sequence of stock prices, in which today prices are useless for tomorrow prices prediction. Thus, the random walk theory is sufficient condition for weak-form market efficiency which postulates that historical prices are fully reflected in the stock prices as mentioned before. In addition, these historical prices adjust rapidly to the arrival of new information.

As noted by Fawson *et al.* (1996), investors in weak-form efficient markets cannot expect to find any patterns in the historical sequence of stock prices that would provide insight into future price movements and allow them to earn an abnormal rate of return. Since the historical information do not follow any patterns or trends over time and behave randomly, the random walk theory states that the previous price movement of securities or historical price movements are useless and can not be used as the future prediction for investors to gain abnormal returns. In contrast, market analysts who employ time series modeling and technical analysts who believe that history tends to repeat itself may not help investors in any meaningful way. These groups of analysts assume that the successive price changes are dependent. As suggested by Fama (1965), if the random walk theory is an accurate description of reality, then various technical and chartist procedures for predicting stock prices are completely without value. Al-Loughani and Chappell (1997), Dimson and Mussavian (2000), Cheung and Coutts (2001), Islam and Khaled (2005), Tas and Dursunoglu (2005), amongst others also shared the same views about the random walk theory.



Al-Loughani and Chappell (1997) point out that, the weak form efficiency market hypothesis postulates that the successive one period stock returns are independently and identically distributed (i.i.d). Specifically, the current price of a security reflects all available information is assumed to imply that successive price changes are independent. Since new information is deemed to come in a random fashion, thus changes in prices that occur as a consequence of that information will seem random (Lim *et al.*, 2003). Therefore, price movements in a weak-form efficient market occur randomly and successive price changes are independent of one another. Furthermore, it was also assume that successive prices are identically distributed. As a result, the hypotheses independent and identically distributed constitute the cornerstone of the random walk model (Fama, 1965).

The simplest form version of the random walk model is given by the equation as below:

$$P_t = P_{t-1} + \mu_t \quad \mu_t \sim \text{i.i.d} (0, \sigma^2) \quad (1)$$

where  $P_t$  is the price at time  $t$ ,  $P_{t-1}$  is the price in the immediate preceding period and  $\mu_t$  is a random error term. A purely random process is called ‘independent and identical distribution’ (i.i.d), such as a Gaussian with zero mean and constant variance. The independence of increments implies not only that increments are uncorrelated, but that any nonlinear functions of the increments are uncorrelated. This model is known as random walk 1 (RW1).  $\mu_t$  is simply the price change,  $\Delta P_t = P_t - P_{t-1}$ , in which being white noise, is unpredictable from the historical price changes. In other words, the probability distribution for the price changes of a security at time  $t$  is independent of the sequence of

price changes during previous time periods (Fama, 1965). Therefore, exploitation of historical or previous price movements is meaningless and hence, tomorrow or the next time period price is anybody's guess. As stated by Fama (1965), the series of price changes has no memory, that is, the past cannot be used to predict the future in any meaningful way. Thus, in a weak-form efficient market, it is not possible to make extra profits based on the past information and the prediction for the future price conditional on the past prices on an average should be zero.

From the above explanations, the market efficiency postulates that prices of a security are adjusted rapidly to reflect all available information. The random walk theory is applied to examine the market efficiency hypothesis and the random walk theory suggests that stock prices are unpredictable. However, there are few issues that will affect the efficiency of a stock market and might improve or decline the efficiency and price randomness that will be discussed in this study. For instances, this study give consideration and proceed to investigate the issue and impact of financial liberalization, the 1997 Asian financial crisis and market size onto the stock markets under examination.

### **Random Walk Behaviour and Financial Liberalization**

With the spread of liberal, emerging countries have been reducing restrictions on transactions and barriers to international investment communities into local financial markets since the early 1980s. For instance, Malaysia is welcoming the foreign investors to hold the domestic securities since the early establishment of Kuala Lumpur Stock

Exchange in 1973. Liberalization within this country towards financial market globalization creates a higher and active transaction within the stock market. As suggested by Antoniou *et al.* (1997), the pursuit of liberalization policies within developing countries and trends towards financial markets globalization provide the environment in which stock markets could thrive. Besides pursuing an international portfolio diversification, international investors are also attracted by the potentially higher returns offered by emerging stock markets for holding the securities and stocks.

Financial liberalization and globalization will impact the efficiency of financial markets since eliminating the barriers of capital inflow within countries will cause changes in institutional and regulatory environment (Antoniou and Ergul, 1997). Antoniou *et al.* (1997) demonstrate that, the regulatory changes encouraged participation, improved information quality and led to prices impounding information more rapidly, suggesting that markets become efficient with high trading volume, reliable information and an appropriate institutional framework. On the other hand, Groenewold and Ariff (1998) also support that financial liberalization could enhance stock market efficiency since liberalization of financial market improves competitiveness; narrow interest rate spreads and increase openness. Kawakatsu and Morey (1999) also share the same view, in which the authors state that when stock markets are open for public, share prices should become more efficient due to the reflection of the increasing availability of information. In contrast, inefficiency can be caused by the stringent capital control and such a regulation and imperfection in financial markets can result the information to be less efficiently disseminated (Yuhn, 1997). As a result, it is possible to examine the market

efficiency taken into account of financial liberalization and regulatory changes to identify its effectiveness of implementation.

### **Random Walk Behaviour and Asian Financial Crisis 1997**

The Asian financial crisis in 1997 was largely unanticipated and was characterized by sharp fall in currencies value and asset prices in several countries simultaneously. As noted by Chowdhry and Goyal (2000), two most visible characteristics of the occurrence of financial crisis are the sharp fall of the value of a country's currency and the traded equity prices. As the research carried on by Jeon and Seo (2003) and Phengpis (2006), the authors find that Asian financial crisis had affected the across country market efficiency of the foreign exchange markets. Since the occurrence of 1997 Asian financial crisis was unanticipated and affected the stock markets as well, there is a conjecture that the Asian financial crisis will affect the efficiency of the stock markets and prevent the stock prices movement from following the random walk behaviour of East Asian stock markets. The most severely affected capital markets are Malaysia, Indonesia, South Korea and Thailand.

In the stock markets efficiency context, Lim *et al.* (2004) reveal that 1997 Asian financial crisis had affected the efficiency of Hong Kong stock index namely Hong Kong Hang Seng (HKHS). HKHS was efficiently perform before the crisis period and the authors find that this index follow the random walk movement. However, this result disappears during the period after the occurrence of Asian financial crisis in year 1997. Thus, the 1997 Asian financial crisis is an important issue since the crisis had changed



and triggered the operational and structure of financial markets especially East Asia countries. This study attempts to investigate whether the Asian financial crisis that occurred in the year of 1997 will prevent the stock markets in Asian countries from efficiently perform and the random walk behaviour of these markets since this issue is not widely investigated in the literature.

### **Random Walk Behaviour and Market Size**

Earlier literatures on the random walk and efficient market hypothesis have been observed in well developed stock markets such as U.S and U.K. stock indices and individual stocks traded on these stock markets are actively traded and have high market capitalizations. Conversely, emerging market such as Asian stock markets, in which these markets are small in size, less developed and thin trading is widely spread. Antoniou et al. (1997) demonstrate that, emerging markets are typically characterized by low liquidity, thin trading, and possibly less well informed investors with access to unreliable information. This statement also supported by Islam and Khaled (2005), who find that the emerging markets are characterized by a lower volume and lower frequency of trading compared to stock markets in developed countries.

Even in emerging stock markets such as Bursa Malaysia, most of the studies investigate the behaviour of price movement traded on the Main Board, especially the composite index. Most of these stocks are frequently traded and have large market capitalization. Besides, thinly traded stocks are normally characterized as higher risk, less liquidity and with a higher transaction costs. Only a few researchers showed interest on the smaller