Are Asian Stock Markets Characterized by Rational Speculative Bubbles?

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Seven Asian stock markets (Japan, South Korea, Singapore, China, Indonesia, Malaysia and Philippines) were tested by using two methodologies. First, cointegration method tested the long run relationship among stock prices, dividends and earnings. Second, duration dependence method tested the hazard rate. The conclusion of this research is that rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets, but not in Japan, Singapore, Korea and Philippines over the sample period from 1991 to 2009; and the presence of rational speculative bubbles is more prevalent in emerging than developed stock markets. Further sub-period analysis shows that the rational speculative bubbles existed mainly during the pre-financial crisis sub-period, but not in post-financial crisis sub-period. In the case of the duration dependence test, weekly data was more sensitive than monthly data in detecting speculative bubbles.

Keywords: Rational speculative bubbles; Asian stock markets; cointegration, duration dependence.

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Chapter 1 Introduction

1.1 Introduction

According to the dividend discount model (DDM) there is a long run relationship between stock price and dividends (James and Farrell, 1985) given as follows:

Stock Price = Dividend per Share/ (Discount Rate – Dividend Growth Rate)

However, empirical evidence shows that sometimes the stock price deviates from fundamental value, which can be explained by the presence of rational speculative bubbles in the stock price (McQueen and Thorley, 1994). Rational speculative bubbles occur when investors realise that stock prices are deviating from their fundamental value, but they are still willing to pay a higher price for the stock because they believe that the possible return derived from further increases in price more than compensates them for the probability of a crash (Chan et al., 1998). This episode has raised a problem for researchers and investors as to whether the stock market is characterized by rational speculative bubbles rather than by fundamental factors alone. Testing for the presence of rational speculative bubbles can be used by investors to possibly predict market crashes, prompting them to change their investment strategies in time. Therefore, testing for rational speculative bubbles in the stock market has become an important task. Asian stock markets have experienced several apparent boom and bust cycles in the last 20 years, which raises the question of whether they were characterized by rational speculative bubbles during this period.

The characteristic found in markets traditionally believed to contain rational speculative bubbles is that of a long sequence of increases in stock prices followed by a dramatic price drop. The famous historical examples of rational speculative bubbles include the Dutch Tulipmania (1634-1637), the Mississippi Bubble (1719-1720) and the South Sea Bubble (1720) (McQueen and Thorley, 1994; Chan et al., 1998). Most researchers and investors ascribe the stock price drops to bubble bursts. For example, practitioners believe that the U.S. stock market was characterised by bubbles in the mid-1980s, because the strong performance by U.S. stocks was followed by a dramatic price drop in 1987. The situation of the Asian stock markets in the 1990s was similar to that of the 1980s' U.S. stock market, with the Asian stock prices dropping dramatically after 1997 (Asian financial crisis). Most Asian countries were the victims of a stock market bubble and many previous studies have tested whether the stock price behaviours in these stock markets were consistent with the characteristics of rational speculative bubbles. Two major tests are employed by these researchers, which are the cointegration test and duration dependence test.

The cointegration test can be used to test the long-run relationship between security prices and fundamental variables. If the stock price and fundamental variables are cointegrated, it is viewed as evidence against the existence of rational speculative bubbles. On the other hand, if there is no cointegration relationship between stock price and fundamental variables, rational speculative bubbles must exist. However, the cointegration method is inaccurate. Firstly, the cointegration test relies heavily on the correct identification of controversial fundamental variables. Furthermore, the cointegration test has low power when limited data spans are used. Therefore, the duration dependence test, as a new testable implication of the rational speculative bubbles model, was developed by McQueen and Thorley (1994). They suggest that rational speculative bubbles occur when investors have already realized that stock prices exceed fundamental values but are reluctant to liquidate their position because they believe that the probability of a high return will adequately compensate them for the probability of the bubble bursting. As the bubble expands, its innovation is positive and small, compared to an infrequent, large, negative innovation when the bubble bursts. Therefore, if the stock market is characterized by rational speculative bubbles, there is a negative relationship between the probability that a positive run will end and the length of the positive run, namely a negative duration dependence or a decreasing hazard rate. The benefit of the duration dependence test over the cointegration test is that it does not require correct identification of the observable fundamental components. Therefore, the multivariate cointegration method is used only as a complement to the duration dependence method in this research.

The aim of this research is to test for the presence of rational speculative bubbles in Asian stock markets by means of cointegration and duration dependence tests.

1.2 Research Question

Garber (1990) showed three famous historical examples of bubbles: namely the Dutch Tulipmania, the Mississippi Bubble and the South Sea Bubble. A long-run up in the price of U.S. stocks followed by a dramatic price drop in 1987 is another example of rational speculative bubbles in the U.S. stock market over the period from 1929 to 1987 (Blancard and Raymond, 2004). If the stock market is characterized by rational speculative bubbles, it will exhibit a boom and bust cycle during a time period (Jirasakuldech et al. 2008). Applying this definition, we find that certain periods in the Asian stock market appear consistent with the presence of rational speculative bubbles. For example, most major Asian stock markets had strong performances before 1997, however, after the Asian financial crisis, stock prices dropped dramatically. In 2007, most Asian stock markets were affected by the subprime loan financial crisis. The empirical evidence above has sparked a renewed interest in the presence of rational speculative bubbles in Asian stock markets and rigorous statistical tests are needed. Therefore, the research question is whether Asian stock markets were characterized by rational speculative bubbles over the sample period from 1991 to 2009.

1.3 Research importance, implications and contributions:

1.3.1 Research importance:

There is still a debate about whether or not rational speculative bubbles exist in Asian stock markets. Chan et al. (1998) have employed the duration dependence test to examine six Asian stock markets (Hong Kong, Japan, Korea, Malaysia, Thailand, Taiwan) and found that although Asian stock markets exhibited some unusual characteristics over the sample period from 1975 to 1994, these characteristics do not conform to those of rational speculative bubbles. This finding conflicts with those of Sarno and Taylor (1999), who report evidence of rational speculative bubbles in East Asian stock markets (China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand, in addition to Japan and Australia) during the sample period from 1989 to 1997. Sarno and Taylor, however, employed the cointegration method. The two studies used similar sample period, both including 1989 to 1994, but their results are completely different. So far, there is still no authoritative evidence of whether or not rational speculative bubbles existed in Asian stock markets. Therefore, it is important to test the presence of rational speculative bubbles in Asian stock markets and to use the duration dependence test, complemented by a cointegration test, to confirm the findings of this research.

Testing whether stock prices deviate from fundamental values can imply a new security pricing concept. According to a standard efficient market model, the stock price should be characterized by fundamental values. Hence

$$p_t = p_t^*$$

p_t : stock market price

p_t^* : fundamental value of the stock

However, West (1987) found that the stock market price can deviate from the fundamental value by the rational speculative bubble factor, b_t. Therefore, the following formula shows the new stock pricing concept:

$$p_t = p_t^* + b_t$$

b_t : Rational speculative bubble factor

We can see that testing for the presence of rational speculative bubbles in stock markets is important. When the investors realize that rational speculative bubbles exist in the stock market, they have to reprice the stock portfolio which they hold or will purchase. Investors could reconsider their entire investment portfolio, whether it is overvalued or undervalued. Therefore, testing for the presence of rational speculative bubbles in stock markets can help investors to make better decisions in terms of stock repricing.

The sample period of previous studies on Asian stock markets only included one financial crisis, namely the Asian financial crisis, but this research sample period also tests the subprime loan financial crisis. Furthermore, this research tests the relative sensitivity of rational speculative bubbles' effect on financial crises, whether or not the stock market is still characterized by rational speculative bubbles after the financial crisis breaks out.

This study will explore the sensitivity of duration dependence tests for rational speculative bubbles to the use of weekly versus monthly returns. It can help both researchers and investors to better understand the duration dependence test, and improve the efficacy of its use in determining the existence of rational speculative bubbles in stock markets.

1.3.2 Research implications:

Understanding whether or not Asian stock markets are characterized by rational speculative bubbles can help investors, or practitioners, to allocate their investment funds efficiently. If investors find that the stock market is booming, but the stock prices deviate from fundamental values (dividends and earnings), or the changes in stock prices exhibit negative duration dependence (decreased hazard rate) which means that there is a negative relationship between the probability that a positive run will end and the length of the positive run, this stock market is characterized by rational speculative bubbles. If the stock market is characterized by rational speculative bubbles, it will exhibit a boom and bust cycle during a time period. Testing for the presence of rational speculative bubbles can be used by investors to possibly predict market crashes, and consequently use short-selling to benefit from declining stock prices. Even though, in a country like China, it is impossible to benefit from declining prices due to the prohibition of short-selling, the prediction that a stock market will crash can force investors to act rationally by selling their stocks, thereby adjusting the share prices toward their fair value as well as causing the market to be efficient.

This study also provides important implications for policy makers. The presence of rational speculative bubbles indicates the imperfections of stock markets and leads the financial system and the macro economy to be unstable. In such cases, policy makers should stabilize the financial system and steer the economy away from these rational speculative bubbles by increasing interest rates, restricting short-selling of stocks, controlling inside trading activities and increasing brokerage fees.

1.3.3 Research contributions:

Some previous research shows evidence of the presence of rational speculative bubbles in Asian stock markets, such as Sarno and Taylor (1999), but some others imply different results, such as Chan et al. (1998). Therefore, testing for rational speculative bubbles existence in Asian stock markets is important. Strong evidence of the presence of rational speculative bubbles in some emerging stock markets was found, namely China, Indonesia and Malaysia although not in Philippines. Also, no evidence of the presence of rational speculative bubbles was found in developed stock markets, such as Japan, Korea and Singapore. Therefore, it would appear that emerging stock markets are more conducive to the presence of rational speculative bubbles than developed stock markets. However, the question of whether or not rational speculative bubbles existed in Asian stock markets is still largely unanswered.

McQueen and Thorley （1994） found that for such bubbles to be rational, the bubbles must be positive and explosive and Jirasakuldech et al. （2008）confirmed their result. Jirasakuldech et al. （2008）found the presence of rational speculative bubbles in the SET index in the first sub-period, ending with the Asian financial crisis in 1997, but not in the post-1997 sub-period. This research will include two financial crises, which are the Asian financial crisis and subprime loan financial crisis. The results of this research can contribute to previous studies in terms of whether or not the stock market was still characterized by rational speculative bubbles after the subprime loan financial crisis.

Harman and Zuehlke (2004) found that the results of duration dependence tests for weekly and monthly data are different, which calls into question the efficacy of using duration dependence test for rational speculative bubbles. This research will use the Asian stock markets example to find out to which kind of data duration dependence results are more sensitive. .

1.4 Research objectives

(1) Test for presence of rational speculative bubbles in seven stock markets, which include Japan, Singapore, Korea, China, Indonesia, Malaysia and Philippines.

(2) Test if the presence of bubbles is sensitive to selected subperiods.

(3) Test if the presence of bubbles is sensitive to types of markets i.e. emerging versus developed stock markets.

(4) Test the sensitivity of duration dependence tests for rational speculative bubbles to the use of weekly versus monthly returns.

The first research objective can be separated into two independent steps. First, the Johansen-Juselius method is employed to test the cointegration relationship between stock prices and fundamental variables for each of the seven countries (Japan, Singapore, Korea, China, Indonesia, Malaysia and Philippines). Second, the duration dependence technique is employed as a complement to the cointegration to test the presence of bubbles for the sample countries. The first objective is important for the research, because it is the path to finding whether or not rational speculative bubbles exist in Asian stock markets.

The second objective is to test if rational speculative bubbles are more apparent in the period leading up to known crises in the past. The sample period was separated into pre- and post- 1997 Asian financial crisis subperiods and pre- and post- 2007 subprime loan financial crisis subperiods, then each was tested for the presence of rational speculative bubbles.

The second research objective is important because it can test the relative sensitivity of rational speculative bubbles' effect on a financial crisis: whether or not the stock market is still characterized by rational speculative bubbles after the financial crisis breaks out. It can help policy makers to better understand stock markets and macro economy after a financial crisis so they can choose the best way to stabilise the financial system.

The third objective is to determine if rational speculative bubbles are more prevalent in emerging rather than developed markets. To address this objective, the seven markets were sorted according to their stage of development. China, Indonesia, Malaysia and Philippines belong to the emerging markets while Japan, Singapore and Korea are developed markets. First, emerging and developed markets were compared in terms of the presence of rational speculative bubbles. Second, whether the presence of bubbles is sensitive to the type of market--- emerging versus developed stock market – was tested. It is very useful for investors to understand stock markets in terms of rational speculative bubbles. As investors can earn high returns while the bubbles are explosive and can also use short-selling to benefit from declining stock prices.

The fourth objective is to test the robustness of the results of the duration dependence test when using weekly versus monthly data: to test if duration dependence results are sensitive to the kind of data used.

1.5 Outline of the Thesis

This research consists of five chapters. Chapter One introduces the background of rational speculative bubbles, the research importance and research objectives. Chapter Two provides an overview of the empirical research relative to the research topic. Chapter three describes the source of data and methodology used in this research

Chapter Four discusses the results obtained. Chapter Five gives the conclusion, results implications, and research limitations of the study.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews previous studies which identify the evidence for rational speculative bubbles in stock markets. The general rational speculative bubble model is reviewed in section 2.2 which introduces negative skewness, leptokurosis, positive autocorrelation, the cointegration test, duration dependence test and other methods. In section 2.3, previous studies on rational speculative bubbles in Asian and international stock markets are reviewed. Finally, section 2.4 provides the conclusions for this chapter.

2.2 General rational speculative bubble model

2.2.1 Negative Skewness, Leptokurtosis and Positive Autocorrelation

The presence of rational speculative bubbles in stock markets can be inferred from strong evidence of negative skewness (Evans, 1986), leptokurtosis and positive autocorrelation (Blanchard and Watson, 1982). These empirical attributes of rational speculative bubbles result from the two traditional characteristics of the bubbles; a long run-up in stock prices followed by a rapid crash, the probability of the bubble continuing must be greater than 1/2 (McQueen and Thorley, 1994).

Negative Skewness

Skewness is a measure of the asymmetry of the probability distribution of real- valued random variables. Negative skewness indicates that the left tail is longer and the mass of the distribution is concentrated on the right of the figure with relatively few low values. Chan et al. (1998) suggest that the expected value of the total price innovation should be zero in an efficient stock market. However, if rational speculative bubbles exist in a stock market, the probability of an abnormal positive return should be greater than 1/2 which means the positive returns should be more than negative returns. Therefore, the skewness of stock returns should be negative if rational speculative bubbles exist in a stock market.

Leptokurtosis

Kurtosis is a measure of the “peakedness” of the probability distribution of a real-valued random variable. A distribution with positive excess kurtosis is called leptokurtic. And has a more acute peak around the mean. Jirasakuldech et al. (2008) suggest that leptokurtic stock returns imply that the stock price changes occasionally deviate by large amounts, an indication of the possible presence of rational speculative bubbles and stock price departures from fundamental values.

Positive Autocorrelation

Autocorrelation is a mathematical tool for finding repeating patterns. If a stock historically has positively autocorrelated returns, it indicates that the stock price increased a lot over past time and investors may reasonably expect upward movements of this stock price in the future. This is also characteristic of rational speculative bubbles; investors realize that stock prices exceed fundamental values, but they still believe there is a good probability that the bubble will continue to expand and yield a high return (McQueen and Thorley, 1994).

Many previous studies used negative skewness, leptokurtosis and positive autocorrelation as a diagnostic test for rational speculative bubbles. Chan et al. (1998) find consistent evidence of leptokurtic distributions signalling the presence of rational speculative bubbles in Asian stock markets, such as Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan. However there is mixed evidence when it comes to negative skewness and positive autocorrelation as shown in the studies of Jirasakuldech et al. (2008), McQueen and Thorley (1994), Jaradat (2009) and Zhang (2008).

Jirasakuldech et al. (2008) found the presence of rational speculative bubbles in the Thai stock market could be inferred from strong negative skewness (-0.8371 for the full sample period from 1975 to 2006, -1.1381 for the Pre-Asian financial crisis sub-period from 1975 to 1997), excess kurtosis (3.6794 for the full period, 5.4394 for the sub-period) and positive autocorrelation (0.0897 full and 0.1080 Pre-Asian crisis) of returns. McQueen and Thorley (1994) also show monthly returns for value-weighted portfolios have negative skewness (-0.3690), excess kurtosis (6.7441) and positive autocorrelation (0.10).

Unfortunately, negative skewness, leptokurtic and positive autocorrelation tests for the presence of rational speculative bubbles are inaccurate. McQueen and Thorley (1994) found that time-varying risk premiums could induce autocorrelation, skewness could also result from asymmetric fundamental news and excess kurtosis could be a consequence of the batched arrival of information. Jaradat (2009) found strong evidence for the presence of rational speculative bubbles in the Jordanian stock market over the sample period from 1992 to 2007 although the skewness of monthly returns was positive (0.6648). This result is the same as Zhang (2008), who found that rational speculative bubbles existed in the Chinese stock market over a sample period from 1991 to 2001, even though the skewness of weekly returns were positive (2.73 for the Shanghai Exchange and 1.33 for the Shenzhen Exchange). The reason is probably that the characteristic movement of the indices are to increase very fast and decline slowly.

2.2.2 Cointegration test

A cointegration approach is used to test the long-run relationship between stock prices and fundamental variables. The lack of a cointegration relationship between prices and fundamental values implies that rational speculative bubbles exist in the stock market.

Using U.S. data, Campbell and Shiller (1987) found no evidence of a cointegration relationship between annual stock prices and dividends for the S&P 500 index over their sample period from 1959 to 1983. Also, Sarno and Taylor (1999) employed cointegration analysis when investigating the moral hazard problem, asset price bubbles, and capital flows during the East Asian financial crisis with their results strongly suggest the existence of bubbles in the East Asian stock markets; namely China, Indonesia, Malaysia, Philippines, Singapore, South Korea , Taiwan, Thailand and Japan. Blancard and Raymond (2004) used cointegration tests to examine the presence of rational speculative bubbles in the five developed stock markets of France, Germany, Japan, UK and USA. The result of this research confirmed disconnection between stock prices and dividends over the sample period from 1973 to 2002, indicating the probable presence of rational speculative bubbles in these markets. Furthermore, their results did not change when an additional fundamental variable (earnings) was included.

In their study, testing whether rational speculative bubbles existed in the Thai stock market over the sample period from June 1975 to June 2006, Jirasakuldech et al. (2008) employed the Johansen- Juselius multivariate cointegration vector autoregression approach to test the long run relationship among stock price, dividends and earnings. Their results indicate that the trace test and the maximum eigenvalue test cannot reject the null hypothesis of no cointegration between stock prices and dividends at traditional significance levels. The null hypothesis of no cointegration among stock prices, dividends and earnings also cannot be rejected. These results imply that Thai stock prices deviated from fundamental values and the Thai stock market was probably characterized by rational speculative bubbles.

From 1965 to 1999, a sharp divergence of London Stock Exchange equity prices from dividends had been noted. Brooks and Katsaris (2003) investigated whether this situation could be explained by the existence of rational speculative bubbles in the London stock market. The authors employed three different empirical methodologies: variance bounds tests, bubble specification tests and cointegration tests. The results of this research showed that the London Stock Exchange equity prices deviated significantly from fundamental values during the late 1990's, which could be explained by the presence of rational speculative bubbles.

Lee (1996) tested whether the log of U.S. stock prices, dividends and earnings moved together during the sample period from 1871 to 1992. He found that the three series were cointegrated with a single cointegrating vector, showing that there was an equilibrium force that tended to keep the log of U.S. stock prices, dividends and earnings together during the sample period, thus meaning there were no rational speculative bubbles in the U.S. stock market then. This force was particularly strong between earnings and dividends.

In summary, although, according to previous studies, a cointegration test is a useful approach for detecting the presence of rational speculative bubbles it has its limitations. Firstly, the test relies heavily on the correct identification of controversial fundamental variables and, secondly, the cointegration test has low power when a limited data span is used. [1]Therefore, the multivariate cointegration method is only used in this study as a complement to the duration dependence method.

2.2.3. Duration dependence test

Fortunately, the cointegration test is not the only technique that can test for the presence of rational speculative bubbles. The duration dependence test, developed by McQueen and Thorley (1994), is another powerful tool. McQueen and Thorley (1994) believe that rational speculative bubbles occur when investors realize that the stock prices have already exceeded fundamental values, but still think there is a high probability that the bubble will continue to expand and yield a high return, thus this good probability of high returns will compensate these investors for the probability of

[1] The limitations of the cointegration test will be more fully explained in Chapter 3 (Data and Methods).

a crash. Therefore, if rational speculative bubbles exist in a stock market there will be a negative relationship between the probability that a positive run will end and the length of the positive run. In other words, the changes in stock prices will exhibit negative duration dependence or a decreasing hazard rate. McQueen and Thorley (1994) tested the monthly returns of NYSE stock portfolios, with the result rejecting the no-bubble hypothesis, based on duration dependence tests. This significant evidence of negative duration dependence in runs of positive abnormal returns could be attributed to rational speculative bubbles.

Chan et al. (1998) also used duration dependence tests in evaluating evidence for speculative bubbles in six Asian stock markets (Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan) and the U.S. stock market by testing monthly and weekly stock market returns of the seven stock markets over a sample period from January 1975 to April 1994. However, Chan et al.'s (1998) results contradict those of McQueen and Thorley (1994) for the U.S. stock market and none of the seven markets was completely consistent with the predictions of the rational speculative bubbles model. McQueen and Thorley (1994) found the strong evidence of presence of rational speculative bubbles in U.S. stock market over the sample period from 1927 to 1991, but Chan et al. (1998) showed that there is no rational speculative bubble in U.S. stock market from1975 to 1994.

In other testing for the presence of rational speculative bubbles, Jirasakuldech et al. (2008) found the cointegration methodology to be inaccurate for the reasons already mentioned; therefore they also employed the duration dependence test as a complement. The result of the duration dependence test confirmed that the Thai stock market was characterized by rational speculative bubbles. Furthermore, they found evidence of the presence of rational speculative bubbles in the SET index during the first pre-1997 Asian financial crisis subperiod but not in the Post- 1997 subperiod.

In summary, the duration dependence test for detecting the presence of rational speculative bubbles was developed by McQueen and Thorley (1994). Unlike other tests, such as cointegration, negative skewness, leptokurtic and positive autocorrelation, the duration dependence test is unique to rational speculative bubbles. This test also specifically addresses nonlinearity by allowing the parameter (probabilities of ending a run) to vary, depending on the length of the run and on whether the run is of positive or negative abnormal returns hence the results of duration dependence tests are more reliable. Consequently, the duration dependence test is the main test used in this research and cointegration, skewness, kurtosis and autocoreelation tests are used as its complements.

2.3 Review of studies on rational speculative bubble in stock markets

2.3.1 Evidence of rational speculative bubbles in Asian stock markets.

Chan et al. (1998) employ two types of tests to evaluate the evidence of rational speculative bubbles in six Asian stock markets, namely Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan, and the U.S. stock market. They used two types of tests, the duration dependence and conditional skewness tests, when examining both monthly and weekly stock market returns over the sample period of January 1975 to April 1994. Consistent with the predictions of the rational speculative bubble model, the returns from the seven stock markets generally exhibited positive autocorrelation, negative skewness and leptokurtosis. However, the results of duration dependence tests contradicted the results of conditional skewness tests. For the runs of positive monthly indices' returns, the log-logistic function parameters (β) from the duration dependence test are negative in Hong Kong, South Korea, Malaysia and Thailand, but none of the coefficients are significant. This means that even though the log-logistic function parameter (β) is negative, there is still no evidence of rational speculative bubbles in these stock markets. On the other hand, Malaysia's stock returns exhibited significant negative duration dependence in runs of negative monthly returns, yet McQueen and Thorley (1994) suggest that rational speculative bubbles cannot be negative. The evidence of negative duration dependence in Malaysia must therefore be driven by some other reasons, but not by rational speculative bubbles. The results of weekly returns are similar to monthly returns', only Thailand's positive weekly returns showing a significant β (β is -0.278 and the p-value is 0.06), therefore Chan et al. (1998) concluded that none of the six Asian stock markets nor the U.S. stock market has return characteristics that completely conform to the predictions of the rational speculative bubbles model.

Some evidence suggests that the increasing returns prior to the crash in the Hong Kong, Malaysia and Thailand stock markets are consistent with the presence of rational speculative bubbles, but these markets collapsed from their peaks over several months, unlike the instantaneous crash predicted by the theory. On the other hand, the U.S. stock market crashed very quickly after October 1987, but the returns prior to the crash tapered off slowly, unlike the increasing returns prior to the crash suggested by the rational speculative bubble theory. Finally, Chan et al. (1998) suggest that only some marginal empirical evidence can support the presence of rational speculative bubbles in Asian stock markets.

Subsequently, however, the results of Sarno and Taylor (1999) partly contradict those of Chan et al. (1998). Sarno and Taylor (1999) employ cointegration tests and data on monthly aggregate stock prices and dividends for eight East Asian countries, China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand, to test the existence of rational speculative bubbles from 1989 to 1997. Their results imply the existence of rational speculative bubbles in these East Asian stock markets. Consequently, the difference between the two studies raises the question of whether the Asian stock markets are characterized by rational speculative bubbles. However, the differing results could be due to the differing sample periods: Chan et al. (1998)'s being from 1975 to 1994 and Sarno and Taylor (1999)'s from 1989 to 1997. It could be said that Chan et al. (1998) missed the two most important years for Asian stock markets: 1995 and 1996. Until 1997, Asian countries received more than half of the total capital inflow of the whole world. The Asian economies maintained high interest rates, and foreign investors looked to Asia for a high rate of return. As a result, Asian economies attracted a large inflow of money and the asset price went up dramatically, with the foreign debt to GDP ratio rising from 100% to 167% from 1993 to 1996. At the same time, the GDP of Thailand, Malaysia, South Korea, China, Singapore and Indonesia grew at growth rates between 8% and 12%, an achievement called the "Asian economic miracle" by the IMF and the World Bank. Therefore, during 1995 and 1996, namely the pre-Asian financial crisis period, when the Asian economy and Asian stock markets grew dramatically, rational speculative bubbles may have existed. In another study, Zhang (2008) utilizes weekly composite closing index prices of the Shanghai and Shenzhen Exchanges to test the existence of rational speculative bubbles in the Chinese stock market over the sample period of 1991 to 2001. This research focuses on the Chinese Shanghai Composite Index (SHG) and the Shenzhen

Composite Index (SHZ), as they represent the whole Mainland China stock market. The positive autocorrelation and leptokurtosis of stock returns imply that China's stock market had clear characteristics conforming to evidence of rational speculative bubbles. Consistent with the summary statistics and correlation coefficient test, the results of duration dependence tests show that the probability of ending a run of positive excess returns decrease with the length of the return, further implying that rational speculative bubbles existed in Mainland China's stock market over the sample period from 1991 to 2001.

Zhang (2008)'s results support Sarno and Taylor (1999) in terms of China's stock market, but Lehkonen (2010) finds it hard to show a clear answer as to whether rational speculative bubbles existed in the Chinese stock market. Lehkonen (2010) investigates the weekly and monthly price indices of both Mainland China and Hong Kong. The sample period of Shanghai A-shares, Shanghai B-shares, Shenzhen A-shares and Shenzhen B-shares is from 1992 to 2008; and Hong Kong China Enterprises (HKE) and China Affiliated Corporations (HKA) indices are sampled from 1993 to 2008. The results of weekly data show that the Shanghai A-share index has a significant negative β coefficient, at -0.620, for the sample period, and the null hypothesis of a constant hazard rate is rejected at the 1% significance level, with the p-value of 0.0001. This implies that rational speculative bubbles existed in the Shanghai A-share index over the sample period from 1992 to 2008. The weekly data results for Shanghai B-shares, Shenzhen A-shares and Shenzhen B-shares are similar to those of the Shanghai A-shares. On the other hand, the results of weekly data for the Hong Kong China Enterprises and China Affiliated Corporations indices are insignificant at traditional significance levels. As for runs of abnormal negative returns, the constant hazard rate hypothesis is not rejected for any of the markets. The results of weekly data therefore imply that rational speculative bubbles existed in the Mainland Chinese stock markets but monthly data lead to different conclusions. None of the markets has a significant negative coefficient β and the null hypothesis of no rational speculative bubbles cannot be rejected by monthly data in any of these markets. Therefore, the final results do not show a clear answer as to the presence of rational speculative bubbles in China's stock market, but confirm that the duration dependence test is sensitive to the use of weekly data versus monthly data, and the reliability of the duration dependence test for rational speculative bubble detection is questionable.

In the Malaysian stock market, Ali et al. (2009) and Mokhtar et al. (2006) both find evidence of rational speculative bubbles, consistent with the results of Sarno and Taylor (1999). Ali et al. (2009) test the linkage between stock overreaction behaviour and financial rational speculative bubbles by using duration dependence tests. Monthly market returns from the Kuala Lumpur Stock Exchange Composite Index (KLSE CI), over a sample period between January 1987 and December 2006, show no clear evidence of stock overreaction behaviour in the market. They also use the abnormal continuously compounded real monthly returns of the Kuala Lumpur Composite Index (KLCI) to test for the presence of rational speculative bubbles over the sample period between January 1989 and December 2006 using duration dependence tests. Their results indicate the absence of rational speculative bubbles in the KLCI over the full sample period. Interestingly, when the authors separate the full sample period into two sub-periods, evidence of stock overreaction behaviour becomes significant in the pre-crisis sub-period and seems to diminish in the post-crisis sub-period. Therefore there is significant evidence for the presence of rational speculative bubbles in the post-crisis sub-period, but not in the pre-crisis sub-period. The final conclusion of this study is that the evidence for rational speculative bubbles, observed in the Malaysia stock market in the post crisis period, is actually due to stock overreaction that took place in the market prior to the crisis.

Mokhtar et al. (2006) employ a duration dependence test to investigate the existence of rational speculative bubbles in the KLCI over a sample period from January 1994 to December 2003. The study split the analysis into three sub-periods: before the Asian financial crisis (1994-1996), during the Asian financial crisis (1997-1998) and after the Asian financial crisis (1999-2003). This research revealed the existence of rational speculative bubbles in Malaysia's stock market before and after the Asian financial crisis sub-periods.

Jirasakuldech et al. (2008) employ both multivariate cointegration and duration dependence tests to examine whether the Thai equity market was characterized by rational speculative bubbles over their sample period from June 1975 to June 2006. Conducted using monthly closing prices, corresponding dividend yields and price earnings ratios of the SET index, the results of cointegration tests for the full sample period, and pre-1997 Asian Crisis sub-period, cannot reject the null hypothesis of no cointegration between stock prices and dividends at traditional significance levels. The use of earnings in addition to dividends does not improve the results, but, for the post-1997 Asian Crisis sub-period, the λtrace and λmax test provide evidence of cointegrated relationships between stock prices and fundamental factors. Therefore, the results of the cointegration tests imply that rational speculative bubbles existed in the Thai stock market from 1975 to 2006, especially before the Asian financial crisis happened. The results of the duration dependence test are the same as those of the cointegration tests and are also consistent with the results of Watanapalachaikul and IsIam (2007). That rational speculative bubbles exist in the Thai stock market is close to the results of Chan et al. (1998who do not reject the null hypothesis of no rational speculative bubble in the Thai stock market at a 5% significance level, but reject it at a 10% significance level (β is -0.278 and p-value is 0.06).

Elsewhere, Rangel and Pillay (2007) employ four different tests; namely excess volatility tests, unit root/cointegration tests, duration dependence tests, and the intrinsic bubbles model, to examine the presence of rational speculative bubbles in the Singapore stock market from January 1975 to January 2007. Results of all four tests indicate that rational speculative bubbles were present over this sample period, consistent with the findings of Sarno and Taylor (1999).

In conclusion, some studies show evidence of the presence of rational speculative bubbles in Asian stock markets, but others imply different results. Therefore, the question of whether or not rational speculative bubbles existed in Asian stock markets is still largely unanswered.

2.3.2 Evidence of rational speculative bubble in other international stock markets.

McQueen and Thorley (1994) apply the duration dependence test to the New York Stock Exchange (NYSE) over the sample period of 1927 to 1991, and find significant evidence of a negative hazard function in runs of positive returns for both equally-weighted and value-weighted portfolios. They also show strong evidence of the presence of rational speculative bubbles in the New York Stock Exchange (NYSE) over the same period. The results for runs of excessive monthly equally-weighted portfolio returns show decreasing hazard rates of 0.542, 0.409 and 0.154, relative to run lengths of 3, 4 and 5 months respectively. The log-logistic function parameter (β) for the equally-weighted runs of positive abnormal returns is -0.238, which means that the probability of ending a run of abnormal positive returns decreases with the length of the run, as predicted by the rational speculative bubble model. For the equally-weighted portfolio, the null hypothesis of no rational speculative bubble is rejected, with a 0.05 p-value for runs of positive returns. However, for runs of negative abnormal returns of the equally-weighted portfolio, the constant hazard rate is not rejected at traditional significance levels; the p-value being 0.65. For the positive runs of the value-weighted portfolio, hazard rates decrease from 0.525 to 0.222, relative to run lengths of 2 months to 5 months respectively. β for the value-weighted runs of positive abnormal returns is -0.303 and it is significant at a p-value of 0.03, however, β at -0.118 for negative runs is still insignificant at a p-value of 0.52.

In another study, Jirasakuldech et al. (2006) test for the presence of rational speculative bubbles in the equity REIT industry from 1973 to 2003. They employ different bubble identification techniques, cointegration analysis and a duration dependence test using the cointegration procedures, but found no evidence of rational speculative bubbles in the REIT market. Furthermore, both the trace test and maximum eigenvalue test reject the null hypothesis of no cointegration relationship between REIT price index and macroeconomic fundamental variables, namely the consumer price index, industrial production, the risk premium and federal funds rate, at 1% significance levels over the full sample period (1973 to 2003), the first subperiod (1973 to 1991) or the second subperiod (1991 to 2003). The results of the duration dependence test show no evidence of negative duration dependence, suggesting that the REIT market is not affected by rational speculative bubbles. The β of negative runs is 0.2656 and β of positive runs is -0.1440, however, the p-value is too big, at 0.4716it is insignificant. Applying the same tests, they found similar results in the Russell 2000 index, both for the cointegration test and duration dependence test. Neither show the presence of rational speculative bubbles in the index over the sample period from 1980 to 2003.

In Finland, according to unit root tests and cointegration analysis, Junttila (2003) finds some evidence of rational speculative bubbles in the Helsinki Stock Exchange using monthly data. Juntilla (2003) reports their presence mainly in the information technology (IT) sector from 1991 to 2000.

From 1993 to 1999, the Financial Times All Share Index offered investors a return of more that 200 percent over the six year period, which raises a question as to whether rational speculative bubbles existed in the London stock market. Therefore, Brooks and Katsaris (2003) use FIAS Index monthly closing prices and a constructed FTAS dividend index from January 1965 to March 1999 to perform the tests for whether stock prices in the London stock market reflect their fundamental values. The results of the cointegration test show that the long-run relationship between stock prices of the FTAS Index and dividends did not hold in the late 1990s, implying that the FTAS Index was not driven by market fundamentals, hence rational speculative bubbles existed in the London stock market during the sample period.

Furthermore, Hassan and Yu (2006) employed the long-established cointegration test and the duration dependence test to examine the existence of rational speculative bubbles from 1996 to 2003 in the nine frontier emerging stock markets: Bangladesh, Botswana, Coted'Ivoire, Ecuador, Ghana, Jamaica, Kenya, Mauritius, and Trinidad & Tobago. The results of the cointegration test tend to support the existence of rational speculative bubbles in the frontier emerging stock markets, but the duration dependence test does not show strong evidence.

In the Middle East, Jaradat (2009) employs the duration dependence test to examine the presence of rational speculative bubbles in the Jordanian equity market known as the Amman Stock Exchange (ASE index), over a sample period from January 1992 to May 2007. The ASE index has a significant negative β coefficient of -0.0924 on positive returns, with the p-value of 0.001. This evidence of negative duration dependence in runs of positive returns is consistent with the presence of rational speculative bubbles in the Jordanian stock market, and also consistent with the results of summary statistics for ASE index monthly returns which are characterized by a positive autocorrelation, negative skewness and leptokurtosis.

2.4 Conclusions

In this chapter, general rational speculative bubble models were reviewed in section 2.2 and previous studies on the presence of rational speculative bubbles in stock markets were also reviewed in section 2.3. In section 2.2, the usefulness of negative skewness, leptokurtic, positive autocorrelation, cointegration tests and duration dependence tests were also examined. Compared with other tests, the results of the duration dependence test seem more reliable, consequently the duration dependence test is the main test utilised in this research. In section 2.3 previous studies on rational speculative bubbles in Asian stock markets and other international stock markets were reviewed. Some studies provided strong evidence for the presence of rational speculative bubbles in U.S., and European stock markets and some Asian stock markets' performance were consistent with their presence, especially during the pre-1997 Asian financial crisis period. However, other studies had opposing results and, since there are conflicting points of view, there is a need to investigate this issue further.

Chapter 3

Data and Methods

3.1 Introduction

This chapter discusses the data and methods used in this study to test for the presence of rational speculative bubbles. The research objectives and hypotheses are identified, followed by a description of the Asian stock markets in the sample countries of Japan, South Korea, Singapore, China, Indonesia, Malaysia and Philippines. The data collection is also discussed in this chapter followed, finally, by the model testing method.

3.2 Research Objectives

In the literature review section, it was found that the Asian stock markets experienced several apparent boom and bust cycles, with a long term boom followed by a dramatic drop, in recent years. These unusual characteristics are similar to those of rational speculative bubbles, which raises the question whether or not rational speculative bubbles exist in Asian stock markets.

The first research objective is to test for presence of rational speculative bubbles in eight Asian stock markets in seven countries Japan, Singapore, Korea, China (Shanghai and Shenzhen stock markets), Indonesia, Malaysia and Philippines. This objective is addressed by two independent tests. First, a duration dependence test is performed on both monthly and weekly real returns of the eight stock markets. If the stock prices are affected by rational speculative bubbles, price changes will exhibit negative duration dependence (a decreasing hazard rate) (McQueen and Thorley, 1994). Second, the Johansen-Juselius multivariate cointegration method (Johansen, 1998; Johansen and Juselius, 1992) is employed as a complement to the duration dependence test to examine for the presence of bubbles in the sample markets. This method tests the cointegration relationship among monthly stock prices, dividends and earnings of value-weighted portfolios for each of the seven. The benefit of the duration dependence test over the cointegration test is that it does not require the correct identification of the observable fundamental components, therefore the duration dependence test is the main methodology, and the Johansen-Juselius multivariate cointegration test is the associate methodology.

The second research objective is to test for rational speculative bubbles over sub-periods. As Jirasakuldech etc. (2008) found, no cointegration relationship exists between stock price and fundamental variables for Thai stock market over the pre-1997 Asian financial crisis subperiod. However, a cointegrated relationship does exist over the post-1997 subperiod, indicating that rational speculative bubbles existed before the Asian financial crisis, and disappeared thereafter. In this research, the sample period is divided into four parts, which are: pre- and post- 1997 (1991-1997 and 1997-2001) Asian financial crisis subperiods and pre- and post- 2007 (2001-2007 and 2007-2009) subprime loan financial crisis subperiods. Testing for the presence of rational speculative bubbles in each subperiod can measure the relative sensitivity of our results to the presence of extraordinary events.

The third research objective is to test if the existence of rational speculative bubbles depends on the type of market. Consequently, the seven countries are sorted into emerging and developed markets; China, Indonesia, Malaysia and Philippines belonging to emerging markets and Japan, Singapore and Korea belonging to developed markets.

The fourth research objective is to test the robustness of the results of the duration dependence test by using weekly rather than monthly data. Previous studies have employed a number of methods to test for presence of rational speculative bubbles in stock markets, with the duration dependence method shown to be quite powerful. However, prior research has questioned the efficacy of using duration dependence tests especially when using monthly data versus weekly data. Harman and Zuehlke (2004) have explored the sensitivity of duration dependence tests for rational speculative bubbles in terms of monthly versus weekly data. They found evidence supporting rational speculative bubbles in the NYSE (New York Stock Exchange) portfolio with monthly data; however, there was no evidence of rational speculative bubbles with weekly data. Lehkonen (2010) found that the empirical evidence from weekly data indicate rational speculative bubbles exist in Shanghai A share, Shanghai B share, Shenzhen A share and Shenzhen B share markets, however, the monthly data fail to yield evidence of rational speculative bubbles in any. Therefore, this research objective tests the sensitivity of the duration dependence method of detecting rational speculative bubbles in terms of monthly data versus weekly data use.

3.3 Research Hypotheses

The following research hypotheses are based on the research objectives.

The first research objective is to test for the presence of rational speculative bubbles in eight Asian stock markets; Japan, Singapore, Korea, China (Shanghai and Shenzhen stock markets), Indonesia, Malaysia and Philippines.

Hypothesis 1(Duration dependence test):

The null hypothesis is that the "hazard rate" is constant, which means that the probability of a positive run's ending is unrelated to prior runs, implying that no rational speculative bubble exists in any of the sample Asian stock markets. The alternative hypothesis is that the "hazard rate" is decreasing, which means that the probability of a positive run's ending should decrease with the length of the run, implying that the rational speculative bubbles existed in each of the sample Asian stock markets::

H_0: $\beta=0$

H_1: $\beta<0$

Hypothesis 2 (Cointegration test):

The cointegration test (Trace test) is employed as a complement to the duration dependence technique to test the presence of rational speculative bubbles in the sample markets. The null hypothesis is that the cointegrating vector (r) is zero, in other words, the non-stationary variables, such as stock prices, dividends and earnings are not cointegrated, implying the presence of rational speculative bubbles. The alternative hypothesis is that the r is bigger than zero, in other words, the non-stationary variables, such as stock prices, dividends and earnings are cointegrated, implying that no rational speculative bubble exists in the sample:

H_0: $r=0$

H_1: $r>0$

Hypothesis 3:

The second research objective is to test the sensitivity of the results to the presence of extraordinary events. The null hypothesis is that rational speculative bubbles exist in Asian stock markets in the subperiods ending with the Asian financial crisis in 1997 and subprime loan financial crisis in 2007 respectively, but not in the post- 1997 and post- 2007 subperiods. The alternative hypothesis is that rational speculative bubbles exist in Asian stock markets in the post- 1997 and post- 2007 subperiods, but not in the pre- 1997 and pre- 2007 subperiods.

Hypothesis 4:

The third research objective is to compare emerging and developed markets in terms of the presence of rational speculative bubbles. The null hypothesis is that rational speculative bubbles are more prevalent in emerging stock markets than in developed stock markets.

Hypothesis 5:

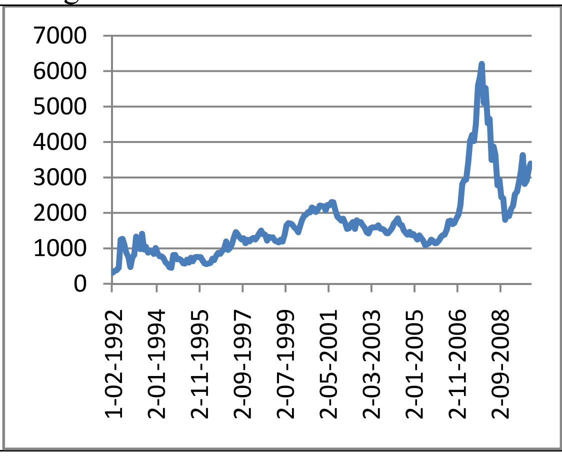
The last research objective is to test the robustness of the duration dependence test results using weekly data. The null hypothesis is that the duration dependence test for rational speculative bubbles is more sensitive to the use of weekly data than monthly data.

3.4 Background on Asian stock markets

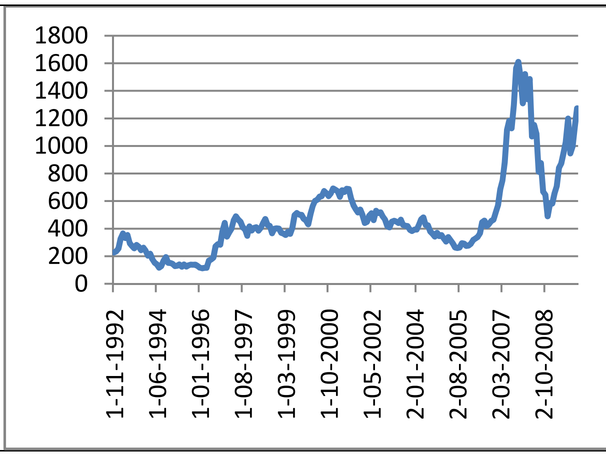
The following graphs (Figure 1) show changes in the major Asian stock indices over the sample period from 1991-2009 (Shanghai A share and Shenzhen A share are from 1992).

Figure 1: Monthly stock index levels for eight Asian markets

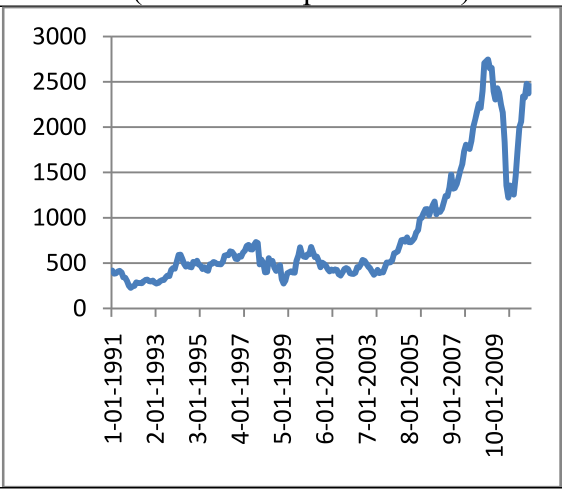
Shanghai A share Index



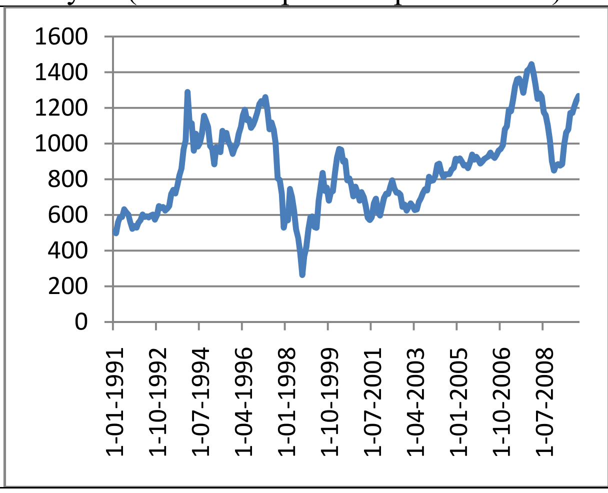
Shenzhen A share Index



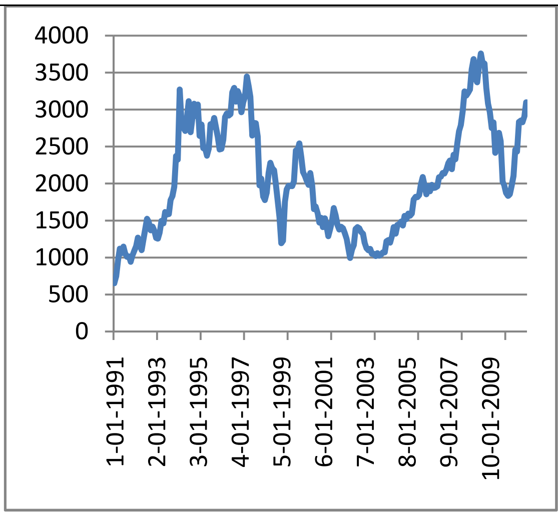
Indonesia (Jakarta Composite Index)



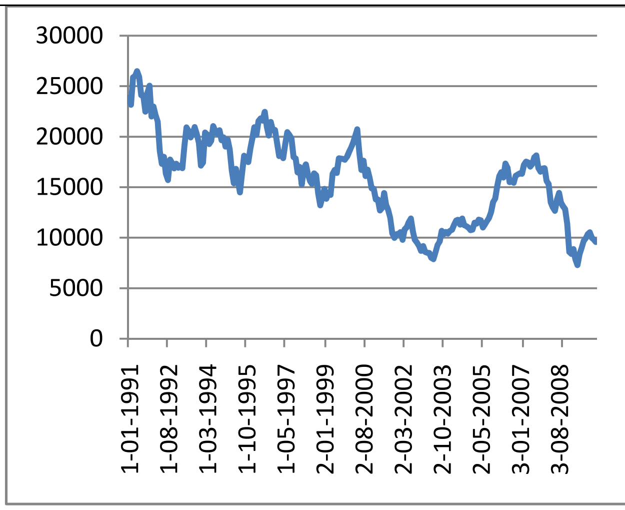
Malaysia (Kuala Lumpur Composite Index)



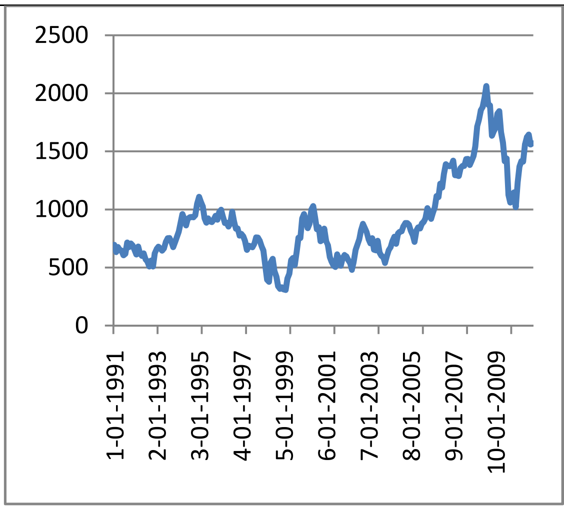
Philippine (Philippine Composite Index)



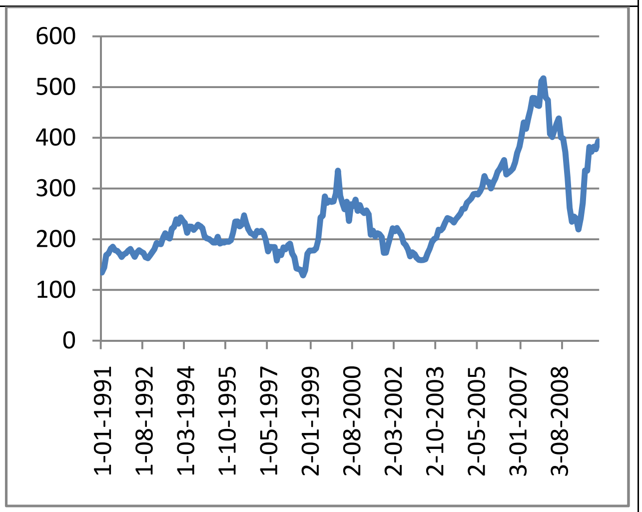
Japan (Nikkei 225 Index)



South Korea (KOSPI)



Singapore (ST Index)



The eight Asian markets experienced several apparent boom and bust cycles in the last twenty years and were deeply affected by two financial crises, namely the Asian financial crisis and Subprime loan financial crisis.

3.4.1 The Asian financial crisis

Until 1997, Asian countries have received more than half of total capital inflow from the whole world. The Asian economies in particular maintained high interest rates, and foreign investors paid more attention on Asia for a high rate of return. As a result, Asian economies have attracted a large inflow of money and the asset price went up dramatically, and foreign debt to GDP ratio rose from 100% to 167% from 1993 to 1996. At the same time, the GDP of Thailand, Malaysia, South Korea, China, Singapore and Indonesia grew at a growth rates around 8% to 12%. This achievement was called “Asian economic miracle” by the IMF and the World Bank.

The Asian financial crisis started in Thailand in July 1997, and raised fears across the other Asian economies. The deepest effects of the crisis were felt in Indonesia, South Korea and Thailand, although the Philippines, Malaysia and Hong Kong were also hurt by the slump. China, Singapore and Japan were even less affected, but also suffered from this event. Sharp reductions in stock market values were seen in Asian capital markets. The main stock index of Indonesia, namely the Jakarta Stock Exchange, reached an historic low in September 1997; the Seoul stock exchange fell by 4% on 7 November , 7% on 8 November, and 7.2% on 24 November; while the PSE Composite Index, the main index of the Philippine Stock Exchange, dropped 1000 points from a high of some 3000 points in the same year. The Kuala Lumpur Composite Index lost more than 50%, from above 1,200 points to fewer than 600 points during May to December and the Straits Times Index dropped 60% in less than one year. Between 20 October and 23 October, the Hang Seng Index dropped 23% in only 4 days. (Radelet and Sache, 1998).

3.4.2 The Subprime loan financial crisis:

The Subprime loan financial crisis of 2007 was triggered by a liquidity shortfall in the United States banking system. The U.S. housing bubble began in 2001, reached its peak in 2005, and collapsed in 2007. The fallout affected financial institutions globally, with problems regarding bank solvency, decline in credit availability, and the damage to investor confidence impacting global stock markets, especially in Asia (Bianco, 2008). As Figure 1 shows, all of the sample stock indices exhibited significant growth, reflecting their attractiveness to both domestic and international investors, from 2002. However, after the U.S. housing bubble burst and the Subprime loan financial crisis occurred, in 2007, the asset prices of Asian stock markets dropped dramatically.

3.5 Data Collection

All the data used in this research was obtained from the DataStream Database.

3.5.1 Data for duration dependence test

This study used both monthly and weekly stock price indices of eight Asian stock markets, which include the developed markets of Japan, South Korea and Singapore; and the emerging markets of China, Indonesia, Malaysia and Philippines. The data series used from the stock price indices are described in the following table:

Table 3.1: Index Description

Developed Market	Index Name
Japan	Nikkei225 Index
South Korea	Korea composite stock price index
Singapore	Straits Times DS.-Calculated index

Emerging Market	Index Name
China	Shanghai A - Share Index Shenzhen A – Share Index
Indonesia	Jakarta Composite Index
Malaysia	Kuala Lumpur Composite Index
Philippines	Philippine Stock Exchange Index

All the stock price indices are inflation adjusted using monthly and weekly inflation rates computed from Consumer Price Index (CPI) data, which can also be collected from the DataStream Database. The inflation series is computed by taking the first differences of the natural logarithm of the CPI.

Inflation rate= 100 * (Ln CPI_t – Ln CPI_{t-1})

The data used for the duration dependence test is the continuously compounded real return of stocks. The monthly or weekly closing prices are transformed into continuously compounded monthly or weekly returns thus:

$R_t = 100 * (\text{Ln } P_t - \text{Ln } P_{t-1})$

Where P_t is the index closing price for month t, and P_{t-1} is the closing price for the month preceding. The monthly or weekly returns are then converted to the monthly or weekly real returns by following the formula:

$$\text{RealReturn} = \frac{(1+\text{Return})}{(1+\text{Inflation Rate})} - 1$$

Monthly data versus Weekly data:

Both monthly and weekly indices are examined by using duration dependence tests for a number of reasons. Firstly, Chan et al. (1998) suggest that the bubble theory does not give an indication as to the typical length of the rational speculative bubble. Most of the literature implies that rational speculative bubbles may build up over a number of months or years, however, none of the previous studies gives a specific or typical length for this bubble. Secondly, the monthly data series should be relatively shorter hence the use of weekly data series provides us with a longer data set.[2] However, McQueen and Thorley (1994) suggest that the signal-to-noise ratio in weekly data series is higher than in monthly data series. This could cause bubble-related runs to be interrupted by noise. The signal-to-noise ratio is a measure used to quantify how much a signal has been corrupted by noise and in testing data for the presence of bubbles; the noise refers to changes in fundamental prices. The volatility

[2] As shown in table 4.17 and 4.18 (in Chapter 4 Results and Discussions), during the same sample period, the observations of monthly data are around 50 and for the weekly data are around 230.

of weekly fundamental price changes is higher than the volatility of monthly price changes; therefore, the high signal-to-noise ratio is a weakness of weekly tests relative to monthly tests. Finally, Harman and Zuehlke (2004) suggest that duration dependence test results are sensitive to the use of either weekly or monthly returns

China A-Share and B-Share:

China's stock market is a special case compared with other stock markets, as it has two classes of shares, namely A-Share and B-Share. Both of them are traded on two major Stock Exchanges, the Shanghai and Shenzhen Stock Exchanges. A-Shares traded in Renminbi, the currency of mainland China, were open to domestic investors and qualified foreign institutional investors; while the B-Shares, traded in U.S. dollars and Hong Kong dollars, were originally designed for overseas investors. This research will test the mainland China stock market, excluding the Hong Kong stock market. As the A-Shares are dominated by mainland Chinese investors and the B-Shares are dominated by foreign institutional investors (Tan et al. 2008), the A-Shares are more representative of the mainland China stock market than the B-Shares. Therefore, this research will only use the A-Share indices data from both Shanghai and Shenzhen. The emerging Asia-pacific stock markets have short price histories for example, China's stock market only started from 1991. Therefore, this research will analyze the data over the sample period from 1991 to 2009, a collection of 18 years of monthly and weekly data.

3.5.2 Data for cointegration test

The monthly value-weighted stock prices, dividends and earnings are indices of all individual stocks whose components are weighted according to the total market value of their outstanding shares. All of the individual stock prices, dividends earnings and market values are obtained from DataStream Database.

3.6 Testing Model Description

In this section, summary statistics, duration dependence methods and multivariate cointegration, are discussed in respect of their suitability to test for the existence of rational speculative bubbles in stock markets.

3.6.1 Summary Statistics

Summary statistics can be used to test for the presence of rational speculative bubbles. The presence of rational speculative bubbles in stock market can be inferred from evidence of negative skewness, excess kurtosis and positive autocorrelation of real returns.

3.6.2 Multivariate cointegration test

The Johansen-Juselius multivariate cointegration vector autoregression approach is used to examine the long-run relationship between stock prices and fundamental values. This research will choose two fundamental variables, namely value-weighted dividends, and earnings. Campbell et al. (1997) show that the use of dividends as a fundamental variable comes directly from the present value model of stock prices. Earnings are included as an additional fundamental variable in this study; because it is also an important determinant of stock pricing, consistent with the suggestions of Lee (1996) and Lim (2005), who suggest that in addition to dividends, earnings also play an important role in pricing stocks. This study will examine the cointegration between value-weighted prices and dividends. It will also examine the cointegration among value-weighted prices, dividends and earnings.

However, the cointegration method has its limitations. First, the cointegration test relies heavily on the correct identification of controversial fundamental variables. Brooks and Katsaris (2003) suggest that lack of cointegration may be caused by model misspecification through the exclusion or misidentification of significant variables that affect stock prices. Johansen (1991) shows that the lack of a cointegration relationship between stock prices and dividends may not be caused by the presence of rational speculative bubbles, but by other factors, such as large, highly persistent shocks in the systems, or a change in the economic regime which would bias the cointegration test in favor of no cointegration relationship (Chow, 1998). The empirical evidence of Campbell and Shiller (1987) support this conclusion. They test the cointegration relationship between U.S. stock prices and discounted dividends and find that this methodology is very sensitive to the discount rate used.

Secondly, the cointegration test has low power when a limited data span is used. Pierse and Snell (1995) show that consumption and wealth in the UK are not cointegrated based on the sample period over 1966 to 1981, but cointegrated after updating the span to 1987. Although the cointegration test seems weak in detecting the presence of rational speculative bubbles, it is still the best analytical tool available for identifying the presence of a long run relationship between stock prices and fundamental variables (Brooks and Katsaris, 2003). Therefore, the multivariate cointegration method is used as a complement to the duration dependence method.

The relationship between the variables is expressed per the following equation:

$$p_t = \alpha + \beta_1 d_t + \beta_2 y_t + \mu_t$$

where:

α is the constant term, β_1, β_2, are the coefficient for the independent variables.

pt = the monthly value-weighted stock price

dt = the monthly value-weighted dividends

yt= the monthly value-weighted earnings

μ_t = the error term

If the stock prices and fundamental variables are cointegrated, it will be viewed as evidence against the presence of rational speculative bubbles. The Johansen-Juselius test is based on the following vector autoregression or VAR model:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} ... + \Gamma_{k-1} \Delta X_{t-k-1} + \Pi X_{t-k} + \varepsilon_t$$

where, X_t is a vector of non-stationary variables, $X_t = [p_t, d_t, y_t]$. If the rank of Π or the number of cointegrating vectors (r) is zero, then the variables in vector X_t are not cointegrated. Before testing the cointegration relationship among the three variables, the Augmented Dickey – Fuller (ADF) and Phillips – Perron (PP) unit root tests are first applied to the time series of the log of value-weighted stock price, dividends and earnings (Dickey and Fuller, 1979; Phillips and Perron, 1988). All of the three variables must have unit root or non-stationarity for any of the variables in their logarithm form at traditional levels of significance, before we can perform the cointegration analysis.

The Johansen-Juselius test is used to examine the cointegration relationship among the three variables, which employs the trace (λ_{trace}) and the maximum eigenvalue test ($\lambda_{\max}$) to determine the number of cointegrating vectors.

The trace statistic method examines the null hypothesis that r = 0, or no cointegration, against the alternative hypothesis of r > 0, or at most r, cointegrating vectors.

$$\lambda_{trace}(r) = -T \sum_{i=r=1}^{p} \ln(1-\lambda_i)$$

The maximum eigenvalue method examines the null hypothesis that the number of cointegrating vectors is r, against the alternative hypothesis that there are r+1 cointegrating vectors.

$$\lambda_{\max}(r, r+1) = -T \ln(1-\lambda_{r+1})$$

3.6.3 Duration dependence test

The duration dependence test developed by McQueen and Thorley (1994) is employed as a further test of the presence of rational speculative bubbles. The advantage of this test is that it does not require correct identification of the observable fundamental components.

Rational speculative bubbles occur when investors have already realized that stock prices exceed fundamental values but are reluctant to liquidate their position because they believe that the probability of a high return will exactly compensate them for the probability of the bubble bursting. As the bubble expands, its innovation is positive and small compared to an infrequent large negative innovation when the bubble bursts. Therefore, if the stock market is characterized by rational speculative bubbles, there is a negative relationship between the probability that a positive run will end and the length of the positive run, namely negative duration dependence or a decreasing hazard rate. The sample hazard rate for each run length i is computed as $\hat{h}_i = \frac{N_i}{(M_i + N_i)}$ which is derived from maximising the log-likelihood function of the hazard function with respect to h_i:

$$L(\theta | S_t) = \sum_{i=1}^{\alpha} N_i Lnh_i + M_i Ln(1 - h_i) + Q_i Ln(1 - h_i) \qquad (1)$$

where:

L = the number of run lengths of positive and negative returns

H_i = sample hazard rate

N_i = the numbers of completed runs of length *i*

M_i = the numbers of completed runs with length greater than *i*

Q_i = the numbers of partial runs with length greater than *i*

The following functional form of the hazard function has been employed to test the null hypothesis of no rational speculative bubbles:

$$h_i = \frac{1}{1 + e^{-(\alpha + \beta \ln i)}} \qquad (2)$$

The null hypothesis of no rational speculative bubble is that $\beta = 0$. The alternative suggests that the probability of a positive run ending should decrease with the run length or that the value of the slope parameter, β is negative (decreasing hazard rates).

The test is performed by substituting equation (2) into (1) and maximizing the log likelihood function with respect to α and β. Under the null hypothesis of no rational speculative bubble, the likelihood ratio test (LRT) is asymptotically distributed χ^2 with one degree of freedom.

LRT = 2[Log unrestricted – Log restricted] --- χ_1^2

3.7 Conclusion

This chapter described the data, presented the research objectives and the methods used to achieve those objectives. The chapter briefly outlined the duration dependence test developed by McQueen and Thorley (1994) and multivariate cointegration test attributed to Johansen and Juselius (1992).

Chapter 4 Results and Discussion

4.1 Introduction

Rosser (1997) shows that speculative bubbles can be divided into rational and irrational speculative bubbles. Rational speculative bubbles occur when investors realise that stock prices deviate from their fundamental value but they are still willing to pay a higher price for the stock because they believe that the possible returns derived from further increases in price more than compensates them for the probability of a crash (McQueen and Thorley, 1994). The irrational speculative bubbles occur when the speculation develops as buyers make money with the rising prices (some displacement from the fundamentals) and euphoria emerges. The irrational "outsiders" start buying more while the smarter "insiders" bail out, and, as too many insiders get out, prices reach a peak and begin to drift downwards. During the initial "period of distress", outsiders continue to hang on and expectations undergo a major change. Eventually, something triggers a panic, which could be some bad news regarding the fundamentals.,the outsiders sell suddenly in a rush to get out, and the price falls sharply (Charles Kindleberger, 1989). This research concentrates on the rational speculative bubbles; however, irrational speculative bubbles can also lead the stock market to boom and bust.

This chapter reports the results of summary statistics, duration dependence, unit root and multivariate cointegration tests.

The results of summary statistics for the monthly and weekly real returns of eight stock indices namely, Shanghai A-Share index, Shenzhen A-Share index, Jakarta Composite Index, Kuala Lumpur Composite Index, Philippine Composite Index, Nikkei 225 Index, Straits Times Index and Korea composite stock price Index, are reported in section 4.2. The results of section 4.3, for the duration dependence test, are based on the log-logistic regression estimates of the hazard function and, finally, section 4.4 reports the results of the unit root and Multivariate cointegration tests for monthly value-weighted portfolios as a complement to the duration dependence test.

4.2 Summary statistics

Table 4.1, Panels 1 to 16, report the summary statistics for the monthly and weekly real returns of eight stock indices. There are five panels in each table: panel A refers to the full sample period, panel B covers the pre-1997 Asian financial crisis period, panel C covers the post-1997 Asian financial crisis period, panel D covers the pre-2007 subprime loan financial crisis period, and panel E covers the post- 2007 subprime loan financial crisis period.

Summary statistics can be used to test for the presence of rational speculative bubbles as the presence of rational speculative bubbles in a stock market can be inferred from evidence of negative skewness, excess kurtosis and non-normality of real returns. Negative skewness indicates that the tail on the left side of the probability density function is longer than the right side, which means the series has relatively few low values. The negative skewness of real stock returns implies that the numbers of positive returns are more than negative returns, and the movement of the stock index is increasing slowly and declining fast, a characteristic of the presence of rational speculative bubbles. Kurtosis is a measure of the "peakedness" of the probability distribution of a real-valued random variable and distributions with excess kurtosis (kurtosis greater than 3) are called leptokurtic. Compared to a normal distribution, a distribution with excess kurtosis has a fatter tail and higher central peak implying that more of the variance is the result of infrequent extreme deviations, and the returns distribution may not be normal. This is another indication of the possible existence of rational speculative bubbles. Non-normality of real returns indicates that linear dependencies exist in the real returns series, which means the returns are serially correlated and not random. This characteristic also implies the presence of rational speculative bubbles.

4.2.1 Monthly real returns: Full sample period

Table 4.1, Panels 1 to 8 (full sample period sections) shows that the presence of rational speculative bubbles in the stock markets of Malaysia, Singapore, Indonesia and Japan can be inferred from the strong evidence of negative skewness, excess kurtosis and non-normality of monthly real returns. The stock markets of South Korea, Shenzhen A-Share and Philippine have the features of leptokurtic and positive first-order autocorrelation coefficients signalling the existence of rational speculative bubbles, but their skewness coefficients are positive. The Shanghai A-Shares conform to only one characteristic of rational speculative bubbles, which is excess kurtosis.

4.2.2 Monthly real returns: Subperiod analysis

Table 4.1, Panels 1 to 8 (Subperiodsections) shows evidence of negative skewness, excess kurtosis and non-normality of real returns, consistent with the presence of rational speculative bubbles. For the first subperiod, namely the pre-Asian financial crisis subperiod, none of the eight stock markets has all three characteristics, while the Malaysian and Philippine stock markets show evidence of negative skewness, excess kurtosis and non-normality of monthly real returns in the post-Asian financial crisis subperiod. Malaysia exhibits evidence of a bubble during the pre-subprime loan financial crisis, while, during the post- subprime loan financial crisis subperiod, South Korea, Philippines, Japan, Indonesia and Singapore stock markets have all three characteristics signalling the presence of rational speculative bubbles.

4.2.3 Weekly real returns: Full sample period

For the full sample period of weekly real returns, (Table 4.1, Panels 9 to 16), only the Singapore stock market has all three characteristics of rational speculative bubbles returns. Furthermore, the first-order autocorrelation coefficients of South Korea, Philippines and Indonesia are negative, conflicting with the features of rational speculative bubbles. The Chinese stock markets, namely Shanghai A-share and Shenzhen A-share, show evidence of excess kurtosis and non-normality of weekly real returns, however, the skewness results are positivewhile Japan and Malaysia exhibit only one feature that accords with the characteristics of rational speculative bubbles, which is excess kurtosis.

4.2.4 Weekly real returns: Subperiod analysis

Table 4.1, Panels 9 to 16, shows the results of the sub-period analysis using weekly returns. Panels 11 and 12 show that, for the pre-Asian financial crisis , the presence of rational speculative bubbles in the Malaysian and Indonesian stock markets can be inferred from the strong evidence of negative skewness, excess kurtosis and non-normality of weekly real returns. None of the eight stock markets has all three characteristics of presence of rational speculative bubble over the post-Asian financial crisis subperiod. However, seven out of eight stock markets indicate the existence of rational speculative bubbles over the pre-subprime loan financial crisis subperiod, all except the Philippines. Furthermore, panels 10, 12, 15 and 16 shows that, for the post-subprime loan financial crisis subperiod, Malaysia, Shenzhen A-share, South Korea and Singapore stock markets have all three characteristics indicative of rational speculative bubbles.

Summary

The full sample period analysis indicates the presence of rational speculative bubbles in the stock markets of Malaysia, Singapore, Indonesia and Japan. The sub-period analyses further indicate the presence of rational speculative bubbles in seven Asian stock markets, those of China, Indonesia, Malaysia, Philippines, Japan, Korea and Singapore, especially over the pre and post- subprime loan financial crisis sub-periods. Therefore, the results of the summary statistics show strong evidence for the presence of rational speculative bubbles in Asian stock markets over the sample period from 1991 to 2009.

This result is consistent with Chan et al. (1998), who reported that, for monthly returns, Hong Kong, Japan, Malaysia, Thailand and Taiwan have negative skewness, although South Korea exhibits positive skewness. All countries are leptokurtic and all, except South Korea, exhibit positive first-order autocorrelation. Overall, the consistent evidence of negative skewness, leptokurtosis and autocorrelation point to the potential for rational speculative bubbles. Meanwhile, the Singaporean stock market is consistent with Rangel (2007), who reported it exhibiting negative skewness and leptokurtosis, while the Chinese stock markets are consistent with Lehkonen (2010) and Zhang (2008) since both of them reported these markets exhibiting positive skewness, leptokurtosis and positive first-order autocorrelation.

Table 4.1 Results of Summary Statistics (Panel 1)

Shanghai A-Share index real returns, monthly

	Full sample period	Subperiod			
	03/1992-12/2009	03/1992-09/1997	10/1997-06/2001	7/2001-11/2007	12/2007-12/2009
Observations	214	67	45	77	25
Mean	0.011350	0.021657	0.013118	0.012245	-0.022208
Maximum	1.016292	1.016292	0.164672	0.249818	0.143234
Minimum	-0.461122	-0.461122	-0.129884	-0.120690	-0.289008
Standard Deviation	0.143014	0.219101	0.064135	0.076739	0.147781
Skewness	1.805501	1.603961	0.155466	0.666709	-0.709611
Kurtosis	15.45375	8.540332	2.859112	3.399615	1.963627
Jarque-Bera	1499.206	114.4194	0.218490	6.216776	3.216936
ρ 1	-0.037	-0.051	0.024	0.265	-0.268
ρ 2	0.088	0.034	0.089	0.041	0.386
ρ 3	-0.094	-0.113	-0.247	0.103	-0.069
ρ 4	-0.087	-0.207	-0.084	0.302	0.302
ρ 5	-0.086	-0.111	-0.171	0.136	-0.008
ρ 6	-0.042	-0.045	-0.072	0.080	-0.079
ρ12	-0.095	-0.068	-0.072	-0.026	-0.168
Q(6)	7.6155	5.4096	5.6780	16.339	9.6905
Q(12)	22.405	11.706	10.771	36.844	13.256

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.
2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.
3. ρt is the sample autocorrelation at lag t.
4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics, identifying the presence of six-order and twelve-order autocorrelation, distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test .

Table 4.1 (Panel 2)

Shenzhen A-Share index real returns, monthly

	Full sample period	Subperiod			
	12/1992-12/2009	12/1992-05/1997	06/1997-06/2001	07/2001-10/2007	11/2007-12/2009
Observations	205	54	49	76	26
Mean	0.008765	0.015311	0.007270	0.010575	-0.007305
Maximum	0.380431	0.380431	0.194666	0.229020	0.188516
Minimum	-0.330526	-0.249451	-0.134418	-0.133816	-0.330526
Standard Deviation	0.110287	0.140617	0.073266	0.083533	0.160370
Skewness	0.046727	0.456143	0.501208	0.476318	-0.742416
Kurtosis	4.112496	3.279135	3.062209	2.677036	2.206494
Jarque-Bera	10.64617	2.047912	2.059443	3.204101	3.070576
ρ 1	0.047	0.112	-0.011	0.302	-0.251
ρ 2	0.116	-0.017	0.101	0.092	0.398
ρ 3	0.101	0.283	-0.213	0.166	-0.057
ρ 4	0.094	-0.027	-0.058	0.296	0.217
ρ 5	-0.023	-0.103	-0.103	0.112	0.030
ρ 6	0.069	0.220	0.012	0.129	-0.131
ρ12	0.012	0.135	-0.032	0.028	-0.061
Q(6)	8.4291	9.2482	3.8055	19.804	8.9551
Q(12)	12.643	12.435	5.5660	34.365	11.346

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-values arethe marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 3)

Indonesia (Jakarta Composite Index) real returns, monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-07/1997	08/1997-08/2001	09/2001-12/2007	01/2008-12/2009
Observations	227	78	49	76	24
Mean	-0.000809	0.000727	-0.026319	0.016886	-0.009748
Maximum	0.286522	0.166262	0.286522	0.130416	0.167736
Minimum	-0.401982	-0.197198	-0.401982	-0.131489	-0.304383
Standard Deviation	0.089032	0.070640	0.130004	0.060353	0.107334
Skewness	-0.818110	0.029186	-0.552965	-0.353723	-0.507832
Kurtosis	6.451037	3.304888	4.555683	2.796015	3.821830
Jarque-Bera	137.9675	0.313183	7.438269	1.716619	1.706977
ρ 1	0.229	0.234	0.092	0.222	0.480
ρ 2	0.000	0.047	-0.112	-0.013	0.186
ρ 3	0.051	0.058	-0.005	0.021	0.204
ρ 4	0.102	-0.043	0.114	0.023	0.204
ρ 5	0.002	-0.072	0.052	-0.061	-0.173
ρ 6	0.048	-0.120	0.284	-0.203	-0.204
ρ12	-0.074	-0.137	0.004	-0.070	-0.108
Q(6)	15.680	6.7480	6.6772	7.7679	12.193
Q(12)	20.708	13.729	8.9986	8.9736	17.177

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-values are the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 4)

Malaysia (Kuala Lumpur Composite Index) real returns, monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-06/1997	07/1997-09/2001	10/2001-01/2008	02/2008-12/2009
Observations	227	77	51	76	23
Mean	0.001691	0.007329	-0.011593	0.007789	-0.007878
Maximum	0.334583	0.231861	0.334583	0.096243	0.111799
Minimum	-0.386219	-0.159910	-0.386219	-0.116479	-0.114452
Standard Deviation	0.079253	0.062472	0.135618	0.040047	0.055030
Skewness	-0.275717	0.201694	-0.019950	-0.290816	0.179793
Kurtosis	7.841069	4.612226	3.731687	3.654177	2.623974
Jarque-Bera	224.5411	8.861405	1.141037	2.426436	0.259419
ρ 1	0.104	-0.123	0.133	0.126	0.541
ρ 2	0.145	0.259	0.120	-0.066	0.355
ρ 3	-0.119	-0.216	-0.149	-0.037	0.414
ρ 4	-0.061	-0.019	-0.182	0.093	0.382
ρ 5	-0.071	-0.224	-0.105	0.029	0.220
ρ 6	-0.074	-0.109	-0.072	-0.147	-0.099
ρ12	-0.066	-0.008	-0.075	-0.004	-0.175
Q(6)	13.978	15.774	5.8696	4.3205	22.336
Q(12)	36.509	25.109	16.730	7.8052	33.723

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-values are the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 5)

Philippine (Philippine Composite Index) real returns, monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-06/1997	07/1997-06/2001	07/2001-11/2007	12/2007-12/2009
Observations	227	77	48	77	25
Mean	0.001758	0.012267	-0.018835	0.008780	-0.012703
Maximum	0.336165	0.316255	0.336165	0.174086	0.151137
Minimum	-0.294769	-0.181687	-0.294769	-0.127652	-0.233525
Standard Deviation	0.083648	0.087363	0.107300	0.056872	0.085746
Skewness	0.183939	0.536180	0.321242	0.179879	-0.382872
Kurtosis	5.222854	4.254827	4.882329	3.102218	3.729643
Jarque-Bera	48.01441	8.741255	7.911897	0.448765	1.165355
ρ 1	0.109	-0.041	0.208	0.077	0.173
ρ 2	0.074	0.102	-0.082	0.101	0.269
ρ 3	-0.049	-0.083	-0.111	-0.068	0.130
ρ 4	-0.044	-0.168	-0.221	0.046	0.262
ρ 5	0.011	0.112	-0.078	-0.140	-0.045
ρ 6	-0.023	-0.190	0.005	-0.016	0.036
ρ12	0.073	0.007	0.091	0.027	-0.003
Q(6)	5.1811	8.0545	6.2211	3.5381	5.7998
Q(12)	11.048	15.790	7.8631	9.3306	7.3330

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistic identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 6)

Japan (Nikkei 225 Index) real returns, monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-06/1997	07/1997-05/2001	06/2001-11/2007	12/2007-12/2009
Observations	227	77	47	78	25
Mean	-0.004184	-0.002942	-0.007082	0.002157	-0.022349
Maximum	0.158875	0.158875	0.132587	0.103377	0.136211
Minimum	-0.275359	-0.153868	-0.124536	-0.137075	-0.275359
Standard Deviation	0.062119	0.063364	0.063491	0.050161	0.085604
Skewness	-0.328207	0.181108	-0.022929	-0.309598	-0.776827
Kurtosis	3.895111	2.802127	2.318112	2.870612	4.362137
Jarque-Bera	11.65363	0.546553	0.914686	1.300467	4.447144
ρ 1	0.095	0.011	-0.070	0.202	0.293
ρ 2	-0.074	-0.226	-0.025	0.143	-0.120
ρ 3	0.104	0.148	-0.016	0.118	0.151
ρ 4	0.076	0.111	0.076	-0.028	0.186
ρ 5	-0.008	0.024	0.248	-0.086	-0.324
ρ 6	-0.168	-0.218	-0.244	0.059	-0.440
ρ12	-0.030	-0.208	0.078	-0.062	0.138
Q(6)	13.840	11.078	7.3147	7.1523	15.085
Q(12)	14.838	18.689	10.763	11.029	18.294

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-values are the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 7)

Singapore (Straits Times Index) real returns,monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-06/1997	07/1997-05/2001	06/2001-11/2007	12/2007-12/2009
Observations	227	77	47	78	25
Mean	0.003481	-0.002942	-0.007082	0.002157	-0.022349
Maximum	0.217075	0.158875	0.132587	0.103377	0.136211
Minimum	-0.204630	-0.153868	-0.124536	-0.137075	-0.275359
Standard Deviation	0.062608	0.063364	0.063491	0.050161	0.085604
Skewness	-0.109764	0.181108	-0.022929	-0.309598	-0.776827
Kurtosis	4.883660	2.802127	2.318112	2.870612	4.362137
Jarque-Bera	34.01564	0.546553	0.914686	1.300467	4.447144
ρ 1	0.137	0.011	-0.070	0.202	0.293
ρ 2	0.178	-0.226	-0.025	0.143	-0.120
ρ 3	-0.045	0.148	-0.016	0.118	0.151
ρ 4	0.132	0.111	0.076	-0.028	0.186
ρ 5	-0.099	0.024	0.248	-0.086	-0.324
ρ 6	0.036	-0.218	-0.244	0.059	-0.440
ρ12	0.089	-0.208	0.078	-0.062	0.138
Q(6)	18.773	11.078	7.3147	7.1523	15.085
Q(12)	27.356	18.689	10.763	11.029	18.294

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 8)

South Korea (Korea composite stock price Index) real returns, monthly

	Full sample period	Subperiod			
	02/1991-12/2009	02/1991-06/1997	07/1997-06/2001	07/2001-11/2007	12/2007-12/2009
Observations	227	77	48	77	25
Mean	0.000374	-0.003209	-0.007605	0.013531	-0.013796
Maximum	0.344956	0.206885	0.344956	0.176214	0.187940
Minimum	-0.281790	-0.118302	-0.281790	-0.156927	-0.240957
Standard Deviation	0.087895	0.064963	0.136299	0.065865	0.091286
Skewness	0.243439	0.478551	0.480852	-0.181468	-0.312095
Kurtosis	4.478668	3.044923	2.981924	2.931430	3.419232
Jarque-Bera	22.92237	2.945456	1.850406	0.437694	0.588925
ρ 1	0.156	-0.040	0.254	0.097	0.075
ρ 2	-0.044	-0.001	-0.117	0.011	0.062
ρ 3	0.044	-0.062	0.033	0.155	0.102
ρ 4	-0.052	-0.076	-0.074	-0.194	0.297
ρ 5	-0.019	-0.131	0.110	-0.098	-0.254
ρ 6	0.090	0.138	0.169	-0.000	-0.182
ρ12	-0.080	-0.032	-0.170	-0.058	0.060
Q(6)	9.0624	4.0245	6.6566	6.6959	6.7790
Q(12)	12.260	13.217	9.5222	15.379	8.1821

Notes:

1. All returns are continuously compounded. Monthly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 9)

Shanghai A-Share index real returns, weekly

	Full sample period	Subperiod			
	14/01/1992-01/12/2009	14/01/1992-22/07/1997	29/07/1997-26/06/2001	03/07/2001-20/11/2007	27/11/2007-01/12/2009
Observations	934	289	205	334	106
Mean	0.002654	0.005098	0.003033	0.002447	-0.004091
Maximum	0.809146	0.809146	0.126790	0.112412	0.112079
Minimum	-0.363312	-0.363312	-0.137306	-0.142288	-0.178350
Standard Deviation	0.063752	0.098964	0.034656	0.034220	0.056045
Skewness	2.754292	2.374882	-0.161653	-0.159960	-0.370370
Kurtosis	39.51853	21.60436	6.544143	4.248176	2.874317
Jarque-Bera	53080.29	4439.551	108.1843	23.10574	2.493173
ρ 1	0.081	0.104	-0.045	0.008	0.062
ρ 2	0.021	0.034	-0.073	0.056	-0.093
ρ 3	0.047	0.030	0.128	0.108	-0.010
ρ 4	0.035	0.044	-0.036	0.042	0.025
ρ 5	-0.059	-0.087	-0.063	-0.017	0.094
ρ 6	-0.025	-0.031	-0.051	0.129	-0.183
ρ12	-0.057	-0.074	-0.034	-0.090	0.096
Q(6)	13.629	6.8234	6.6466	11.406	6.2851
Q(12)	19.288	9.6143	7.5898	17.220	16.888

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-values are the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 10)

Shenzhen A-Share index real returns, weekly

	Full sample period	Subperiod			
	13/10/1992-01/12/2009	13/10/1992-22/07/1997	29/07/1997-26/06/2001	03/07/2001-20/11/2007	27/11/2007-01/12/2009
Observations	895	250	205	334	106
Mean	0.001776	0.001870	0.002492	0.001921	-0.000283
Maximum	0.398706	0.398706	0.143447	0.125629	0.143368
Minimum	-0.260484	-0.260484	-0.149889	-0.196742	-0.201386
Standard Deviation	0.054881	0.076325	0.038328	0.039402	0.063610
Skewness	0.155325	0.424103	-0.045051	-0.215702	-0.656732
Kurtosis	9.028693	7.144263	6.522771	5.263049	3.389763
Jarque-Bera	1358.970	186.3997	106.0707	73.86272	8.290544
ρ 1	0.057	0.089	-0.031	0.032	0.049
ρ 2	-0.035	-0.069	-0.058	0.008	0.037
ρ 3	0.090	0.102	0.140	0.070	0.001
ρ 4	-0.036	-0.029	-0.099	0.052	-0.080
ρ 5	0.002	-0.047	-0.047	0.041	0.129
ρ 6	-0.008	0.013	-0.049	0.100	-0.216
ρ12	0.038	0.084	-0.089	-0.096	0.114
Q(6)	12.564	6.6726	8.0932	6.9685	8.3577
Q(12)	16.403	13.245	11.625	13.195	28.529

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 11)

Indonesia (Jakarta Composite Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-08/07/1997	15/07/1997-26/06/2001	03/07/2001-11/12/2007	18/12/2007-01/12/2009
Observations	987	340	207	337	103
Mean	-0.000379	3.17E-05	-0.006578	0.003741	-0.002750
Maximum	0.218598	0.080119	0.218598	0.081591	0.208689
Minimum	-0.259975	-0.102975	-0.180759	-0.162288	-0.259975
Standard Deviation	0.041312	0.024973	0.061235	0.031881	0.057998
Skewness	-0.288350	-0.258330	0.349201	-0.813614	-0.704524
Kurtosis	8.298191	4.542810	4.469431	5.065720	7.676784
Jarque-Bera	1168.090	37.50201	22.83032	97.09908	102.3894
ρ 1	-0.025	0.217	-0.128	0.057	-0.060
ρ 2	0.081	0.217	0.183	-0.026	-0.155
ρ 3	0.119	0.170	0.085	0.024	0.222
ρ 4	0.087	0.083	0.059	0.058	0.131
ρ 5	0.061	0.103	0.043	0.039	0.064
ρ 6	0.065	0.056	0.078	-0.036	0.135
ρ12	0.020	0.036	0.023	0.000	0.011
Q(6)	36.498	49.387	14.506	3.6333	12.658
Q(12)	50.057	51.601	26.942	3.6944	15.644

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 12)

Malaysia (Kuala Lumpur Composite Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-29/07/1997	05/08/1997-26/06/2001	03/07/2001-30/10/2007	06/11/2007-01/12/2009
Observations	987	343	203	332	109
Mean	0.000347	0.001081	-0.002872	0.002121	-0.001364
Maximum	0.285299	0.107643	0.285299	0.059263	0.087327
Minimum	-0.210479	-0.143936	-0.210479	-0.127656	-0.106676
Standard Deviation	0.035344	0.029133	0.058944	0.020587	0.029226
Skewness	0.143651	-0.221828	0.437894	-0.892863	-0.597564
Kurtosis	12.22985	6.053454	6.798801	8.705010	5.128339
Jarque-Bera	3503.283	136.4593	129.1821	492.8584	26.56346
ρ 1	-0.018	0.008	-0.060	0.005	0.097
ρ 2	0.005	-0.007	-0.000	0.047	-0.031
ρ 3	0.082	-0.022	0.157	-0.054	-0.021
ρ 4	-0.006	-0.065	-0.013	0.029	0.043
ρ 5	0.060	0.014	0.080	0.069	0.080
ρ 6	0.044	0.062	0.020	-0.065	0.190
ρ12	-0.061	-0.111	-0.086	0.002	0.107
Q(6)	12.585	3.0750	7.3945	5.0340	6.3047
Q(12)	25.569	11.408	13.970	8.2589	8.8167

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 13)

Philippine (Philippine Composite Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-24/06/1997	01/07/1997-19/06/2001	03/07/2001-30/10/2007	06/11/2007-01/12/2009
Observations	987	338	208	332	109
Mean	0.000276	0.002609	-0.004359	0.001915	-0.003107
Maximum	0.180984	0.108765	0.180984	0.086710	0.163112
Minimum	-0.216020	-0.099555	-0.167102	-0.113491	-0.216020
Standard Deviation	0.039632	0.037298	0.051267	0.029939	0.046215
Skewness	-0.043448	0.083120	0.362931	-0.049378	-0.809781
Kurtosis	5.551043	3.231660	4.523546	4.053198	7.845417
Jarque-Bera	267.9447	1.145007	24.68325	15.47921	118.5422
ρ 1	-0.011	0.101	-0.088	-0.006	-0.100
ρ 2	0.064	0.012	0.129	0.056	-0.005
ρ 3	0.079	0.090	0.099	0.033	0.036
ρ 4	-0.020	-0.047	-0.059	0.059	-0.018
ρ 5	0.035	-0.065	0.087	0.002	0.129
ρ 6	-0.016	0.049	-0.050	-0.107	0.054
ρ12	-0.006	-0.083	-0.002	-0.001	0.140
Q(6)	12.218	9.3687	10.179	6.5141	3.5952
Q(12)	24.632	22.325	15.822	10.794	13.972

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 14)

Japan (Nikkei 225 Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-29/07/1997	05/08/1997-26/06/2001	03/07/2001-11/12/2007	18/12/2007-01/12/2009
Observations	987	343	204	337	103
Mean	-0.000982	-0.000702	-0.002160	0.000644	-0.004902
Maximum	0.181452	0.134329	0.112736	0.105884	0.181452
Minimum	-0.199463	-0.086072	-0.079364	-0.078833	-0.199463
Standard Deviation	0.032010	0.028992	0.032240	0.028574	0.047972
Skewness	0.048508	0.416890	0.306050	-0.286996	0.017821
Kurtosis	6.022124	5.075899	3.510891	3.463208	6.470188
Jarque-Bera	375.9913	71.52331	5.403250	7.639081	51.68657
ρ 1	-0.027	0.035	-0.034	0.023	-0.153
ρ 2	-0.026	-0.008	-0.060	-0.077	0.037
ρ 3	0.050	0.042	0.004	0.009	0.139
ρ 4	-0.013	0.016	-0.002	-0.009	-0.069
ρ 5	-0.010	-0.089	0.009	0.014	0.016
ρ 6	-0.029	-0.091	-0.054	-0.022	0.059
ρ12	0.022	-0.030	-0.005	0.026	0.131
Q(6)	4.9694	6.8538	1.6327	2.4931	5.6805
Q(12)	11.102	12.024	4.6029	5.0923	10.989

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 15)

Singapore (Straits Times Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-29/07/1997	05/08/1997-26/06/2001	03/07/2001-30/10/2007	06/11/2007-01/12/2009
Observations	987	343	204	331	109
Mean	-0.000141	-0.000849	0.000369	0.001689	-0.004422
Maximum	0.129952	0.065538	0.129952	0.068193	0.117889
Minimum	-0.151649	-0.070295	-0.116111	-0.143257	-0.151649
Standard Deviation	0.029356	0.021368	0.037845	0.023952	0.044114
Skewness	-0.175328	-0.199650	0.188096	-0.702529	-0.112237
Kurtosis	5.820278	3.472969	3.604374	6.649761	4.364621
Jarque-Bera	332.1637	5.475717	4.307701	210.9428	8.686304
ρ 1	0.026	-0.058	-0.036	0.078	0.114
ρ 2	-0.000	0.015	-0.004	0.015	-0.033
ρ 3	0.110	0.059	0.164	-0.067	0.198
ρ 4	0.027	0.039	-0.092	0.027	0.160
ρ 5	0.036	-0.012	0.039	0.038	0.048
ρ 6	0.038	0.067	0.021	0.009	0.093
ρ12	0.021	-0.059	0.022	0.028	0.032
Q(6)	16.093	4.5660	8.0434	4.3929	10.287
Q(12)	27.040	9.8968	13.053	8.2035	15.821

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

Table 4.1 (Panel 16)

South Korea (Korea composite stock price Index) real returns, weekly

	Full sample period	Subperiod			
	08/01/1991-01/12/2009	08/01/1991-08/07/1997	15/07/1997-19/06/2001	26/06/2001-11/12/2007	18/12/2007-01/12/2009
Observations	987	340	206	338	103
Mean	-5.16E-06	-0.000857	-0.001897	0.002825	-0.002697
Maximum	0.173272	0.120963	0.173272	0.087249	0.144285
Minimum	-0.191121	-0.077947	-0.191121	-0.108369	-0.179722
Standard Deviation	0.043071	0.031372	0.067072	0.032454	0.045790
Skewness	-0.192983	0.418372	-0.089651	-0.472019	-0.390963
Kurtosis	4.935810	4.143957	2.868925	3.301260	5.054906
Jarque-Bera	160.2366	28.45769	0.423414	13.82932	20.74611
ρ 1	-0.022	0.011	-0.071	0.031	0.030
ρ 2	0.018	-0.015	0.065	0.021	-0.152
ρ 3	0.035	0.043	0.062	-0.047	0.006
ρ 4	0.021	-0.035	0.009	0.018	0.148
ρ 5	0.073	-0.068	0.153	-0.004	0.059
ρ 6	-0.018	0.028	-0.042	0.001	-0.017
ρ12	-0.002	-0.014	-0.040	0.053	0.112
Q(6)	8.1217	3.0941	8.1355	1.3469	5.3728
Q(12)	11.323	4.1739	8.6409	5.8311	19.721

Notes:

1. All returns are continuously compounded. Weekly real returns in local currency are nominal returns less monthly inflation rates.

2. T is the number of monthly observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of six-order and twelve-order autocorrelation., distributed as χ^2 with 6 and 12 degrees of freedom, and p-valuesare the marginal significance levels of the Ljung-Box test.

4.3 Duration dependence

In this research, only the positive, not negative, runs are used for duration dependence tests as McQueen and Thorley (1994) show that, for bubbles to be rational, the bubbles must be positive, and the expected value of the bubble should be increasing to compensate the investor for the possibility of a crash. Formerly, rational speculative bubbles only appeared in runs of positive abnormal returns a finding supported by Jirasakuldech et al. (2008), implying that rational speculative bubbles cannot occur in runs of negative abnormal returns. The evidence from the Thai stock market alone can hardly support the existence of rational speculative bubbles in negative returns.

The following results refer to the log-logistic regression estimates of the hazard function. The null hypothesis, that no rational speculative bubbles exist in stock markets, implies a constant hazard rate ($\beta=0$). The alternative hypothesis implies a negative hazard rate ($\beta<0$) for runs of positive returns. The p-value, the marginal significance level, which is the probability of obtaining the calculated value of the likelihood ratio test (LRT is 10%.

4.3.1 Monthly returns: Full sample period

The positive runs of monthly returns for the full sample period are reported in Table 4.2, Panel 1. A total of 50 runs for Indonesia, 55 runs for Japan, 46 runs for Korea, 53 runs for Malaysia, 56 runs for Philippine, 52 runs for Shanghai, 45 runs for Shenzhen and 48 runs for Singapore were documented. The longest positive run lasts 10 months and occurs once only in the Shenzhen A-Share stock market. The second longest positive runs last 9 months. They occur once each in the stock markets of Japan, Korea and Singapore, and 24 times in Indonesia. One characteristic of a rational speculative bubble is that the hazard rate should be a declining function of the length of positive runs; otherwise, the bubble cannot be sustained. For the full sample period, there is no discernible decreasing pattern in hazard rates in positive runs of the stock indices. This implies that no rational speculative bubbles are evident in any stock markets over the full sample period when we analyse monthly returns. Consistent with the rational speculative bubble model prediction, the runs of positive returns yield point estimates of β that are negative in Indonesia, Japan, Shanghai, Shenzhen and Singapore, however, none of the p- values are lower than 10%, which imply that none of the coefficients are significant. This result fails to reject the null hypothesis of no rational speculative bubble at traditional significance levels, which means no rational speculative bubble existed in any of the stock markets studied when using monthly data over the full sample period.

4.3.2 Weekly returns: Full sample period

The duration dependence test results for positive runs of weekly returns for the full sample period are reported in Table 4.2, Panel 2. There are a total of 221 runs for Indonesia, 248 for Japan, 245 for Korea, 227 for Malaysia, 238 for Philippine, 213 for Shanghai, 218 for Shenzhen and 244 for Singapore. The longest positive returns run lasts 13 weeks, and it occurs once in the Shenzhen A-Share stock market. As noted earlier, a declining hazard rate is one characteristic of a rational speculative bubble and, or the positive runs of weekly, full sample period data , the sample hazard rates of Indonesia, Shanghai A-Share and Shenzhen A- share markets are decreasing. The decreasing hazard rates for lengths 1 to 5 of Indonesia are 0.4842, 0.4123, 0.4030, 0.4000 and 0.3333, respectively for the Shanghai A-Share are 0.4930, 0.4722, 0.3860, 0.2857 and 0.2000, respectively and of the Shenzhen A-Share are 0.5183, 0.4571, 0.3860 and 0.2857, respectively. For the other stock markets there are no discernible decreasing hazard rates. Therefore, using weekly data, our results indicate the presence of rational speculative bubbles only in the stock markets of Indonesia and China over the full sample period. Though the β of all stock markets are negative, consistent with the rational speculative bubble model prediction, only the coefficients of Indonesia, Shanghai and Shenzhen are statistically significant. This result is consistent with the earlier observation of decreasing hazard rates in the stock markets of Indonesia and China.

Now for the sub-period analysis.

4.3.3 Monthly returns: sub-period analysis

Table 4.2, Panel 3, shows that, for the pre-Asian financial crisis subperiod (1991-1997), the runs of positive returns yield point estimates of β that are negative in Malaysia (β=-0.31352) and Shenzhen (β=-0.05311), consistent with the rational speculative bubble model prediction, For the post-Asian financial crisis subperiod (1998-2001), β is negative in Indonesia, Japan, Malaysia and Singapore, at -0.84681, -0.44267, -0.39236 and -0.52867 respectively. In the pre-subprime loan financial crisis subperiod, only the β of the China stock markets, Shanghai A-share (β=-0.03088) and Shenzhen A-share (β=-0.36299) are negative, while,for the post-subprime loan financial crisis subperiod, βis negative in Indonesia, Shanghai, Shenzhen and Singapore, -1.22916, -0.85848, -0.98315 and -0.29851 respectively. Though the β estimates are negative, none of them are statistically significant; hence the null hypothesis of no rational speculative bubble at traditional significance levels is not rejected. Therefore, for all subperiods, none of the stock markets have returns characteristics completely conforming to the rational speculative bubbles model using monthly data.

4.3.4 Weekly returns: sub-period analysis

Table 4.2, Panel 4, shows that, for Indonesia and Shanghai, the β coefficients are significantly negative, at -0.42708 and -0.56492 respectively, over the pre-Asian financial crisis subperiod (1991-1997). The empirical evidence rejects the null hypothesis of no rational speculative bubbles in the stock markets of Indonesia and China during this subperiod at 10% and 5% significance levels respectively. Over the pre-subprime loan financial crisis subperiod (2002-2007), both Shanghai and Shenzhen have characteristics that completely conform to the predictions of the rational speculative bubbles model. The β coefficients of Shanghai and Shenzhen are -0.45598 and -0.55943, with corresponding p-values of 0.0039 and 0.0125 therefore, rational speculative bubbles existed in the Chinese stock market over the pre-subprime loan financial crisis subperiod (2002-2007). The Malaysian stock market also has negative β coefficients over the post-Asian financial crisis (1998-2001) and pre-subprime loan financial crisis subperiods (2002-2007) at -0.54013 and -0.21222 respectively, but the p-values are high and fail to reject the null hypothesis of no rational speculative bubble at traditional significance levels. Chan et al. (1998) contend that duration dependence tests may lack power when used over short sample periods, therefore, these two subperiods were connected together and the sample period from 1998 to 2007 was tested. The empirical results suggest the presence of rational speculative bubbles in the Malaysian stock market over the sample period from 1998 to 2007withthe β coefficient at -0.3479 statistically significant at the 10% level.

In summary, monthly and weekly returns, over the full and subperiods for the stock markets of Indonesia, Japan, Korea, Malaysia, Philippine, Shanghai, Shenzhen and Singapore from 1991 to 2009were examined. No rational speculative bubbles were detected in any of the eight stock markets over the full or any of the sub-periods when monthly returns were used.

The results were different however, when weekly returns were utilised. For the weekly, full sample period, we find that rational speculative bubbles existed in the stock markets of Indonesia and China (Shanghai and Shenzhen). The results of the sub-period analysis also indicate their presence in the Indonesian stock market over the pre-Asian financial crisis subperiod (1991-1997), the Chinese stock market over both the pre-Asian financial crisis subperiod (1991-1997) and the pre-subprime loan financial crisis subperiod (2002-2007), and in Malaysia over the sample period from 1997 to 2007.

The results of Chinese stock markets is consistent with Zhang (2008), Lehkonen (2010) and Haque et al. (2008), which imply that rational speculative bubbles existed in this market. All three studies employed the duration dependence test, with sample periods from 1991 to 2001, 1992 to 2008 and 1991 to 2007 respectively. Rational speculative bubbles existence in China, Indonesia and Malaysia is also consistent with Sarno and Taylor (1999), who employed cointegration tests and found strong evidence of their presence in Asian stock markets over the sample period from 1989 to 1997. Furthermore, these results are also consistent with Mokhtar et al. (2006) and Ali et al. (2009) in terms of the Malaysian stock market, with both studies employing duration dependence tests and reporting evidence of rational speculative bubbles in Malaysia over the periods from 1999 to 2003 and 1987 to 1997 respectively.

Table 4.2 Results of Duration dependence tests (Panel 1)

Tests of duration dependence for positive runs of monthly indices' returns for the full period (1991-2009)

Country	Indonesia		Japan		Korea		Malaysia		Philippine		Shanghai		Shenzhen		Singapore	
Run Length	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates
1	24	0.4800	29	0.5273	16	0.3478	25	0.4717	26	0.4643	29	0.5577	23	0.5111	24	0.5000
2	9	0.3462	16	0.6154	15	0.5000	9	0.3214	12	0.4000	5	0.2174	8	0.3636	5	0.2083
3	9	0.5294	4	0.4000	6	0.4000	9	0.4737	11	0.6111	9	0.5000	7	0.5000	9	0.4737
4	2	0.2500	2	0.3333	5	0.5556	3	0.3000	5	0.7143	3	0.3333	2	0.2857	4	0.4000
5	2	0.3333	1	0.3333	2	0.5000	4	0.5714	2	1.0000	3	0.5000	0	0.0000	1	0.1667
6	1	0.2500	2	0.6667	1	0.5000	2	0.6667			1	0.3333	0	0.0000	2	0.4000
7	2	0.6667	0	0.0000	0	0.0000	1	1.0000			1	0.5000	3	0.6000	0	0.0000
8	1	1.0000	0	0.0000	0	0.0000					1	1.0000	1	0.5000	2	0.6667
9	24	0.4800	1	1.0000	1	1.0000							0	0.0000	1	1.0000
10													1	1.0000		
Total	50		55		46		53		56		52		45		48	
Log-logistic test																
α	-0.17166			0.20087	-0.5228			0.27139		0.28014	0.008687			-0.01868		-0.2024
β	-0.14474		-0.27972		0.339278		0.036843		0.555493		-0.30725		-0.43886		-0.27192	
LRT of H0: β=0		0.2390		0.7838		1.1107		0.0145		2.2331		1.0420		2.4372		0.9578
(*p*-value)		0.6249		0.3760		0.2919		0.9041		0.1351		0.3074		0.1185		0.3278

Notes:

1. The sample hazard rate, $h_i = N_i/(M_i + N_i)$ represents the conditional probability that a run ends at i, given that it lasts until i, where N_i is the count of runs of length i and M_i is the count of runs with a length greater than i.
2. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the log it regression, where the independent variable is the log of the current length of the run and the dependent variable is either 1 if the run ends or 0 if it does not end in the next period.
3. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
4. The P-value is the marginal significance level, which is the probability of obtaining that value of the LRT, or higher, under the null hypothesis.

Table 4.2 (Panel 2) Tests of duration dependence for positive runs of weekly indices' returns for the full period (1991-2009)

Country	Indonesia		Japan		Korea		Malaysia		Philippine		Shanghai		Shenzhen		Singapore	
Run Length	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates	Actual Run Counts	Sample Hazard Rates
1	107	0.4842	129	0.5202	115	0.4694	107	0.4714	122	0.5126	105	0.4930	113	0.5183	131	0.5369
2	47	0.4123	61	0.5126	67	0.5154	54	0.4500	59	0.5086	51	0.4722	48	0.4571	48	0.4248
3	27	0.4030	30	0.5172	32	0.5079	29	0.4394	24	0.4211	22	0.3860	22	0.3860	34	0.5231
4	16	0.4000	11	0.3929	11	0.3548	14	0.3784	11	0.3333	10	0.2857	10	0.2857	10	0.3226
5	8	0.3333	9	0.5294	9	0.4500	7	0.3043	12	0.5455	5	0.2000	10	0.4000	12	0.5714
6	6	0.3750	5	0.6250	4	0.3636	4	0.2500	7	0.7000	8	0.4000	8	0.5333	4	0.4444
7	2	0.2000	2	0.6667	4	0.5714	8	0.6667	3	1.0000	5	0.4167	4	0.5714	3	0.6000
8	2	0.2500	1	1.0000	0	0.0000	3	0.7500			3	0.4286	1	0.3333	0	0.0000
9	4	0.6667			2	0.6667	0	0.0000			1	0.2500	0	0.0000	1	0.5000
10	1	0.5000			0	0.0000	0	0.0000			1	0.3333	1	0.5000	0	0.0000
11	0	0.0000			1	1.0000	0	0.0000			1	0.5000	0	0.0000	0	0.0000
12	1	1.0000					1	1.0000			1	1.0000	0	0.0000	1	1.0000
13													1	1.0000		
Total	221		248		245		227		238		213		218		244	
Log-logistic test																
α	-0.09387		0.068596		-0.06625		0.11663		0.026118		-0.01703		0.044013		0.097074	
β	-0.26994		-0.02154		-0.05585		-0.16384		-0.07468		-0.36095		-0.32708		-0.23204	
LRT of H0: β=0		4.0593		0.0176		0.1493		1.3875		0.2230		7.2064		5.2823		2.4698
(p-value)		0.0440		0.8943		0.6992		0.2388		0.6367		0.0073		0.0215		0.1161

Notes:

1. The sample hazard rate, $h_i = N_i/(M_i + N_i)$ represents the conditional probability that a run ends at i, given that it lasts until i, where N_i is the count of runs of length i and M_i is the count of runs with a length greater than i.
2. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the log it regression, where the independent variable is the log of the current length of the run and the dependent variable is either 1 if the run ends or 0 if it does not end in the next period.
3. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
4. The p-value is the marginal significance level, which is the probability of obtaining that value of the LRT, or higher, under the null hypothesis.

Table 4.2 (Panel 3) Tests of duration dependence for positive runs of monthly indices' returns for sub-periods

		Indonesia	Japan	Korea	Malaysia	Philippine	Shanghai	Shenzhen	Singapore
1991-1997	α	-0.4947	0.50644	-0.1985	0.006562	-0.39061	-0.08908	0.027139	-0.25341
	β	0.511646	2.381218	0.575137	-0.31352	0.869177	0.117231	-0.05311	0.270081
	LRT	0.7373	3.0687	0.7265	0.4122	1.7131	0.0688	0.0126	0.1946
	p - value	0.3905	0.0798	0.3940	0.5209	0.1906	0.7931	0.9106	0.6591
1998-2001	α	1.113205	0.488211	-0.70736	0.365165	0.351353	0.414888	-0.3828	0.489063
	β	-0.84681	-0.44267	0.727433	-0.39236	-0.32962	-0.3243	0.179172	-0.52867
	LRT	0.6741	0.3446	0.7941	0.4310	0.1599	0.3248	0.1246	0.5750
	p - value	0.4116	0.5572	0.3729	0.5115	0.6892	0.5687	0.7240	0.4483
2002-2007	α	-1.35115	-0.56713	-1.06046	-0.83989	-0.36268	-0.37313	-0.11542	-1.93937
	β	0.510639	0.059812	0.35422	0.563952	0.5304	-0.03088	-0.36299	0.622871
	LRT	1.1668	0.0162	0.5483	1.1639	0.7969	0.0067	1.1054	1.5188
	p - value	0.2801	0.8987	0.4590	0.2807	0.3720	0.9348	0.2931	0.2178
2008-2009	α	0.890085	-0.74855	-1.02139	-1.22568	-1.10348	0.626966	0.51478	0.318147
	β	-1.22916	0.068134	1.32522	0.949599	1.892696	-0.85848	-0.98315	-0.29851
	LRT	1.2510	0.0041	1.3978	0.7055	1.9281	1.7618	1.6785	0.0674
	p - value	0.2634	0.9487	0.2371	0.4009	0.1650	0.1844	0.1951	0.7952

Notes:

1. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the log it regression where the independent variable is the log of the current length of the run and the dependent variable is either 1, if the run ends,or 0, if it does not end in the next period.
2. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
3. The p-value is the marginal significance level, which is the probability of obtaining that value of the LRT or higher under the null hypothesis.

Table 4.2 (Panel 4) Tests of duration dependence for positive runs of weekly indices' returns for sub-periods

		Indonesia	Japan	Korea	Malaysia	Philippine	Shanghai	Shenzhen	Singapore
1991-1997	α	-0.06359	0.271575	0.046151	-0.31126	-0.0772	0.123926	0.157734	0.216664
	β	-0.42708	-0.30337	0.005392	0.037624	0.105562	-0.56492	-0.42952	-0.24484
	LRT	3.4558	1.2353	0.0004	0.0255	0.1523	5.9286	2.3492	0.8707
	p - value	0.0630	0.2664	0.9844	0.8732	0.6964	0.0149	0.1253	0.3508
1998-2001	α	0.202392	0.141309	-0.12204	0.384873	0.174027	-0.30057	-0.2534	0.156889
	β	0.255737	-0.07564	0.294122	-0.54013	-0.08751	0.029121	0.130231	-0.4282
	LRT	0.3527	0.0432	0.7039	2.6310	0.0509	0.0088	0.1705	2.1062
	p - value	0.5526	0.8354	0.4015	0.1042	0.8216	0.9253	0.6797	0.1467
2002-2007	α	-0.37766	-0.31912	-0.15972	-0.21155	0.097248	0.030968	0.228603	-0.13993
	β	-0.18976	0.224088	-0.26462	-0.21222	-0.26455	-0.45598	-0.55943	-0.04263
	LRT	0.8418	0.7946	1.5183	0.8985	1.0574	8.3520	6.2353	0.0289
	p - value	0.3589	0.3727	0.2179	0.3432	0.3038	0.0039	0.0125	0.8651
2008-2009	α	-0.30705	0.32422	-0.40679	-0.4558	-0.29281	-0.12598	-0.38806	0.3045
	β	0.458229	-0.11489	1.383604	0.321495	0.118261	-0.02143	-0.00591	-0.18476
	LRT	0.7715	0.0453	4.2865	0.4595	0.0680	0.0025	0.0002	0.1105
	p - value	0.3798	0.8314	0.0384	0.4979	0.7943	0.9601	0.9883	0.7396
1997-2007	α				0.021484				
	β				-0.3479				
	LRT				3.5837				
	p - value				0.0584				

Notes:

1. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the log it regression where the independent variable is the log of thecurrent length of the run and the dependent variable is either 1, if the run ends, or 0, if it does not end in the next period.
2. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
3. The p-value is the marginal significance level, which is the probability of obtaining that value of the LRT or higher under the null hypothesis.

4.4 Results of the unit root and Multivariate cointegration tests

The time series properties of monthly stock price indices, dividends and earnings for value-weighted portfolios were examined via unit root and cointegration analysis from 1991 to 2009. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to test for unit roots, and the Johansen-Juselius multivariate cointegration vector autoregression approach is used to test the long-run relationship between stock prices and fundamental variables.

4.4.1 The unit root test

Both ADF and PP tests are performed on the model with and without a trend. The 4 lag length in the ADF and PP regressions is the highest significant lag order from either the autocorrelation function or the partial autocorrelation function of the first differenced series, chosen by the Akaike Information Criterion (AIF). As shown in Table 4.3, the results of the ADF test, based on the monthly full sample period data, cannot reject the null hypothesis of a unit root or non-stationary for most of the variables in their logarithmic form at traditional levels of significance, except for stock prices for China and Singapore which reject the null hypothesis at a 5% significance level, while Chinese dividends and Korean stock prices reject the null hypothesis at the 10% significance level. After a trend is added to the model, most of the variables are still non-stationary at traditional significance levels; however, the results for Indonesian earnings, China dividends and Singaporean stock reject the null hypothesis at a 1% significance level. with China stock prices and Indonesia dividends rejecting it at 5% and 10% significance levels respectively. The results of the PP tests with no trend model cannot reject the null hypothesis for most of the variables at traditional levels of significance, either. Only the earnings of the Indonesian stock market and stock prices of Singapore’s stock market reject the null hypothesis at 1% and 5% significance levels, respectively. After a trend is added to the PP test, most of the variables still get unit roots at traditional significance levels, however, the results of Indonesia dividends, China dividends, earnings and Singapore stock prices reject the null hypothesis at the 10% significance level, and Indonesia earnings reject at a 1% significance level.

The cointegration test only can be used for non-stationary variables. Table 4.3 shows that monthly stock prices, dividends and earnings are non-stationary variables, which means that the cointegration test can be used for these data.

Table 4.3 Results of the ADF and PP unit roots tests

The ADF and PP unit roots tests for variables used in the study

Full period (1991-2009)

Markets	Variables	ADF		PP	
		No Trend	Trend	No Trend	Trend
Indonesia	p_t	-0.5896	-2.0614	-0.6198	-2.1535
	d_t	-1.2984	-3.2419	-1.2903	-3.3700*
	y_t	-1.0146	-4.5405***	-5.4601***	-12.2781***
China	p_t	-3.2837**	-3.6571**	-2.5126	-2.8489
	d_t	-2.6714*	-4.7710***	-2.1733	-3.3490*
	y_t	-2.5170	-3.1000	-2.4622	-3.2968*
Malaysia	p_t	-1.9726	-2.3804	-1.5137	-1.9310
	d_t	-2.1398	-2.0728	-1.9769	-1.9205
	y_t	-2.1650	-2.4556	-2.0073	-2.2947
Philippine	p_t	-1.0461	-2.2665	-1.6322	-2.5319
	d_t	-0.4118	-1.6884	-0.4227	-1.7464
	y_t	-0.8206	-1.8513	-0.7431	-1.4937
Japan	p_t	-1.0678	-1.6366	-1.1637	-1.8388
	d_t	-0.9731	-2.3544	-0.9819	-2.5281
	y_t	-1.2661	-1.3031	-1.2559	-1.4054
Korea	p_t	-2.7042*	-2.6447	-2.3247	-2.2876
	d_t	-2.3942	-2.3964	-2.1390	-2.1312
	y_t	-1.9651	-2.0247	-2.0440	-2.0163
Singapore	p_t	-3.3676**	-4.1261***	-2.9084**	-3.3285*
	d_t	-0.5810	-2.5047	-0.5893	-2.5204
	y_t	-1.1730	-2.9414	-1.2865	-3.0618

Notes:

(1) The 4 lag length in the ADF and PP regressions is the highest significant lag order from either the autocorrelation function or the partial autocorrelation function of the first differenced series.
(2) p_t, d_t and y_t denote the log of monthly stock price indices, dividends and earnings for value-weighted portfolios from 1991-2009, respectively.
(3) Corresponding critical values for models with no trend for the ADF and PP unit root tests are -3.45, -2.86 and -2.57 at 1%, 5% and 10% significance levels respectively.
(4) Corresponding critical values for models with trends for the ADF and PP unit root tests are -3.98, -3.42 and -3.13 at 1%, 5% and 10% significance levels respectively.
(5) ***， ** and * indicate significance at the 1%, 5% and 10% levels respectively.

4.4.2 Multivariate cointegration tests

Full sample period analysis:

Following the unit root tests, cointegration analysis was performed. The results of the cointegration tests for the monthly full sample period are reported in Table 4.4, where Panel A shows the cointegration relationship between value-weighted stock prices and value-weighted dividends; panel B shows the relationship between value-weighted stock price and value-weighted earnings; and panel C shows the relationship among valued-weighted stock price, value-weighted dividends and value-weighted earnings.

The value-weighted stock prices, dividends and earnings are the indices whose components are weighted according to the total market value of their outstanding shares. The mathematical formula is expressed as follows:

Value-weighted stock price = $\frac{\sum \mathrm{Pt} \times \mathrm{Mt}}{\sum \mathrm{Mt}}$

Value-weighted dividend = $\frac{\sum \mathrm{Dt} \times \mathrm{Mt}}{\sum \mathrm{Mt}}$

Value-weighted earning = $\frac{\sum \mathrm{Et} \times \mathrm{Mt}}{\sum \mathrm{Mt}}$

where:

M_t = Individual stock market value

P_t = Individual stock price

D_t = Individual stock dividend

E_t = Individual stock earning

The results of the cointegration tests indicate the presence of rational speculative bubbles in Indonesia and Japan. As shown in Table 4.4 (Japan), the Trace test and Max-eigenvalue test cannot reject the null hypothesis of no cointegration between p_t, d_t and $y_{t;}$ p_t and y_t ; nor p_t and d_t for Japan at traditional significance levels. Panel C of Table 4.4 (Indonesia) shows both Trace and Max-eigenvalue tests indicate that one cointegration equation exists, between p_t, d_t and $y_{t\ ,}$ at 5% and 1% significance levels however, Panel A and Panel B of Table 4.4 (Indonesia) indicate that there is no cointegrated relationship between p_t and y_t ,nor between p_t and d_t in Indonesia at traditional significance levels. This evidence suggests that Indonesian and Japanese stock prices deviated from fundamental values, indicating the presence of rational speculative bubbles

The Trace test and Max-eigenvalue test provide evidence of a cointegrated relationship between stock prices and fundamental factors in China and Singapore. As shown in Table 4.4 (China), the λ_{trace} and λ_{max} statistics reject the null hypothesis of no cointegration between p_t, d_t and $y_{t;}$ p_t and y_t ; and d_t and y_t in China at both 5% and 1% significance levels. Panel B and panel C of Table 4.4 (Singapore) indicate that p_t and y_t, and p_t, d_t and y_t are cointegrated at both 5% and 1% significance levels While Panel A shows that the λ_{trace} and λ_{max} statistics reject the null hypothesis of no cointegration between p_t and d_t at 5%, but not at 1% significance level. These results indicate the absence of rational speculative bubbles in China and Singapore.

None of the Malaysian, Philippine or Korean stock markets has the characteristics that completely conform to or contradict the prediction of the rational speculative bubbles model, which is that stock prices deviate from fundamental values. Therefore, the Trace test and Max-eigenvalue test cannot provide strong evidence whether or not rational speculative bubbles exist in Malaysia, Philippines or Korea. As shown in panel A of Table 4.4 (Malaysia),

λ_{trace} and λ_{max} statistics indicate that p_t deviates from d_t in the long run relationship in Malaysia, however, panels B and C show evidence rejecting the null hypothesis of no cointegration between p_t, d_t and y_t, and p_t and y_t at both 5% and 1% significance levels. Therefore, the cointegration results for Malaysia are inconclusive. For the Philippines, Panel A and panel B of Table 4.4 (Philippines) show evidence sufficient to reject the null hypothesis of no cointegration relationship between p_t and d_t, but cannot reject the null hypothesis of no cointegration between p_t and y_t, at either 5% or 1% significance levels.. As shown in panel C of Table 4.4 (Philippines), p_t, d_t and y_t are cointegrated at the 5% significance level, but not at 1%, therefore, the cointegration results for the Philippines are also inconclusive. Finally, for the Korean stock market, the results reported in panel B of Table 4.4 (Korea) cannot reject the null hypothesis of no cointegration relationship between p_t and y_t at either 5% or 1% significance levels. Furthermore, as shown on panel A and panel C, the results of Trace tests and Max-eigenvalue tests contradict each other therefore, the cointegration test cannot provide strong evidence whether or not rational speculative bubbles exist in the stock markets of Malaysia, the Philippines and Korea.

Table 4.4 Results of Cointegration tests (China)

China (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	22.76	15.49	19.49	r=0 or r=1	20.48	14.26	18.52
r≤1	2.27	3.84	6.63	r=1 or r=2	2.27	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	21.27	15.49	19.49	r=0 or r=1	11.26	14.26	18.52
r≤1	10.01	3.84	6.63	r=1 or r=2	10.01	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	60.57	29.80	35.46	r=0 or r=1	46.61	21.03	25.86
r≤1	13.96	15.49	19.94	r=1 or r=2	10.44	14.26	18.52
r≤2	3.51	3.84	6.63	r=2 or r=3	3.51	3.84	6.63

Table 4.4 (Indonesia)

Indonesia (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	13.02	15.49	19.49	r=0 or r=1	13.01	14.26	18.52
r≤1	0.01	3.84	6.63	r=1 or r=2	0.01	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.68	15.49	19.49	r=0 or r=1	7.60	14.26	18.52
r≤1	0.09	3.84	6.63	r=1 or r=2	0.09	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	36.17	29.80	35.46	r=0 or r=1	26.42	21.03	25.86
r≤1	9.74	15.49	19.94	r=1 or r=2	9.69	14.26	18.52
r≤2	0.06	3.84	6.63	r=2 or r=3	0.06	3.84	6.63

Table 4.4 (Japan)

Japan (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	3.95	15.49	19.49	r=0 or r=1	3.06	14.26	18.52
r≤1	0.90	3.84	6.63	r=1 or r=2	0.90	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	4.85	15.49	19.49	r=0 or r=1	3.48	14.26	18.52
r≤1	1.37	3.84	6.63	r=1 or r=2	1.37	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	17.38	29.80	35.46	r=0 or r=1	12.39	21.03	25.86
r≤1	4.99	15.49	19.94	r=1 or r=2	3.79	14.26	18.52
r≤2	1.20	3.84	6.63	r=2 or r=3	1.20	3.84	6.63

Table 4.4 (Malaysia)

Malaysia (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	7.72	15.49	19.49	r=0 or r=1	5.47	14.26	18.52
r≤1	2.26	3.84	6.63	r=1 or r=2	2.26	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	23.02	15.49	19.49	r=0 or r=1	18.82	14.26	18.52
r≤1	4.20	3.84	6.63	r=1 or r=2	4.20	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	35.82	29.80	35.46	r=0 or r=1	28.35	21.03	25.86
r≤1	7.41	15.49	19.94	r=1 or r=2	5.48	14.26	18.52
r≤2	1.98	3.84	6.63	r=2 or r=3	1.98	3.84	6.63

Table 4.4 (Philippines)

Philippines (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	21.36	15.49	19.49	r=0 or r=1	21.22	14.26	18.52
r≤1	0.14	3.84	6.63	r=1 or r=2	0.14	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	10.51	15.49	19.49	r=0 or r=1	10.05	14.26	18.52
r≤1	0.46	3.84	6.63	r=1 or r=2	0.46	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	30.31	29.80	35.46	r=0 or r=1	21.82	21.03	25.86
r≤1	8.49	15.49	19.94	r=1 or r=2	8.45	14.26	18.52
r≤2	0.04	3.84	6.63	r=2 or r=3	0.04	3.84	6.63

Table 4.4 (Singapore)

Singapore (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	16.37	15.49	19.49	r=0 or r=1	16.13	14.26	18.52
r≤1	0.24	3.84	6.63	r=1 or r=2	0.24	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	23.07	15.49	19.49	r=0 or r=1	21.65	14.26	18.52
r≤1	1.42	3.84	6.63	r=1 or r=2	1.42	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	37.70	29.80	35.46	r=0 or r=1	24.65	21.03	25.86
r≤1	13.05	15.49	19.94	r=1 or r=2	12.77	14.26	18.52
r≤2	0.28	3.84	6.63	r=2 or r=3	0.28	3.84	6.63

Table 4.4 (Korea)

Korea (value weight portfolio) full sample, monthly

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	20.13	15.49	19.49	r=0 or r=1	12.43	14.26	18.52
r≤1	7.70	3.84	6.63	r=1 or r=2	7.70	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	13.52	15.49	19.49	r=0 or r=1	9.34	14.26	18.52
r≤1	4.17	3.84	6.63	r=1 or r=2	4.18	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	33.38	29.80	35.46	r=0 or r=1	14.75	21.03	25.86
r≤1	18.62	15.49	19.94	r=1 or r=2	10.46	14.26	18.52
r≤2	8.16	3.84	6.63	r=2 or r=3	8.16	3.84	6.63

Notes:

(1) All variables are inflation adjusted.
(2) p_t, d_t and y_t denote the log of monthly stock price indices, dividends and earnings for value-weighted portfolios from 1991-2009 respectively.
(3) r denotes the number of cointegrating vectors.
(4) The optimal lag lengths for VAR were chosen based on lag exclusion tests and Akaike's Information Criteria.
(5) H_0 is the null hypothesis that there exist, at most, *r* cointegration vectors in the system.
(6) The cointegration tests are estimated under the assumption of trends in data and an intercept but no trends in the cointegrating equation.
(7) CV (5%) and CV (1%) are the critical values of the trace statistics and maximum eigenvalue statistics for the cointegration tests.

Sub-period analysis

Table 4.5 (The summary of Appendix 1)

	China	Indonesia	Japan	Korea	Malaysia	Philippine	Singapore
1991-1997	Y	Y	Y	Y	Y	Y	Y
1998-2001	Y	Y	Y	Y	Y	Y	Y
2002-2007	Y	Y	Y	Y	Y	Y	Y
2008-2009	N	Y	Y	Y	N	Y	Y

Where:

Y: Rational speculative bubbles existed in stock market.

N: Rational speculative bubbles did not exist in stock market.

Table 4.5 shows the summary result of the multivariate cointegration sub-period tests using monthly data. For the first three sub-periods, namely the pre-Asian financial crisis sub-period (1991-1997), post-Asian financial crisis sub-period (1998-2001) and pre-subprime loan financial crisis sub-period (2002-2007), rational speculative bubbles existed in all seven stock markets. The results for the post-subprime loan financial crisis sub-period (2008-2009) indicate the presence of rational speculative bubbles in Indonesia, Japan, Korea, Philippine and Singapore, but not in China and Malaysia.

In summary, the results of full sample period cointegration tests indicate the presence of rational speculative bubbles in Indonesia and Japan over the period from 1991 to 2009, while suggesting the absence of rational speculative bubbles in China and Singapore. However the tests are inconclusive for Malaysia, the Philippines and Korea. The results of sub-period tests indicate the presence of rational speculative bubbles in all stock markets for all sub-periods, except Chinese and Malaysian stock markets over the post-subprime loan financial crisis sub-period (2008-2009).

The results of sub-period analysis are different from the full sample period, which may be due to rational speculative bubbles being short-run bubbles. Jaradat (2009) shows that stock prices can be driven higher when a few uninformed traders cause a stock price to rise above its fundamental value. Other rational traders then buy the stock, with the assumption that the price will rise and they can sell it before the stock price drops. This speculative behaviour drives the stock price away from its fundamental value, resulting in a short-run rational speculative bubble which ultimately ruptures when the price returns to its fundamental value. This viewpoint is consistent with Kirman and Teyssiere (2005), who suggest that the underlying reasons for the short run bubbles are that there are switches in expectations caused by individuals changing their forecasting rules. The tendency is for these changes to be self reinforcing so, when the expectations change from positive to negative, the investors start to sell the stock and markets start to drop. Therefore, a rational speculative bubble cannot exist in a stock market forever thus must be a short run bubble.

The results of the full sample period cointegration tests are close to those of Chan et al. (1998), who employ the duration dependence test to find the absence of rational speculative bubbles in Japan, Korea and Malaysia over the sample period from 1975 to 1994 (20 years). Furthermore, the results of sub-period tests are similar to Sarno and Taylor (1999), finding no cointegration relationship between stock prices and dividends in China, Indonesia, Malaysia, Philippine, Singapore, Korea and Japan over the sample period from 1989 to 1997 (9 years).

Comparing the results of Chan et al. (1998) and Sarno and Taylor (1999), we can see that rational speculative bubbles exist in the short-run (9 years) rather than in the long-run (20 years). This is consistent with the current study's finding that the rational speculative bubble is a short-run bubble.

4.5 Conclusion

Comparing the results of the three types of tests, the duration dependence test is more accurate in identifying rational speculative bubbles that other tests, such as the cointegration test, skewness, kurtosis and autocorrelation. As previously discussed, the cointegration method has two limitations. Relying heavily on the correct identification of controversial fundamental variablesand and having low power when using limited data span. McQueen and Thorley (1994) show the weaknesses of skewness, kurtosis and autocoreelation as skewness could result from asymmetric fundamental news, leptokurtosis could be a consequence of the batched arrival of information and autocorrelation could be induced by time-varying risk premiums. Therefore, it appears that the results of the duration dependence test are more reliable which is why it was chosen as the main test for this research study.

The presence of rational speculative bubbles in stock markets can also be inferred from evidence of negative skewness, excess kurtosis and non-normality of real returns as reported in the summary statistics. The summary statistics results of this research are similar to the results of Chan et al. (1998), indicating that rational speculative bubbles may exist in Asian stock markets, namely China, Indonesia, Malaysia, Philippine, Japan, Korea and Singapore.

For duration dependence tests the null hypothesis of no rational speculative bubble implies a constant hazard rate (β=0). Using monthly data, the duration dependence tests indicate no evidence of rational speculative bubbles in all eight stock markets considered in this study, whether is for the full sample period or in sub-periods. However, the use of weekly data indicates the presence of rational speculative bubbles in Indonesia, Malaysia, and China (Shanghai and Shenzhen) for the full sample period. Further, the weekly sub-period tests show that rational speculative bubbles existed in the Indonesian stock market over the pre-Asian financial crisis subperiod (1991-1997), in the Chinese stock markets over both the pre-

Asian financial crisis subperiod (1991-1997) and the pre-subprime loan financial crisis subperiod (2002-2007), and in Malaysia over the sample period from 1997 to 2007. Therefore, based on duration dependence tests employing weekly data, rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets, but not in Japan, Singapore, Korea and Philippines. This result is consistent with Zhang (2008), Lehkonen (2010) and Haque et al. (2008), who all imply that rational speculative bubbles existed in the Chinese stock market. All three studies employed the duration dependence test, with sample periods from 1991 to 2001, 1992 to 2008 and 1991 to 2007 respectively. The duration dependence test results of the current study are partly consistent with to Sarno and Taylor (1999), who find strong evidence of the presence of rational speculative bubbles in China, Indonesia, Malaysia, Philippines, Singapore, Korea and Japan over the sample period from 1989 to 1997. However, the current finding is that rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets, but not in Japan, Singapore, Korea and the Philippines. This is also consistent with Mokhtar et al. (2006) and Ali et al. (2009) in terms of Malaysian stock market. Both studies employed duration dependence tests and report evidence of rational speculative bubbles in Malaysia over the period from 1999 to 2003 and 1987 to 1997 respectively.

The results of the unit root and multivariate cointegration tests support the conclusion that rational speculative bubbles exist in the stock markets of Indonesia and Japan while indicating the absence of rational speculative bubbles in China and Singapore. However the tests are inconclusive for Malaysia, Philippines and Korea. In addition, the results of the cointegration sub-period tests indicate that rational speculative bubbles may exist in all Asian stock markets examined, namely China, Indonesia, Malaysia, Philippine, Japan, Korea and Singapore. The results of the cointegration full sample period tests is close to those of Chan et al. (1998), which employed the duration dependence test to find the absence of rational speculative bubbles in Japan, Korea and Malaysia from 1975 to 1994 while the sub-period test results are similar to Sarno and Taylor (1999), finding no cointegration relationship between stock prices and dividends in China, Indonesia, Malaysia, Philippine, Singapore, Korea and Japan over the period from 1989 to 1997.

In summary, the results of duration dependence test show strong evidence for the presence of rational speculative bubbles in the Chinese, Indonesian and Malaysian stock markets. This result is consistent with those of summary statistics and cointegration tests. Therefore, the conclusion may be drawn that rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets over the sample period from 1991 to 2009. The subperiod analyses show evidence of the presence of rational speculative bubbles in the Chinese stock market over both pre-Asian financial crisis and pre-subprime loan financial crisis sub-periods, in the Indonesian stock markets over the pre-Asian financial crisis sub-period and in the Malaysian stock market over the pre-subprime loan financial crisis sub-period.

According to Figure 1 in chapter 3, the Japanese stock market trended downwards over the period from 1991 to 2009; therefore, there was no bubble in the Japanese stock market over the sample period. However, the long sequence of increases in stock prices from 2002, followed by a dramatic price drop in 2007 in the Singaporean, Philippine and South Korean stock markets would seem to indicate the presence of bubbles. According to the current results, there were no rational speculative bubbles in these stock markets from 1991 to 2009, therefore the boom and bust cycles in the three stock markets could be attributed to irrational speculative bubbles with positive feedback, noise trader and herd behaviour as their possible causes.

Chapter 5
Conclusions, Limitations and Future Research Directions

5.1 Introduction

This chapter summarizes the findings of this study on the detection of rational speculative bubbles in the Asian stock market (Japan, Singapore, Korea, China, Indonesia, Malaysia and Philippines). Section 5.2 gives an overview of the study while sections 5.3 and 5.4 discuss the results and implications of the study. The conclusion of the study is provided in section 5.5 followed by the limitations of the research in Section 5.6. Finally, section 5.7 gives recommendations for future research.

5.2 Overview of the study

Empirical evidence shows that sometimes stock prices deviate from fundamental values, which can be explained by the presence of rational speculative bubbles. Stock markets traditionally believed to contain rational speculative bubbles typically exhibit a long sequence of increases in stock prices followed by a dramatic price drop (McQueen and Thorley, 1994). Asian stock markets have experienced several boom and bust cycles in the last 20 years, which would appear consistent with the presence of rational speculative bubbles, therefore this research investigates whether Asian stock markets were characterized by rational speculative bubbles during the last 20 years.

Prior studies have tested the presence of rational speculative bubbles in the Asian stock markets, for example, Chan et al. (1998) and Sarno and Taylor (1999). However, the results of these studies contradict each other. So far, there is still no conclusive evidence of whether or not rational speculative bubbles exist in Asian stock markets over the chosen sample period from 1991 to 2009. The first research objective is to test for presence of rational speculative bubbles in the Asian stock markets over this period. Furthermore, the second research objective is to test for rational speculative bubbles over sub-periods, namely, pre- and post- 1997 (1991-1997 and 1997-2001) the Asian financial crisis sub-periods and pre- and post- 2007 (2001-2007 and 2007-2009) the Subprime loan financial crisis sub-periods. The third objective is to test if the presence of bubbles is sensitive to types of markets---emerging versus developed stock market while the fourth objective is to test the robustness of the results of the duration dependence test when using weekly rather than monthly data.

This research used both monthly and weekly stock price indices of eight Asian stock markets, all inflation adjusted using monthly and weekly inflation rates computed from the Consumer Price Index (CPI) data for Summary Statistics and a duration dependence test. The monthly value-weighted stock prices, dividends and earnings are also used by this research in cointegration tests. Three methods were employed to detect for the presence of rational speculative bubbles: a) the use of summary statistics, b) duration dependence tests, and c) cointegration tests. Summary statistics can be used to test for the presence of rational speculative bubbles as this can be inferred from evidence of negative skewness, excess kurtosis and positive autocorrelation of real returns. The duration dependence test for rational speculative bubbles, developed by McQueen and Thorley (1994), tests for another characteristic, the presence of a negative relationship between the probability that a positive run will end and the length of the positive run, i.e., negative duration dependence or a decreasing hazard rate, while the cointegration approach is used to examine the long-run relationship between stock prices and fundamental values. If stock prices and fundamental values are not cointegrated, rational speculative bubbles can be said to exist in the stock market.

5.3 Results of this study

5.3.1 Result for objective one

Many previous studies tested the presence of rational speculative bubbles in Asian stock markets, but there is still a debate about whether or not they exist thus, the first research objective is to test for the presence of rational speculative bubbles in the Asian stock markets, namely Japan, Singapore, Korea, China, Indonesia, Malaysia and Philippines between 1991 and 2009. The results of duration dependence tests show strong evidence of the presence rational speculative bubbles in the Chinese, Indonesian and Malaysian stock markets consistent with summary statistics and cointegration test results. Therefore, we conclude that rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets, but not in Japanese, Singaporean, Korean and Philippine stock markets over the period from 1991 to 2009.

Many previous studies tested the presence of rational speculative bubbles in Asian stock market, but there is still a debate about whether or not rational speculative bubbles exist in Asian stock markets. Our results indicate that rational speculative bubbles exist in some of Asian stock markets, such as Indonesia, Malaysia and China, but not in the others, such as Japan, Korea, Singapore and Philippines over the period from 1991-2009.

5.3.2 Result for objective two

The second research objective tests for rational speculative bubbles over sub-periods, namely, the pre- and post- 1997 (1991-1997 and 1997-2001) Asian financial crisis sub-periods and the pre- and post- 2007 (2001-2007 and 2007-2009) Subprime loan financial crisis sub-periods. The subperiod analysis shows evidence of rational speculative bubbles in the Chinese stock market over both the pre-Asian financial crisis and the pre-subprime loan financial crisis sub-periods; in the Indonesian stock market over the pre-Asian financial crisis sub-period; and in the Malaysian stock market over the pre-Subprime loan financial crisis sub-period.

5.3.3 Result for objective three

The third objective is to test if bubbles are more prevalent in emerging, relative to developed, markets. The eight markets are sorted according to their stage of development: China, Indonesia, Malaysia and Philippines belonging to the emerging markets while Japan, Singapore and Korea belong to developed markets. The results of this research indicate evidence of rational speculative bubbles in the emerging stock markets of China, Indonesia, and Malaysia, but not in the Philippines. No rational speculative bubbles were detected in the developed stock markets of Japan, Singapore and Korea. It therefore appears that rational speculative bubbles are more prevalent in emerging stock markets than developed stock markets.

5.3.4 Result for objective four

The fourth research objective is to test the robustness of the results of the duration dependence test when using weekly rather than monthly data. The results of this research show stronger evidence of rational speculative bubbles in the Chinese, Indonesian and Malaysian stock markets using weekly data, rather than monthly data. Therefore, the conclusion is that weekly data is more sensitive than monthly data to duration dependence tests.

5.4 Research implications

First, understanding whether or not stock markets are characterized by rational speculative bubbles can help policy makers to better understand stock markets and the macro economy as their presence indicates imperfections in the stock market and causes the financial system and the macro economy to be unstable. In such cases, policy makers should seek to stabilize the financial system and steer the economy away from these bubbles. Some ways of reducing rational speculative bubbles in the stock market include raising interest rates, restricting short-selling of stocks, controlling inside trading activities and increasing brokerage fees.

Secondly, it appears that rational speculative bubbles always exist in pre-financial crisis sub-periods, which means rational speculative bubbles can be found before stock market crashes. This study only used data when market boomed, without including the data when market crashed. Therefore, investors could possibly predict market crashes before a financial crisis occurs, which is very important for two main reasons. First, investors could use short-selling to benefit from declining stock prices and second, even though in countries like China it is impossible to benefit from declining prices due to the prohibition of short-selling, information that a stock market will crash can force investors to act rationally by selling their stocks and adjust the share prices toward their fair value, as well as causing the market to be efficient.

Additionally, the finding of this research that rational speculative bubbles are more prevalent in emerging stock markets than developed stock markets is also very important to both investors and policy makers. It means that investors should pay more attention to identifying rational speculative bubbles when investing in emerging stock markets. When such bubbles burst, the stock market will crash, which is very dangerous for investors. However, by short-selling stocks, investors could also earn high returns when the bubble explodes and stock prices crash. Moreover, policy makers of emerging countries should pay more attention to rational speculative bubbles in their stock markets and should stabilize the financial system to steer the economy away from them.

Finally, if investors or policy makers want to test for the presence of rational speculative bubbles in a stock market using duration dependence tests, they should understand that the results of weekly data are more reliable than monthly data.

5.5 Conclusion

In conclusion, the results of this research indicate that rational speculative bubbles existed in the Chinese, Indonesian and Malaysian stock markets, but not in the Japanese, Korean, Singaporean and Philippine stock markets, over the sample period from 1991 to 2009. The sub-period analysis showed evidence of rational speculative bubbles in the Chinese stock market over both the pre-Asian financial crisis and pre-Subprime loan financial crisis sub-periods, in the Indonesian stock markets over the pre-Asian financial crisis sub-period and in the Malaysian stock market over the pre-Subprime loan financial crisis sub-period.

The results of this research are consistent with Sarno and Taylor (1999), Zhang (2008), Lehkonen (2010), Ali et al. (2009) and Mokhtar et al. (2006). Sarno and Taylor (1999) found evidence of rational speculative bubbles China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand over their sample period from 1989 to 1997. Zhang (2008) and Lehkonen (2010) showed evidence of rational speculative bubbles in the Chinese stock market over the sample periods from 1991 to 2001and 1992 to 2008, while, in the Malaysian stock market, Ali et al. (2009) and Mokhtar et al. (2006) both found evidence of rational speculative bubbles from 1989 to 2006 and 1994 to 2003. The results of this research also show that rational speculative bubbles are more prevalent in emerging rather than developed stock markets. A better understanding of whether or not stock markets are characterized by rational speculative bubbles can help investors or practitioners to allocate their investment efficiently and can also help policy makers to better understand stock markets and the macro economy.

Another important finding of this research is that rational speculative bubbles were found to exist in the pre-financial crisis sub-periods. Therefore, it might be possible to predict market crashes by identifying their presence.

The last finding of this research is that the duration dependence test is more sensitive to the use of weekly data than monthly data. Results showed that no rational speculative bubble existed in seven sample countries using monthly data, but evidence was found of rational speculative bubbles in the Chinese, Malaysian and Indonesian stock markets using weekly data. This finding confirms the conclusion of Harman and Zuehlke (2004) and Lehkonen (2010) that the duration dependence test is more sensitive to the use of weekly data than monthly data.

5.6 Limitations

5.6.1 Length of full sample period

As the emerging Asia-pacific stock markets have short price histories, for example, China's stock market only started from 1991, this research only analyzes data over the sample period from 1991 to 2009, a collection of just 19 years data. Compared with the previous studies, for example, McQueen and Thorley (1994) who employ the duration dependence test to the New York Stock Exchange (NYSE) over a sample period from 1927 to 1991, our research sample period is short.

5.6.2 Length of post-Subprime loan financial crisis sub-period

Compared with previous studies, this research has extended the sample period to 2009 and thus is the first study to test the presence of rational speculative bubbles over the Subprime loan financial crisis period, which is a very important contribution of this research. However, the post-Subprime loan financial crisis sub-period analysed is only from 2008 to 2009 .and we could obtain only minimal data observations over such a short sub-period. This is the main weakness of this research.

5.6.3 Sub-period analysis by cointegration test

The Johansen-Juselius multivariate cointegration vector autoregression approach is used to examine the long-run relationship between stock prices and fundamental values. The full sample period was separated into the pre- and post- 1997 Asian financial crisis sub-periods and the pre- and post- 2007 Subprime loan financial crisis sub-periods. Consequently, the pre-1997 Asian financial crisis sub-period is from 1991 to 1997 (seven years), the post- 1997 Asian financial crisis sub-period is from 1998 to 2001 (four years), the pre-2007 Subprime loan financial crisis sub-period is from 2002 to 2007 (six years) and the post- 2007 Subprime loan financial crisis sub-period is from 2008 to 2009 (two years). For testing the long run relationships, the pre-1997 Asian financial crisis sub-period of seven years and pre-2007 Subprime loan financial crisis sub-period of six years are suitable. However, the post- 1997 Asian financial crisis sub-period of four years and post- 2007 Subprime loan financial crisis sub-period of two years is too short for meaningful cointegration tests. This is the reason why cointegration tests could only be used as a complement to the duration dependence tests.

5.7 Future research directions

Examining the research limitations, the major problem with this research is the length of the sample period. Future research could and should choose stock markets which have longer price histories. Furthermore, if future researchers want to test for rational speculative bubbles over the Subprime loan financial crisis period, they still need to wait for another two or three years, until they can collect more post-crisis data.

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Appendix: 1

China (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	12.80	15.49	19.49	r=0 or r=1	10.41	14.26	18.52
r≤1	2.39	3.84	6.63	r=1 or r=2	2.39	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	18.06	15.49	19.49	r=0 or r=1	11.16	14.26	18.52
r≤1	6.90	3.84	6.63	r=1 or r=2	6.90	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	23.97	29.80	35.46	r=0 or r=1	12.38	21.03	25.86
r≤1	11.69	15.49	19.94	r=1 or r=2	9.28	14.26	18.52
r≤2	2.41	3.84	6.63	r=2 or r=3	2.41	3.84	6.63

China (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	5.14	15.49	19.49	r=0 or r=1	3.33	14.26	18.52
r≤1	1.81	3.84	6.63	r=1 or r=2	1.81	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.61	15.49	19.49	r=0 or r=1	7.23	14.26	18.52
r≤1	0.39	3.84	6.63	r=1 or r=2	0.39	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	19.44	29.80	35.46	r=0 or r=1	15.80	21.03	25.86
r≤1	3.64	15.49	19.94	r=1 or r=2	3.44	14.26	18.52
r≤2	0.20	3.84	6.63	r=2 or r=3	0.20	3.84	6.63

China (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	8.35	15.49	19.49	r=0 or r=1	7.59	14.26	18.52
r≤1	0.76	3.84	6.63	r=1 or r=2	0.76	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.79	15.49	19.49	r=0 or r=1	6.30	14.26	18.52
r≤1	1.50	3.84	6.63	r=1 or r=2	1.50	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	27.38	29.80	35.46	r=0 or r=1	14.97	21.03	25.86
r≤1	12.41	15.49	19.94	r=1 or r=2	10.14	14.26	18.52
r≤2	2.27	3.84	6.63	r=2 or r=3	2.27	3.84	6.63

China (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	19.50	15.49	19.49	r=0 or r=1	12.69	14.26	18.52
r≤1	6.81	3.84	6.63	r=1 or r=2	6.81	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	26.39	15.49	19.49	r=0 or r=1	18.64	14.26	18.52
r≤1	7.75	3.84	6.63	r=1 or r=2	7.75	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	35.80	29.80	35.46	r=0 or r=1	17.98	21.03	25.86
r≤1	17.82	15.49	19.94	r=1 or r=2	11.82	14.26	18.52
r≤2	6.00	3.84	6.63	r=2 or r=3	6.00	3.84	6.63

Indonesia (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)

Panel A: Cointegration between p_t and d_t							
r=0	12.49	15.49	19.49	r=0 or r=1	10.05	14.26	18.52
r≤1	2.44	3.84	6.63	r=1 or r=2	2.44	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	8.09	15.49	19.49	r=0 or r=1	7.19	14.26	18.52
r≤1	0.90	3.84	6.63	r=1 or r=2	0.90	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	34.87	29.80	35.46	r=0 or r=1	27.75	21.03	25.86
r≤1	7.12	15.49	19.94	r=1 or r=2	6.25	14.26	18.52
r≤2	0.87	3.84	6.63	r=2 or r=3	0.87	3.84	6.63

Indonesia (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	13.53	15.49	19.49	r=0 or r=1	12.46	14.26	18.52
r≤1	1.06	3.84	6.63	r=1 or r=2	1.06	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	5.52	15.49	19.49	r=0 or r=1	4.04	14.26	18.52
r≤1	1.21	3.84	6.63	r=1 or r=2	1.21	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	18.61	29.80	35.46	r=0 or r=1	12.75	21.03	25.86
r≤1	5.86	15.49	19.94	r=1 or r=2	4.07	14.26	18.52
r≤2	1.79	3.84	6.63	r=2 or r=3	1.79	3.84	6.63

Indonesia (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	5.53	15.49	19.49	r=0 or r=1	5.74	14.26	18.52

r≤1	0.05	3.84	6.63	r=1 or r=2	0.55	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	25.77	15.49	19.49	r=0 or r=1	25.53	14.26	18.52
r≤1	0.24	3.84	6.63	r=1 or r=2	0.24	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	36.57	29.80	35.46	r=0 or r=1	26.51	21.03	25.86
r≤1	10.06	15.49	19.94	r=1 or r=2	10.04	14.26	18.52
r≤2	0.02	3.84	6.63	r=2 or r=3	0.02	3.84	6.63

Indonesia (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	6.51	15.49	19.49	r=0 or r=1	6.28	14.26	18.52
r≤1	0.23	3.84	6.63	r=1 or r=2	0.23	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.78	15.49	19.49	r=0 or r=1	6.78	14.26	18.52
r≤1	0.99	3.84	6.63	r=1 or r=2	0.99	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	18.93	29.80	35.46	r=0 or r=1	12.86	21.03	25.86
r≤1	6.07	15.49	19.94	r=1 or r=2	4.99	14.26	18.52
r≤2	1.08	3.84	6.63	r=2 or r=3	1.08	3.84	6.63

Japan (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	3.39	15.49	19.49	r=0 or r=1	3.37	14.26	18.52
r≤1	0.02	3.84	6.63	r=1 or r=2	0.02	3.84	6.63
Panel B: Cointegration between p_t and y_t							

r=0	8.70	15.49	19.49	r=0 or r=1	7.75	14.26	18.52
r≤1	0.95	3.84	6.63	r=1 or r=2	0.95	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	16.29	29.80	35.46	r=0 or r=1	11.54	21.03	25.86
r≤1	4.75	15.49	19.94	r=1 or r=2	4.64	14.26	18.52
r≤2	0.12	3.84	6.63	r=2 or r=3	0.12	3.84	6.63

Japan (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.63	15.49	19.49	r=0 or r=1	8.96	14.26	18.52
r≤1	2.68	3.84	6.63	r=1 or r=2	2.68	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	6.66	15.49	19.49	r=0 or r=1	5.57	14.26	18.52
r≤1	1.08	3.84	6.63	r=1 or r=2	1.08	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	19.26	29.80	35.46	r=0 or r=1	12.26	21.03	25.86
r≤1	6.61	15.49	19.94	r=1 or r=2	5.65	14.26	18.52
r≤2	0.96	3.84	6.63	r=2 or r=3	0.96	3.84	6.63

Japan (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	10.12	15.49	19.49	r=0 or r=1	10.04	14.26	18.52
r≤1	0.08	3.84	6.63	r=1 or r=2	0.08	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	5.59	15.49	19.49	r=0 or r=1	3.19	14.26	18.52
r≤1	2.40	3.84	6.63	r=1 or r=2	2.40	3.84	6.63

Panel C: Cointegration between p_t, d_t and y_t							
r=0	15.38	29.80	35.46	r=0 or r=1	10.53	21.03	25.86
r≤1	4.85	15.49	19.94	r=1 or r=2	3.56	14.26	18.52
r≤2	1.29	3.84	6.63	r=2 or r=3	1.29	3.84	6.63

Japan (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.70	15.49	19.49	r=0 or r=1	10.08	14.26	18.52
r≤1	0.87	3.84	6.63	r=1 or r=2	0.87	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	9.26	15.49	19.49	r=0 or r=1	9.13	14.26	18.52
r≤1	0.13	3.84	6.63	r=1 or r=2	0.13	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	19.60	29.80	35.46	r=0 or r=1	12.02	21.03	25.86
r≤1	7.58	15.49	19.94	r=1 or r=2	6.83	14.26	18.52
r≤2	0.75	3.84	6.63	r=2 or r=3	0.75	3.84	6.63

Korea (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.52	15.49	19.49	r=0 or r=1	9.88	14.26	18.52
r≤1	1.65	3.84	6.63	r=1 or r=2	1.65	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	9.42	15.49	19.49	r=0 or r=1	7.12	14.26	18.52
r≤1	2.30	3.84	6.63	r=1 or r=2	2.30	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	23.06	29.80	35.46	r=0 or r=1	11.61	21.03	25.86

r≤1	11.45	15.49	19.94	r=1 or r=2	8.63	14.26	18.52
r≤2	2.82	3.84	6.63	r=2 or r=3	2.82	3.84	6.63

Korea (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.42	15.49	19.49	r=0 or r=1	8.08	14.26	18.52
r≤1	3.34	3.84	6.63	r=1 or r=2	3.34	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	5.80	15.49	19.49	r=0 or r=1	4.68	14.26	18.52
r≤1	1.11	3.84	6.63	r=1 or r=2	1.11	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	29.24	29.80	35.46	r=0 or r=1	19.01	21.03	25.86
r≤1	10.24	15.49	19.94	r=1 or r=2	9.07	14.26	18.52
r≤2	1.16	3.84	6.63	r=2 or r=3	1.16	3.84	6.63

Korea (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	12.09	15.49	19.49	r=0 or r=1	8.20	14.26	18.52
r≤1	3.90	3.84	6.63	r=1 or r=2	3.90	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	9.20	15.49	19.49	r=0 or r=1	6.81	14.26	18.52
r≤1	2.40	3.84	6.63	r=1 or r=2	2.39	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	29.72	29.80	35.46	r=0 or r=1	18.31	21.03	25.86
r≤1	11.42	15.49	19.94	r=1 or r=2	8.27	14.26	18.52
r≤2	3.15	3.84	6.63	r=2 or r=3	3.15	3.84	6.63

Korea (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	9.93	15.49	19.49	r=0 or r=1	9.17	14.26	18.52
r≤1	0.76	3.84	6.63	r=1 or r=2	0.76	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	18.31	15.49	19.49	r=0 or r=1	17.46	14.26	18.52
r≤1	0.85	3.84	6.63	r=1 or r=2	0.85	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	35.08	29.80	35.46	r=0 or r=1	19.24	21.03	25.86
r≤1	15.82	15.49	19.94	r=1 or r=2	13.10	14.26	18.52
r≤2	2.74	3.84	6.63	r=2 or r=3	2.74	3.84	6.63

Malaysia (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.04	15.49	19.49	r=0 or r=1	10.39	14.26	18.52
r≤1	0.65	3.84	6.63	r=1 or r=2	0.65	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.47	15.49	19.49	r=0 or r=1	6.27	14.26	18.52
r≤1	1.20	3.84	6.63	r=1 or r=2	1.20	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	19.51	29.80	35.46	r=0 or r=1	12.54	21.03	25.86
r≤1	6.96	15.49	19.94	r=1 or r=2	6.00	14.26	18.52
r≤2	0.96	3.84	6.63	r=2 or r=3	0.96	3.84	6.63

Malaysia (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	15.44	15.49	19.49	r=0 or r=1	9.30	14.26	18.52
r≤1	6.14	3.84	6.63	r=1 or r=2	6.14	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	11.82	15.49	19.49	r=0 or r=1	7.07	14.26	18.52
r≤1	4.77	3.84	6.63	r=1 or r=2	4.77	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	25.64	29.80	35.46	r=0 or r=1	10.13	21.03	25.86
r≤1	15.51	15.49	19.94	r=1 or r=2	9.09	14.26	18.52
r≤2	6.42	3.84	6.63	r=2 or r=3	6.42	3.84	6.63

Malaysia (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	11.93	15.49	19.49	r=0 or r=1	11.35	14.26	18.52
r≤1	0.58	3.84	6.63	r=1 or r=2	0.58	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.17	15.49	19.49	r=0 or r=1	6.80	14.26	18.52
r≤1	0.37	3.84	6.63	r=1 or r=2	0.37	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	20.89	29.80	35.46	r=0 or r=1	12.51	21.03	25.86
r≤1	8.83	15.49	19.94	r=1 or r=2	7.22	14.26	18.52
r≤2	1.16	3.84	6.63	r=2 or r=3	1.16	3.84	6.63

Malaysia (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics	H_0	λ_{max}	λ Max statistics

		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	16.30	15.49	19.49	r=0 or r=1	12.69	14.26	18.52
r≤1	3.61	3.84	6.63	r=1 or r=2	3.61	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	30.42	15.49	19.49	r=0 or r=1	17.95	14.26	18.52
r≤1	12.67	3.84	6.63	r=1 or r=2	12.47	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	49.64	29.80	35.46	r=0 or r=1	23.07	21.03	25.86
r≤1	26.57	15.49	19.94	r=1 or r=2	14.60	14.26	18.52
r≤2	11.97	3.84	6.63	r=2 or r=3	11.97	3.84	6.63

Philippine (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	14.55	15.49	19.49	r=0 or r=1	10.71	14.26	18.52
r≤1	3.84	3.84	6.63	r=1 or r=2	3.84	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	14.22	15.49	19.49	r=0 or r=1	12.11	14.26	18.52
r≤1	2.11	3.84	6.63	r=1 or r=2	2.11	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	28.59	29.80	35.46	r=0 or r=1	20.95	21.03	25.86
r≤1	7.64	15.49	19.94	r=1 or r=2	5.51	14.26	18.52
r≤2	2.13	3.84	6.63	r=2 or r=3	2.13	3.84	6.63

Philippine (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							

r=0	8.91	15.49	19.49	r=0 or r=1	7.71	14.26	18.52
r≤1	0.48	3.84	6.63	r=1 or r=2	0.48	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	6.26	15.49	19.49	r=0 or r=1	3.61	14.26	18.52
r≤1	3.06	3.84	6.63	r=1 or r=2	3.06	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	15.85	29.80	35.46	r=0 or r=1	9.46	21.03	25.86
r≤1	6.40	15.49	19.94	r=1 or r=2	4.73	14.26	18.52
r≤2	1.67	3.84	6.63	r=2 or r=3	1.67	3.84	6.63

Philippine (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	7.05	15.49	19.49	r=0 or r=1	6.61	14.26	18.52
r≤1	0.43	3.84	6.63	r=1 or r=2	0.43	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	13.22	15.49	19.49	r=0 or r=1	12.89	14.26	18.52
r≤1	0.33	3.84	6.63	r=1 or r=2	0.33	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	30.77	29.80	35.46	r=0 or r=1	19.02	21.03	25.86
r≤1	11.75	15.49	19.94	r=1 or r=2	11.18	14.26	18.52
r≤2	0.57	3.84	6.63	r=2 or r=3	0.57	3.84	6.63

Philippine (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	25.72	15.49	19.49	r=0 or r=1	23.16	14.26	18.52
r≤1	2.55	3.84	6.63	r=1 or r=2	2.55	3.84	6.63

Panel B: Cointegration between p_t and y_t							
r=0	12.34	15.49	19.49	r=0 or r=1	11.94	14.26	18.52
r≤1	0.40	3.84	6.63	r=1 or r=2	0.40	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	39.06	29.80	35.46	r=0 or r=1	25.18	21.03	25.86
r≤1	13.88	15.49	19.94	r=1 or r=2	13.52	14.26	18.52
r≤2	0.35	3.84	6.63	r=2 or r=3	0.35	3.84	6.63

Singapore (value weight portfolio) sub-period, monthly (1991-1997)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	10.46	15.49	19.49	r=0 or r=1	6.56	14.26	18.52
r≤1	3.90	3.84	6.63	r=1 or r=2	3.90	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	7.54	15.49	19.49	r=0 or r=1	4.63	14.26	18.52
r≤1	2.90	3.84	6.63	r=1 or r=2	2.90	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	15.65	29.80	35.46	r=0 or r=1	9.32	21.03	25.86
r≤1	6.32	15.49	19.94	r=1 or r=2	4.62	14.26	18.52
r≤2	1.70	3.84	6.63	r=2 or r=3	1.70	3.84	6.63

Singapore (value weight portfolio) sub-period, monthly (1998-2001)

H_0	λ_{trace}	λ Trace statistics		H_0	λ_{max}	λ Max statistics	
		CV (5%)	CV (1%)			CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	8.24	15.49	19.49	r=0 or r=1	6.50	14.26	18.52
r≤1	1.74	3.84	6.63	r=1 or r=2	1.74	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	14.89	15.49	19.49	r=0 or r=1	10.55	14.26	18.52

r≤1	4.34	3.84	6.63	r=1 or r=2	4.34	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	30.11	29.80	35.46	r=0 or r=1	18.12	21.03	25.86
r≤1	11.99	15.49	19.94	r=1 or r=2	9.45	14.26	18.52
r≤2	2.54	3.84	6.63	r=2 or r=3	2.54	3.84	6.63

Singapore (value weight portfolio) sub-period, monthly (2002-2007)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	8.64	15.49	19.49	r=0 or r=1	8.30	14.26	18.52
r≤1	0.34	3.84	6.63	r=1 or r=2	0.34	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	8.63	15.49	19.49	r=0 or r=1	8.63	14.26	18.52
r≤1	0.33	3.84	6.63	r=1 or r=2	0.33	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							
r=0	18.54	29.80	35.46	r=0 or r=1	10.98	21.03	25.86
r≤1	7.56	15.49	19.94	r=1 or r=2	7.55	14.26	18.52
r≤2	0.02	3.84	6.63	r=2 or r=3	0.02	3.84	6.63

Singapore (value weight portfolio) sub-period, monthly (2008-2009)

H_0	λ_{trace}	λ Trace statistics CV (5%)	CV (1%)	H_0	λ_{max}	λ Max statistics CV (5%)	CV (1%)
Panel A: Cointegration between p_t and d_t							
r=0	14.52	15.49	19.49	r=0 or r=1	11.63	14.26	18.52
r≤1	2.89	3.84	6.63	r=1 or r=2	2.89	3.84	6.63
Panel B: Cointegration between p_t and y_t							
r=0	10.77	15.49	19.49	r=0 or r=1	9.21	14.26	18.52
r≤1	1.56	3.84	6.63	r=1 or r=2	1.56	3.84	6.63
Panel C: Cointegration between p_t, d_t and y_t							

r=0	26.00	29.80	35.46	r=0 or r=1	12.22	21.03	25.86
r≤1	13.78	15.49	19.94	r=1 or r=2	8.74	14.26	18.52
r≤2	5.04	3.84	6.63	r=2 or r=3	5.04	3.84	6.63

Notes:

(1) All variables are inflation adjusted.
(2) p_t, d_t and y_t denotes the log of monthly stock price indices, dividend and earnings for value-weight portfolios from 1991-1997, respectively.
(3) r denotes the number of cointegrating vectors.
(4) The optimal lag lengths for VAR were chosen based on lag exclusion test and Akaike's Information Criteria.
(5) H_0 is the null hypothesis that there exist at most r cointegration vectors in the system.
(6) The cointegration tests are estimated under the assumption of trend in data and an intercept but no trend in the cointegrating equation.
(7) CV (5%) and CV (1%) are the critical values of the trace statistics and maximum eigenvalue statistics for the cointegration tests.