Duration Dependence Test of Rational Speculative Bubbles: A Case Study of Hong Kong Stock Market

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Duration Dependence Test of Rational Speculative Bubbles: A Case Study of Hong Kong Stock Market

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This study tests the presence of rational speculative bubbles in the Hong Kong stock market over a sample period from 1993-2008. Two sets of bubble attributes are examined, including traditional diagnostics for autocorrelation, skewness and kurtosis and duration dependence test using the Log-logistic hazard model and the Weibull hazard model.

Using abnormal monthly and weekly real returns of individual stocks listed on Hong Kong stock exchange, the results suggest that the Hong Kong stock market is not subject to rational speculative bubbles in before (1993-1997) and after (1998-2008) the 1997 Asian financial crisis. The evidence of skewness, autocorrelation and leptokurtosis is consistent with the presence of rational speculative bubbles. In contrast, tests for duration dependence show no evidence of duration dependence, indicating that the

Hong Kong stock market is not affected by rational speculative bubbles. The results also suggest that the tests are not sensitive to the choice of different models, monthly versus weekly runs of returns and equally- versus value- weighted portfolios in the Hong Kong stock market. The results of this study imply that the stock prices could be the reflection of the "fundamentals", but not "irrational" behavior of the investors in the Hong Kong stock market.

Keywords: duration dependence test, speculative bubbles, stock markets

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Chapter 1

Introduction

1.1 Introduction

Duration dependence developed by McQueen and Thorley (1994), is derived from the rational speculative bubble model and based on the statistical theory of duration dependence. A stock price bubble is defined as the asset price moving away from its corresponding fundamental value such as the dividend with unexplainable. (Allen and Bujang, 2009; Garber, 1990). According to the origin and nature of the process that generates price movements, there are different concepts of bubbles such as rational, deterministic, stochastic, collapsing, periodically collapsing and shrinking bubbles (Watanapalachaikul and Islam, 2007). This research focuses on the rational speculative bubble.

A rational speculative bubble is present if the stock prices persistently deviate from their fundamental value by a rational speculative bubble factor. The model of rational speculative bubbles allows the deviation of stock prices from their fundamental values without assuming irrationality on the part of market participants (McQueen and Thorley, 1994; Watanapalachaikul and Islam, 2007). There are two characteristics of speculative bubbles: a long run up in positive abnormal returns as a bubble, followed by a collapse in prices (crash) (McQueen and Thorley, 1994; Martin et al., 2004). In other words, a speculative bubble occurs when upswings are gradual and downswings are rapid, which in turn result in an asymmetric return pattern (Jirasakuldech and Zorn, 2002).

The original rational speculative bubble model was developed by Blanchard (1979) and Blanchard and Watson (1982). The asset price has two components: market fundamental part and bubble part. The assumption of the model is that investors expect the movement of asset price in a rational manner, without the error of systematic volatility. The variation of stock prices is due to the self-fulfilling expectations of speculators, regardless of its fundamentals. Although investors are aware of the stocks are overvalued and the possibility of bubble bursts, they believe that the expected value of the returns must be increasing and high enough to compensate for the possibility of a crash. Thus, the model shows the rationality of staying in the market despite the overvaluation (McQueen and Thorley, 1994; Martin et al., 2004). However, it is impossible that the rises in stock prices can be sustained in the long run. In fact, rational speculative bubbles are the effort of irrational behavior of investors because of excessive optimism or the occurrence of herd, eventually stock prices bubble will collapse or burst (Bohl, 2003; Cuthbertson, 1996).

The presence of bubbles has consequence of time-varying volatility, which influences the stock returns (Wu and Xiao, 2008). The fluctuation of stock prices caused by rational speculative bubbles can create stock market instability and inefficiency. The additional price risk will create economic crisis and recession as the financial flows will be diverted from investment in real capital to short-term investment (Watanapalachaikul and Islam. 2007). Therefore, the detection of bubbles and identifying the level of speculative bubbles may provide investors as well as policy makers a better understanding of the volatility and fluctuation of the stock markets (Hassan and Yu, 2000).

As McQueen and Thorley (1994) argued, for bubbles to be rational, the bubbles must be positive and explosive, combined with serially random innovations in fundamental value, the observed abnormal returns will exhibit duration dependence. Recent studies suggest that stock prices undergo cycles of expansion followed by a contraction exhibiting a fixed cycle length, which is inconsistent with the random walk theory (See Cochran and Defina, 1995; Harman and Zuehlke, 2006). The model proposed by Blanchard and Watson (1982) also indicates that the bubble has a deterministic behavior, whereas Weil (1987) assumes that it is random walk. Cochran and Defina (1995) argued that evidence of duration dependence provided evidence of predictability in stock prices. Based on this concept, the duration dependence test is employed to test for speculative bubbles in asset prices. Duration dependence test provides evidence of nonrandom behavior of stock prices that is consistent with the presence of bubbles.

A large number of approaches have been proposed to detect rational bubbles in stock prices and returns. This includes stationary (or non-stationarity) and cointegration test of the residuals between asset prices and market fundamentals (see Campbell and Shiller, 1987; Diba and Grossman, 1988a, 1988b), tests for bubble premium (see Hardouvelis, 1988; Rappoport and White, 1993) and tests for excess volatility and variance bounds tests or specification test (see Shiller, 1981; LeRoy and Porter, 1981; West, 1987). Another category of bubble tests is examined in the context of empirical attributes of stock returns such as autocorrelation, skewness and kurtosis.

However, there are shortcomings of the traditional bubble tests. For example, the results of cointegration tests have low power because it is sensitive to the data that are subject to size distortion or structural changes (Shiller and Perron, 1985; Brooks and Katsaris, 2003). Variance bounds tests and volatility comparison tests assume linearity relating all the observations using one set of parameters, whereas rational speculative bubbles suggest nonlinear patterns in returns (McQueen and Thorley, 1994; Jirasakuldech and Zorn, 2002). The lack of traditional bubble tests have make the conclusion of the evidence of rational speculative bubbles not effective, which is still ambiguous for various financial markets. The examination based on empirical attributes is also not unique to bubbles as many other factors that unrelated with bubbles can affect market returns (Chan, McQueen and Thorley, 1998; Hassan and Yu, 2000). Duration dependence test is different from other methods because it is flexible and has no requirement of the identification of fundamental factors and also no requirement that the time series have to be normally distributed (Abdul-Haque, Wang and Oyand, 2008; Jaradat, 2009; Jirasakuldech, Emekter and Rao, 2008). It is a joint test of the presence of bubbles and “no model misspecification” (Blanchard and Watson, 1982; Shiller, 1981; West, 1987).

Duration dependence test is a new testable implication for bubbles. The implication of McQueen and Thorley (1994) duration dependence test suggests that the probability that a run (sequence of observations of the same signs) of positive abnormal returns will end should decline with the length of the run (negative hazard functions). It suggests that if security prices contain bubbles, then runs of positive abnormal returns will exhibit negative duration dependence (decreasing hazard rates). That is, the conditional probability of a run ending, given its duration, is a decreasing function of the duration of the run.

The theoretic potential suggests that bubble tests should allow for nonlinearity, therefore, duration dependence tests address nonlinearity by allowing the parameters (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. Therefore, duration dependence test is conducted by analysing the hazard rate (h_i), which is the probability of observing a negative return $(\varepsilon_t<0)$ given a sequence of i prior positive returns $(\varepsilon_{t-1}<0)$. The model states that the presence of bubbles in security prices exhibit duration dependence in runs of positive abnormal returns. This means, the longer the bubble presents, the lower the hazard probability of a crash. In contrast, since bubbles cannot be negative, so bubbles do not generate duration dependence in runs of negative abnormal returns.

Duration dependence test has been widely applied and supported to investigate the presence of rational speculative bubbles in various academic fields, such as real estate market (see Lavin and Zorn, 2001; Das, 2007), business cycle (see Sichel, 1991; Zuehlke, 2003) and equity market (see McQueen and Thorley, 1994; Chan et al., 1998; Watanapalachaikul and Islam, 2007; Yu and Sze, 2003; Hassan and Yu, 2000; Mokhtar, Md.Nassir and Hassan, 2006).

The aim of this research is to verify the presence of rational speculative bubbles by testing duration dependence models on the Hong Kong stock market.

1.2 Research Problem Statement and Research Importance

According to Gürkaynak's (2008) study, it is difficult to detect bubbles precisely using traditional econometric tests because the indication of the presence of bubbles can still be explained by misspecified fundamentals. Deviation from normally distributed returns, time-varying volatility, and small sample sizes make the result of the tests inconclusive (Lunde and Timmermann, 2004). In addition, McQueen and Thorley (1994) indicated that diagnostic tests based on autocorrelation, skewness or kurtosis for bubbles are not unique to bubbles, because these attributes can also be associated with fundamental price movements. They argue that duration dependence test is more indicative of the existence of bubbles since it cannot be the result of asymmetric or leptokurtotic innovations in fundamental alone.

Most researchers who use duration dependence tests on the rational speculative bubbles focus on the US market. Although there are studies applied on developing and emerging markets, there is no comprehensive study exists addressing whether the stock price behavior is consistent with the characteristics of bubbles in the Hong Kong stock market. The current literature on rational speculative bubbles modeling in the Hong Kong stock market is quite limited. Hence, there is a need to correctly identify and analyze the existence of rational speculative bubble in the Hong Kong stock market by applying a suitable approach.

There are several substantial researches testing speculative bubbles in the Hong Kong stock market with different testing approaches, but they present a contradictory finding. For example, Yu and Sze (2003) conclude the existence of asset price bubbles in the Hong Kong stock market during 1974-2002 from the specification test and co-integration test. Their result is confirmed by Wu and Xiao (2008) with co-integration test. However, there is a lack of co-integration test in Wu and Xiao (2008) and Yu and Sze (2003)， and the result also could be interpreted as the reason for missing fundamental factors (Abdul-Haque et al., 2008; Jaradat, 2009; Jirasakuldech et al., 2008). In contrast, Chan et al. (1998) provide no significant evidence of rational bubbles in the Hong Kong stock market during the period 1975-1994 using duration dependence test. Yu and Sze (2003) confirmed Chan et al.'s (1998) result as well.

Compared to Chan et al. (1998) and Yu and Sze (2003) who also use duration dependence test in the Hong Kong stock market, this research will be more comprehensive for the following reasons. First, all the previous tests used Hang Seng Index which limit their analysis to index data rather than individual stocks, which are able to reflect all the stock price behavior. Second, by using time-series stock returns, a new model called Weibull hazard model will be employed that has not been used in other research to detect rational speculative bubbles in the Hong Kong stock market. Third, the time period for the previous studies are limited to 1990s, this study extends data period from 1993 to the ends of 2008. Finally, although the duration dependence test is unique to the bubbles, because of the sensitivity of duration dependence, the results will be impacted by the choice of sample period, the model and the use of data. Therefore, it is necessary to re-examine the existence of rational speculative bubbles in the Hong Kong stock market.

Hong Kong stock market is also affected by the government handover to China in 1997. Investors believed that the stock market would be interfered by the Chinese government (Chen, 1999). However, there is no previous research examines whether there is rational speculative bubbles for the following 10 years after the handover. This research re-examines the possible existence of rational speculative bubbles in the Hong Kong stock market.

This research will provide some important contribution for both the investors and policy makers. First, the results of this research will give insight regarding the identification of asset price bubbles in the Hong Kong stock market. Chan, Lee, and Woo (2003) argue that it is only necessary for the government to take control of the market fundamentals if the rational bubbles are not present. However, if bubbles exist, positive actions are needed to prevent the volatility of the market. Second, evidence of duration dependence provides the information that is predictable for the stock price behavior for investors. It also makes investors aware of the size of bubbles that is helpful to detect the possibility of stock crash (Brooks and Katsaris, 2005). In addition, this study will assess the impact of speculative bubbles on the identification of monetary tools and policy response. Finally, by recognizing the existence and level of price bubbles, it is helpful for policy makers to conduct further protection of the stock market and improve market efficiency through specific actions.

1.3 Research Objectives

Duration dependence test is unique for rational speculative bubbles, and there is no comprehensive study to verify the presence of rational speculative bubble using duration dependence test in the Hong Kong stock market. The research objectives are:

Objective One of this research tests whether rational speculative bubbles exist in the Hong Kong stock market from simple diagnostic test according to the rational speculative bubble model.

Objective Two of this research applies the duration dependence test using the Log-logistic model to detect rational speculative bubbles in the Hong Kong stock market.

Objective Three of this research applies the duration dependence test using the Weibull hazard model to detect rational speculative bubbles in the Hong Kong stock market.

Objective Four of this research compares the performances of the results as tested by value-weighted stock portfolios and equally -weighted stock portfolios.

1.4 Outline of the Thesis

This research consists of five chapters. Chapter One introduces the background of duration dependence test, rational speculative bubbles, the research importance and research objectives. Chapter Two provides an overview of the empirical researches relative to the research topic. Chapter Three describes the source of data and methodology use in this research describes the source of data and methodology use in this research. Chapter Four discusses the results obtained. Chapter Five gives the conclusion, results implications, and research limitation of the study.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews empirical researches using duration dependence test to identify the evidence of rational speculative bubbles in stock market worldwide. First, the propose of rational speculative bubble model will be reviewed including the characteristics of rational speculative bubbles based on the model. Second, studies on rational speculative bubbles in stock markets using duration dependence will be reviewed including the evidence of rational speculative bubbles in the US markets, the international stock markets and Asian markets. Further on, studies of rational speculative bubbles in the Hong Kong stock market are reviewed. Prior to reviewing the previous empirical studies on rational speculative bubbles with duration dependence test, studies using traditional approaches in the Hong Kong stock market are also discussed.

2.2 General Rational Speculative Bubble Model

The original rational speculative bubble model was developed by Blanchard (1979) and Blanchard and Watson (1982). The bubble model below follows the pattern described by McQueen and Thorley (1994).

In a standard "efficient market" condition, an asset's expected return equals to its required return.

Let $R_{t+1} = \dfrac{P_{t+1} - P_t + d_{t+1}}{p_t}$

Then $E\left[R_{t+1}\right] = r_{t+1}$ (1)

Where P_t is the price of the asset at time t, d_{t+1} is the dividend at time t+1 and r is the required rate of return.

Equation (1) implies that, in the competitive equilibrium condition, the current price equals the present value of expected future price plus the dividend, which is described as in Equation (2):

$$P_t = \frac{E_t\left[P_{t+1} + d_{t+1}\right]}{(1 + r_{t+1})} \qquad (2)$$

The fundamental value of the asset is shown in Equation (3), if Equation (2) is solved recursively:

$$P_t^* = \sum_{i=1}^{\infty} \frac{E_t\left[d_{t+1}\right]}{\pi_{j=1}^{i}(1 + r_{t+j})} \qquad (3)$$

That means, the price of an asset reflects market fundamental value of the assets.

However, financial market participants believe that fundamentals are not the only part that determines asset prices. There can be rational deviation of the price which is rational bubbles (Blanchard and Watson, 1982). The price may deviate from its fundamental value due to the size of the rational speculative bubble (Martin et al., 2004). Shiller (1978), Blanchard and Watson (1982) and West (1987) state that any price of the form,

$P_t = P_t^* + b_t$, where $E_t\left[b_{t+1}\right] = (1 + r_{t+1})b_t$

is a solution to the equilibrium condition as well. Therefore, the asset price has two components, a 'market fundamental' part, and a 'bubble' part. Thus, a rational speculative bubble exists when both the fundamental and the bubble components grow by at least the required rate of return. To meet equilibrium condition, the expected bubble value should be the same as the expected return, which rules out the possibility of profit-making arbitrage opportunities (Brooks and Katsaris, 2003; Gilles and LeRoy, 1992). However, the bubble component can be explosive that it does not grow at the require rate of return when investors demand higher returns (Blanchard, 1979).

Based on Blanchard and Watson (1982)there are two sources of uncertainty that determine the unexpected variation in prices: the unexpected variation of fundamental value and unexpected variation of rational speculative bubble. The model of rational speculative bubble is able to reflect the existence of bubbles through the features of distribution of asset prices or returns innovation on three aspects, which are skewness, autocorrelation and leptokurtosis.

Negative skewness

The rational speculative bubble model shows the rationality of staying in the market despite the overvaluation, as there is no arbitrage opportunity when there are rational bubbles (Gürkaynak, 2008). The unexpected total price innovation should be equal to zero in capital market efficiency hypothesis (McQueen and Thorley, 1994; Martin et al., 2004). However, the bubble component does not necessarily grow at the rate of return that makes the inherent skewness of the bubble innovations, even though the fundamental innovations are symmetric around zero.

The probability that a bubble grows must be greater than the probability of a crash to allow for small positive abnormal returns to compensate for the large negative returns when the market crashes (Jirasakuldech and Zorn, 2002). Suppose bubble survives with a probability of π, whereas the bubble bursts with a probability of (1-π). In order for the rational speculative bubble model to be consistent with the two characteristics of bubbles: a long run-up of positive abnormal returns and crashes, the probability of the bubble continuing, π, must be greater than 1/2. That is, if the bubble continues, its innovation is positive and small relative to an infrequent but large negative innovation when the bubble bursts, which reveals negative skewness (McQueen and Thorley, 1994; Chan, McQueen and Thorley, 1998).

Positive autocorrelation

According to rational speculative bubble model, the bubble appears when an asset price is increasing and there is a positive relationship between current price and expected future price movement. If the bubble grows, the observed excess returns can be positive and will tend to be of the same sign. The runs of positive excess returns will then tend to be longer. In contrast, the observed excess returns will turn out to be negative in the case of bubble collapse. Therefore, persistent runs of bubble induce positive autocorrelation for returns (Blanchard and Watson, 1982; McQueen and Thorley, 1994; Martin et al., 2004).

Leptokurtosis

In addition to skewness and autocorrelation, bubbles also induce kurtosis. The kurtosis is produced by mixing the distribution of probability of the price innovations. Extended small positive excess returns will be generated while bubble continues. In turn, there will be low variance return distribution. However, large negative excess returns will be generated while the crash happens which create high variance of return distribution (Blanchard and Watson, 1982; McQueen and Thorley, 1994). In addition, the smaller variance compared with higher variance will produce fatter tails (Martin et al., 2004).

The evidence of autocorrelation, skewness and kurtosis are normally used as a diagnostic test for the examination of bubble attributes. For example, McQueen and Thorley (1994) show that the value-weighted portfolio is negatively skewed, which is consistent with the bubbles model, whereas the equally-weighted portfolio is negative skewed only during post-World War Π subsample period, but positively skewed during pre-war period. The significant excess kurtosis and first-order autocorrelation coefficients are also consistent with the existence of bubbles. Chan et al. (1998) also find the characteristics of Asian stock return distributions are consistent with rational speculative bubbles based on the simple return summary statistics. The rational speculative bubble model implies negative skewness, positive autocorrelation and the return series are leptokurtic. Jaradat (2009) indicates that the ASE (Amman Stock Exchange) returns in Jordanian stock market exhibit significant skewness and leptokurtosis, which imply the possible presence of bubbles and stock price deviate from fundamental values. In addition, the rational bubbles model also implies positive autocorrelation in returns that strengthens the possibility of the presence of bubbles. More examples are also shown in the studies of Jirasakuldech and Zorn (2002), Zhang (2003), Yu and Sze (2003), Jirasakuldech, Emeker and Rao (2007), Hassan and Yu (2007) and Haque, Wang and Oyang (2008).

However, the attributes such as autocorrelation, skewness or kurtosis assume the stationarity and linearity of returns that are not unique for bubbles and are often associated with fundamentals (McQueen and Thorley, 1994). Based on Tauchen and Pitts (1983), skewness could result from asymmetric fundamental news and leptokurtosis could be a consequence of the batched arrival of information. In addition, skewness and kurtosis could also result from the change of economic or political fundamentals. Time-varying risk premium (see Fama and French, 1988), fads (see Poterba and Summers, 1998), non-synchronous trading (see Lo and Mackinlay, 1990a) and pure-psychological effects (see Westrhoff, 2003) could all induce positive autocorrelation.

For example, the results of duration dependence test of Chan et al. (1998) do not provide the evidence that is consistent with the diagnostic test on rational speculative bubbles. Although the returns are examined for positive autocorrelation, negative skewness and leptokurtosis, the return characteristics are less consistent with the presence of rational speculative bubbles when the duration dependence test is used. Therefore, diagnostic tests for bubbles based on positive autocorrelation, negative skewness and kurtosis are inconclusive.

2.3 Review of Studies on Rational Speculative Bubbles in Stock Markets using Duration Dependence Test

Duration dependence test is proposed by McQueen and Thorley (1994) and initially tested in the US stock market. Meanwhile, many researchers have supported duration dependence tests in many academic contexts. Literatures about duration dependence tests used for the detection of rational speculative bubbles in various stock markets are reviewed in the next section.

2.3.1 Evidence of rational speculative bubbles in US stock markets

McQueen and Thorley (1994) introduced duration dependence test as a new test for bubbles by employing abnormal continuously compounded real monthly returns for both equally- and value-weighted portfolios of all New York Stock Exchange (NYSE) stocks from 1927 to 1991 with discrete log-logistic function. To test duration dependence, abnormal returns are divided into positive and negative observed abnormal returns. For the runs of positive abnormal returns, β of equally-weighted portfolio is -0.283, which means that the probability that a run of positive abnormal returns comes to the end declines with the length of the run. The β of value-weighted portfolio -0.303 also rejects the no-bubble hypothesis. In addition, the actual hazard rates of the two portfolios data tend to decrease with the run length (negative hazard function), which implies the nonrandom behavior in monthly real returns that is consistent with the presence of a bubble and a decreased likelihood of negative abnormal returns. On the other hand, for runs of negative abnormal returns, β for both the equally-weighted and value-weighted portfolios are close to zero and the hazard rates are constant, which means the no-bubble hypothesis is not rejected at significant levels. Apparently bubbles do not generate duration dependence in runs of negative abnormal returns. McQueen and Thorley (1994) also conduct a sensitivity tests using three different time series and six different measures of the expected return, and also the linear-logistic model. The sensitivity tests report that more robust results can be obtained with equally-weighted portfolio and the rejection of the no-bubble hypothesis with equally-weighted portfolio is stronger than the value-weighted.

Jirasakuldech, Campbell and Knight (2006) test the presence of rational speculative bubbles for the NAREIT monthly price index and the Russell 2000 index. There is no increasing or decreasing pattern in the hazard rate either in REIT index or Russell 2000 index. Neither of the index show evidence of duration dependence, suggesting that TEIT markets and small stocks are not affected by rational bubbles.

In order to identify the sensitivity of duration dependence test for speculative bubbles to specific decisions, another study conducted by Harman and Zuehlke (2004) tested the evidence of rational speculative bubbles. Harman and Zuehlke's study is based on monthly abnormal returns of all NYSE stocks from 1927 to 1997 and weekly abnormal returns of NYSE-AMEX indices from 1963 to 1997. Abnormal returns are constructed for the value-weighted and equally-weighted portfolios and four different models are employed in their study including discrete hazard model and models for continuously duration and interval duration. With monthly data, both the discrete Weibull and Log-logistic models show evidences of speculative bubbles for value-weighted portfolios, which are consistent with McQueen and Thorley's (1994) hypothesis, but not for the equally-weighted portfolios. The different results of the equally-weighted portfolios from Harman and Zuehlke's (2004) study compared with McQueen and Thorley's (1994) are considered due to different sample period and likelihood ratio test statistic. On the other hand, with weekly data, although the estimated duration elasticity is negative, it is not significantly different than zero. Thus, neither of the models provides evidence of speculative bubbles, which is consistent with Chan et al.'s results. Therefore, the conclusion is that duration dependence test for speculative bubbles are sensitive to the choice of sample period, the models, the use of different portfolios and the use of weekly versus monthly returns.

2.3.2 Evidence of rational speculative bubbles in international stock markets

Since the shortcomings of traditional bubble tests, previous empirical tests on detection of rational speculative bubbles concentrating on developed and emerging stock markets still remains inconclusive (Hassan and Yu, 2000). Researchers extend the bubble tests using duration dependence tests in international stock markets.

Chan et al. (1998) further assessed the presence of rational speculative bubbles for monthly and weekly return on six Asian stock markets (Hong Kong, Japan, South Korea, Malaysia, Thailand and Taiwan) and the US stock market indexes, except for Korea and Malaysia which start in 1977. For the monthly returns, positive and negative excess returns are used that are defined relative to the in-sample mean. The runs of positive excess returns do not support the evidence of rational speculative bubbles in all stock markets. Because positive β is estimated in the markets of Japan, Taiwan and the US, although the estimates of β are negative in Hong Kong, South Korea, Malaysia and Thailand, the coefficients are insignificant. The runs of negative excess returns do not support the evidence of duration dependence in any of the stock market except Malaysia. However, since rational bubbles cannot be negative, the evidence of duration dependence is also rejected in Malaysia stock market. For the weekly returns, excess returns are defined relative to the sign of the error from a AR(4) model. The runs of positive excess returns exhibit significantly negative β in Thailand stock market, shows the evidence of rational speculative bubbles. However, rational speculative bubbles hypothesis is not rejected in other stock markets. Japan, South Korea and Taiwan show the evidence of duration dependence in runs of negative excess returns, but for the same reason that rational bubbles cannot be negative, the no-bubble hypothesis will not be rejected. The results confirm that the rational speculative bubbles do not exist in any of the sample stock markets except weekly returns in the Thai stock market, which provides an opposite conclusion of McQueen and Thorley (1994) findings.

Jirasakuldech and Zorn (2002) conducted a study from 1970 – 2000 focus on eight major international stock markets including the US, Canada, United Kingdom, Netherlands, France, Japan, Germany and Switzerland to test for the presence of bubbles. Duration dependence tests are implemented on monthly real returns for both dollar-denominated and local currencies. For runs of positive real returns with dollar-denominated currency, the no-bubble null hypothesis is rejected at the 5% significance level with β of -0.384 for Japan. Other countries also show negative β except UK and the Netherlands, but they have relatively small magnitude of the coefficients and not significant enough to be rejected. For runs of positive real returns with local currencies, the no-bubble null hypothesis cannot be rejected for all countries. Therefore, positive duration dependence is found in dollar denominated returns for Japan that is consistent with the presence of bubble. The authors also argue that the existence of bubble in Japan is more likely due to the low level of disclosure compared with other sample countries.

Hassan and Yu (2006) test rational speculative bubbles to the rapidly growing frontier emerging stock markets (Bangladesh, Botswana, Cote d'Ivoire, Ecuador, Ghana, Jamaica, Kenya, Mauritius and Trin. & Tobago). Because of the short sample period (1996-2003), nonparametric smoothed hazard functions are employed as they are more reliable to obtain the robust empirical results of duration dependence tests. The authors observe that the hazard rates of the nonparametric smoothed hazard functions are not monotonically decreasing, implying no rational bubbles in the frontier of emerging stock markets.

Further more, Hassan and Yu (2007) investigate the existence of rational speculative bubbles of eight stock markets in the MENA region, including Bahrain, Egypt, Jordan, Morocco, Israel, Oman, Saudi Arabia and Turkey. Still using nonparametric smoothed hazard functions, none of the functions is monotonically decreasing, implying no evidence of bubbles in the MENA stock markets, despite extreme fluctuation of the stock markets.

Yu and Hassan (2009) extend the literature to OIC (Organization of the Islamic Conference) countries to identify whether the OIC stock markets movements are driven by rational speculative bubbles from the perspectives of OIC and US investors. In this study, duration dependence test strongly reject the existence of bubbles, which is supported by nondecreasing nonparametric smoothed hazard functions. The results are identical between the perspective of both OIC and US investors.

Jaradat (2009) examines whether equity prices in the Jordanian stock market are characterized by rational speculative bubbles during sample period 1992 to 2007. The estimates of the duration dependence tests are examined on positive and negative runs of the real returns with Weibull hazard function. The ASE index has shown significant negative β of -0.0924 at 1% significance level in positive runs of returns. On the other hand, a positive β yields in negative runs of returns. Therefore, the returns of ASE index exhibit negative duration dependence in runs of positive returns, but not in runs of negative returns, consistent with the presence of rational bubbles.

2.3.3 Evidence of rational speculative bubbles in Asian stock markets

Because of the volatility of Asian stock markets especially during the 1997 Asian financial crisis period, there is speculation that the Asian markets contain bubbles.

Zhang (2003) examines whether or not the volatility of the markets represents the emergence and collapse of speculative bubbles and the nature of those bubbles. The author focuses on Shanghai Composite Index (SHG) and Shenzhen Composite Index (SHZ) from 1991-2001. Zhang's result shows weekly positive excess returns have significantly negative β, which confirm the rational speculative bubble hypothesis. However, there is constant hazard rate in negative excess returns.

Haque, Wang and Oyang (2008) examine whether the Chinese equity prices is characterized by the rational speculative bubbles from 1991-2007. By employing the weekly data from Shanghai com index and Shenzhen com index with both the Weibull hazard model and Log-logistic hazard model, the empirical finding suggests that Chinese securities prices experience some episodes of rational expectation bubbles during the sample period, which conform the results of Zhang (2003) about Chinese stock markets.

Recently, Lehkonen (2010) also employs duration dependence test for rational bubbles in Chinese stock markets and China-related share indices in Hong Kong. Both monthly and weekly abnormal market returns of Shanghai and Shenzhen A- and B-markets are tested, as well as the Hong Kong China Enterprise and China Affiliated Corporations indices. Mixed results are found that bubbles present in weekly data for both of the Mainland Chinese stock exchanges' share classes, whereas monthly data fail to find bubbles. Furthermore, bubbles are also not found in the Hong Kong Stock Exchange. It is noticed that there are no differences in terms of bubble existence between A-shares and B-shares in Chinese stock market. The results also verify the conclusion of Harman and Zuehlke (2004) regarding the sensitive of duration dependence to the use of weekly versus monthly returns. The results indicate no evidence rational bubbles in Hong Kong stock market with either monthly returns or weekly returns.

Mokhtar, Nassir and Hassan (2006) employ duration dependence test using both the Log Logistic hazard model and the Weibull hazard model in Malaysian stock market covering three time ranges: before the Asian financial crisis (1994-1996), during the Asian financial crisis (1997-1998) and after the Asian financial crisis (1999-2003). Their findings reveal the existence of rational speculative bubbles during pre- (1994-1996) and post- (1999-2003) crisis periods. In addition, they also discover that the size of bubbles during pre-crisis periods is larger than those during post-crisis periods in most indices (except for Composite Index and Trading and Services Index) in both models.

Ali, Nassir, Hassan and Abidin (2009) conducted another study for Malaysian stock market, rather than investigating bubbles only, the authors also investigate potential linkage between stock overreaction and bubbles. They use two hazard models to test the full sample period (1989-2006), pre-1997 Asian financial crisis and post-1997 Asian financial crisis respectively with monthly real returns. With Log logistic hazard model, there is a declining pattern of hazard rates for the full sample period in positive runs of abnormal returns, which suggests the presence of rational speculative bubbles. However, the positive β coefficient is not consistent with the existence of rational bubbles. Unlike the full sample period, the hazard rates of pre-crisis sub-period shows no distinguishable increasing or decreasing pattern in positive runs of abnormal returns. Accompanied with the positive β coefficient, the null hypothesis of no bubbles is also rejected. The pattern of hazard rates for post crisis sub-period is declining, which is consistent with the evidence of rational speculative bubbles. In conjunction with the relatively constant hazard rates in negative runs of abnormal return and negative β coefficient, the evidence of rational speculative bubbles is found in post crisis sub-period. Meanwhile, with Weibull hazard model, the findings are similar with those of log logistic hazard model. The no-bubble hypothesis is not rejected during full sample and pre-crisis sub-period. However, the results of post crisis sub-period suggest the presence of rational speculative bubbles. The results of full sample period and pre-crisis sub-period in Ali et.al's (2009) study are consistent with Chan et al. (1998) that Malaysia stock market is not subject to rational speculative bubbles. The result of post crisis sub-period is also consistent with Mokhtar et al. (2006), but contrary with them during pre-crisis sub-period. The authors also explain that stock overreaction behavior in pre-crisis period may be one of the reasons for the existence of rational speculative bubbles during the post crisis period.

Meanwhile, Allen and Bujang (2009) attempt to do a further detection of rational speculative bubbles in equity securities on the Malaysian stock market. Instead of using sectoral indices data, Allen and Bujang study uses a sample of 50 companies continuously listed on Main Board of Bursa Malaysia from 1994 to 2001. With those methods not employed by previous researchers, positive and negative abnormal returns are generated by the two factor model developed by Fama and French (1998) and conditional beta model developed by Ferson, Sarkissian and Simin (2008). Similar with the results of Mokhtar et al. (2006), both models suggest the existence of duration dependence. The authors also indicate that there is duration dependence in both positive and negative runs of abnormal returns. Consistent with Allen and Bujang's (2009) study, Chan et al. (1998) also found duration dependence in runs of negative excess returns in Malaysia. However, Chan et al. (1998) conclude that the negative duration dependence should be driven by other reason such as fads, but not by rational bubbles.

Jirsakuldech, Emeker and Rao (2007) confirmed the result of Chan et al. (1998) regarding Thailand stock market using the same model (Log-logistic) but with monthly returns for the full sample period from 1975 to 2006. Since a pattern of decreasing hazard rates and significant negative β are observed, they find strong evidence that equity prices depart from fundamental values during the full sample period. However, the sub-period results conform to the presence of rational speculative bubbles only in the pre-1997 period, but not in the post-1997 period. During pre-1997 sub-period with a β of -0.5641, the hypothesis of β=0 is rejected at the 5% significance level with the LRT (log likelihood test) of 5.0762. However, during post-1997 sub-period, the LRT is too small to reject the null hypothesis of no bubble although the estimated β is negative. Thus, the empirical findings suggest that the securities prices in Thai stock market experience rational speculative bubbles in pre-crisis period but not in the post-crisis period.

Watanapalachaikul and Islam (2007) also conduct a study on rational speculative bubbles in the Thailand stock market using Weibull hazard model and four time periods are analysed in their study. The overall study period provides evidence of rational speculative bubbles as a negative α is exhibited with both monthly and daily data. In addition, the presence of bubbles are also shown before the crisis period, and the size of bubbles is significantly high from 1993-1996. In contrast, the estimates provide no evidence of rational speculative bubbles after the crisis period, except 1997 and 1999.

Watanapalachaikul and Isla's study obtains relatively same results as Jirsakuldech et al. (2007) in Thailand stock market.

Rangel and Pilllay (2007) seek to extend the research of stock market bubbles in the Singapore. Using monthly excess returns, their results fail to detect the possibility of rational speculative bubbles as the β coefficient is not significantly different from zero for positive runs implying constant hazard rates. On the other hand, there is significant duration dependence exhibited in negative runs of excess returns. The results are consistent with Chan et al.'s (1998) results. However, the use of in-sample mean return as comparison with monthly real returns to determine a positive and negative run may be biased to the results. Thus, real prices are used in place of excess real returns. The results obtained show significant duration dependence for both positive runs as well as negative runs.

In conclusion, some of the studies apply duration dependence tests reveal the evidence of rational speculative bubbles in Asian stock markets especially during pre-Asian crisis period. However, there are still some other studies showing different results.

2.4 Review of Studies on Rational Speculative Bubbles in the Hong Kong Stock Market

There are some empirical researches explored the detection of rational speculative bubbles in the Hong Kong stock market. Tests with traditional approaches will be reviewed first, followed by the review of researches using duration dependence test.

2.4.1 Evidence of rational speculative bubbles with traditional approaches

Yu and Sze (2003) identify the bubbles in the Hong Kong equity market by employing specification test and co-integration test with monthly data of Hang Seng Index from 1974 to 2002. Both specification test and co-integration test generate similar results that confirm the existence of asset price bubble.

Wu and Xiao (2008) propose an alternative approach against traditional co-integration approach on the detection of speculative bubbles. The conventional unit root based tests may reject the null of a bubble by mistake if the market price contains a collapsible bubble. Wu and Xiao's (2008) study look at the fluctuations in the partial sum process of residuals from regressing asset prices on market fundamentals, and it has advantage to deal with collapse bubbles. The testing procedure is applied to weekly data of Hong Kong Hang Seng Index from 1974 to 1998. Two tests are conducted on the proposed procedure. In the first test, the null hypothesis that there is no bubble is rejected at the 5% level. In the second test, the null hypothesis is rejected at the 5% level for almost all cases but one. Overall, the two tests of Wu and Xiao's (2008) study indicate the possibility of bubbles in the Hong Kong stock market.

2.4.2 Evidence of rational speculative bubbles with duration dependence test

Chan et al. (1998) employs duration dependence test on the existence of rational bubbles on the Hong Kong stock market. The negative but not significant β for monthly data and positive β for weekly data do not provide evidence of rational speculative bubbles, which contradict the result obtained by Wu and Xiao (2008).

Yu and Sze (2003) also test the existence of speculative bubbles using duration dependence test. The estimated β for the full sample and first sub-sample (1974-1987) of monthly excess returns are negative. However, the likelihood ratio tests are insignificant. The estimated β for the second sub-sample (1987-2002) of monthly excess returns and full sample weekly excess returns are positive. Therefore, consistent with Chan et al. (1998), the null hypothesis of no bubble cannot be rejected.

2.5 Conclusions

There have been a number of studies testing for rational speculative bubbles in stock markets using duration dependence tests and different results have been obtained. The reason of mix results are normally attributed to the sensitivity of duration dependence tests in terms of the choice of different types of returns, testing periods and models.

Table 2.1 gives the summary of the empirical researches that have employed duration dependence tests on the test of rational speculative bubbles. The studies find contradicting conclusions in the US stock market. The possibility of the existence of bubbles is found in the stock market of China, Malaysia, Singapore and Thailand in some of the studies, especially during the pre-1997 Asian crisis period , but other studies show conflicting results.

In the Hong Kong stock market, the evidence from previous studies show that the rational speculative bubbles are absence with duration dependence test. However, there is still a lack of research and relatively much less is known about the existence of rationnal speculative bubbles. There is a need to identify and analyze the issue by applying an appropriate approach.

Table 2.1 Summary of Literature Review (with logistic model and weibull hazard model)

Authors	Period	Market	Return	Sample stocks	Model	Results
McQueen and Thorley (1994)	1927-1991	US	Monthly real returns & monthly abnormal returns based on the residuals of real return, TERM and D/P	All NYSE stocks	Log-logistic	Evidence of duration dependence in runs of positive abnormal monthly returns
Chan et al. (1998)	1975-1994	Asian and US	Monthly and weekly nominal returns & monthly excess returns defined relative to the in-sample mean; weekly excess returns defined relative to the sign of the error from AR(4) model	Stock markets indexes	Log-logistic	No evidence of duration dependence in any of the markets
Harman and Zuehlke (2004)	1927-1997 (monthly) 1963-1997 (weekly)	US	Monthly and weekly real returns & monthly abnormal returns based on base case; weekly abnormal returns determined by residual of AR(4) model	NYSE stocks and NYSE-AMEX indices	Log-logistic & Weibull hazard	No evidence of rational speculative bubbles in the monthly equally-weighted portfolio and weekly data. Consistent with the speculative bubbles in monthly value weighted portfolio

Authors	Period	Market	Return	Sample stocks	Model	Results
Jaradat (2009)	1992-2007	Jordanian	Monthly real returns	ASE index	Weibull hazard	Consistent with the presence of rational speculative bubbles
Jirasakuldech and Zorn (2002)	1970-2000	Eight countries	Monthly real returns	Stock price indices including dividend income	Log-logistic	Positive duration dependence is found in dollar denominated returns for Japan only
Zhang (2003)	1991-2001	Chinese	Monthly and weekly returns & weekly excess returns	Shanghai Composite Index and Shenzhen Composite Index	Log-logistic	Confirm the existence of speculative bubbles
Haque, Wang and Oyang (2008)	1991-2007	Chinese	Weekly real returns	Shanghai Composite Index and Shenzhen Composite Index	Log-logistic & Weibull hazard	Presence of rational speculative bubbles in the Chinese stock market
Mokhtar, Md.Nassir and Hassan (2006)	1994-2003	Malaysian	Abnormal monthly real returns	Bursa Malaysia Composite Index &Sectoral Indices	Log-logistic & Weibull hazard	The existence of bubbles during pre-(1994-1996) and post-(1999-2003) crisis

Authors	Period	Market	Return	Sample stocks	Model	Results
Ali et al. (2009)	1989-2006	Malaysia	Abnormal monthly real returns	KLCI Indexes	Log-logistic & Weibull hazard	No evidence of price bubbles during full sample and pre-crisis period; significant evidence of price bubbles during post crisis period
Lehkonen (2010)	1992-2008	Chinese and Hong Kong	Monthly and weekly nominal returns	SHA and SHB Indices; SZA and SZB Indices; HKE Indices; HKA Indices	Log-logistic	Bubble existed in weekly data but not monthly data in Mainland Chinese stock market; no bubbles in Hong Kong stock market
Allen and Bujang (2009)	1994-2001	Malaysia	Monthly aggregate returns	50 companies of Main Board KLSE	Log-logistic & Weibull hazard	Duration dependence in both positive and negative runs of abnormal returns
Jirasakuldech, Emekter and Rao (2007)	1975-2006	Thailand	Monthly real return	SET Index	Log-logistic	Rational speculative bubble in full sample period and pre-1997, no bubbles in post-1997.

Authors	Period	Market	Return	Sample stocks	Model	Results
Watanapalachaikul and Islam (2007)	1992-2001	Thailand	Monthly and daily data	SET Index	Weibull hazard	Rational speculative bubble in overall period and pre-crisis period, no bubbles in post crisis period, except 1997 and 1999.
Rangel and Pillay (2007)	1975-2007	Singaporean	Monthly excess returns defined relative to in-sample mean real return & monthly real prices	Straits Times Index	Log-logistic	*Excess return* No possibility of rational speculative bubble *Real price* Significant duration dependence for both positive and negative runs
Yu and Sze (2003)	1974-2002	Hong Kong	Monthly and weekly nominal return	Hang Seng Index	Log-logistic	No evidence of rational speculative bubbles

Chapter 3

Research Methodology

3.1 Introduction

This chapter presents the data used in this research and methodology in conducting the duration dependence tests. Research objectives are described in Section 3.2, and then a description of Hong Kong stock market is provided in Section 3.3. Data collection and sample data selected are presented in the following section. Finally, Section 3.5 will discuss how the data is grouped and finally the testing models are presented.

3.2 Research Objectives

The motivation of this research is to investigate whether rational speculative bubbles are present in the Hong Kong stock market.

Research Objective One tests whether rational speculative bubbles exist in the Hong Kong stock market from evidence of skewness, leptokurtosis and autocorrelation. According to McQueen and Thorley (1994) and Martin et al. (2004), the bubbles will be present if it represents positive autocorrelation, negative skewness and leptokurtoses. However, the concern of this test is that such statistical results may be driven by factors unrelated to bubbles (Chan et al., 1998).

Research Objective Two applies the duration dependence test using log logistic model to detect rational speculative bubbles in the Hong Kong stock market.

Research Objective Three applies the duration dependence test using Weibull hazard model to detect rational speculative bubbles in the Hong Kong stock market.

Objective two and three will be tested under the same hypothesis. If bubbles present in the Hong Kong stock market, a decreasing hazard rate or negative duration dependence is exhibited for runs of positive abnormal returns, whereas a constant hazard rate or no duration dependence for runs of negative abnormal return. Previous empirical studies that investigate on Hong Kong stock market employed data from Hang Seng Index. This research will use all the stocks listed on main board of Hong Kong Stock Exchange. In addition, the test period will be extended to year 2008, and will be divided into pre (1993-1997) and post-crisis periods (1998-2008).

Research Objective Four compares the performances of the results as tested by value-weighted and equally-weighted stock portfolios. The finding of McQueen and Thorley (1998) suggests that test using value-weighted portfolios is less robust than equally-weighted portfolios in the US stock market. The results of sensitivity tests are consistent with the findings of Lo and Mackinlay (1988) and Fama and French (1988).

3.3 Description of Hong Kong Stock Market

The Hong Kong Stock Exchange (HKSE) has been the main exchange of Hong Kong where shares of listed companies are traded. The first formal securities exchange in Hong Kong was established by Association of Stockbrokers in 1891, whereas informal securities exchanges took place since 1861. This exchange was renamed as Hong Kong Stock Exchange in 1914. The second exchange started in 1921, but was merged with the first in 1947 named Hong Kong Stock Exchange. In an attempt to properly regulate the security industry, an unified exchange was formed since HKSE merged with other four exchanges in 1986, and retained the name. In 2000, in order to increase competitiveness and meet the challenges of an increasingly globalize market, after a completion exchanges merger, Hong Kong Exchanges and Clearing (HKEx) became the holding company for HKSE (Advfn.com, 2010)

There are two trading platforms in HKSE securities market – the Main Board and the Growth Enterprise Market (GEM). As of 31 December 2007, HKSE had 1241 listed companies (Advfn.com, 2010; Wikipedia.org, 2010).

Today, in terms of market capitalization, HKSE is the 8th place in the world and the third largest stock exchange in Asia (Ho, Strange and Piesse, 2005; Advfn.com, 2010). Hong Kong stock market began to play an increasingly important role as a result of strong domestic economic growth. Over the recent 20 years, the performance of the market showed significant improvement reflected by the Hang Seng Index, but the market also demonstrated relative volatility (Ho et al., 2005). Chan et al. 's (1998) study exhibits higher standard deviation of monthly returns in Hong Kong stock market than other Asian stock market, which shows considerably high volatility in Hong Kong stock market. Moreover, the 1997 Asian financial crisis caused a sudden collapse in asset price. Wu (1997) finds that the bubble is able to explain a large proportion of the movement in stock prices. It is also argued that bubbles are indicative of economic crisis and recession. Herein there is a motivation whether the volatility of stock prices is attributed to the presence of bubble.

The following table lists general information of the Hong Kong Stock Exchange Main Board for the recent five years.

Table 3.2 Hong Kong Stock Market (Main Board)

(As of end of December)

	2009	2008	2007	2006	2005
No. of listed companies	1,145	1,087	1,048	975	934
No. of listed securities	6,441	5,654	5,896	3,184	2,448
Total market capitalization (HKD$Million)	17,769,271	10,253,588	20,536,462	13,248,820	8,113,333
Average P/E ratio (times)	18.13	7.26	22.47	17.37	15.57

(Source: Hong Kong Stock Exchange)

3.4 Data Collection and Sample Data

3.4.1 Sample period and sample stocks selection

The stock data is obtained from the DataStream Database, which is the world's largest financial statistical database. This research will test stock returns of the sample stocks listed on the Hong Kong Stock Exchange (Main Board) over the period June 1993 to December 2008. However, as a 3-month lag period is required for obtaining abnormal returns, the data will be collected starting from March 1993. Besides the full sample period, another two sub-periods are also included in the study including pre-crisis period (1993-1997) and post-crisis period (1998-2008). Further, based on Figure 3.1, it is observed that except for 1997, the price index also reached to a higher level between 2000 and 2007. Thus, if rational bubbles are not found during the post crisis period, we will determine if bubbles exist between 2000 and 2007 including 1999-2001 and 2007-2008 respectively.

Figure 3.1 Hang Seng Price Index

Stocks listed on GEM will be excluded in this study as GEM was established in 1999, whose history is too short to complete this study. The list of stocks on Main Board is obtained from Hong Kong Stock Exchange.

Both monthly and weekly data are collected for sample stocks. Both monthly and weekly returns are used for the following reasons. First, as documented in McQueen and Thorley (1994), monthly returns are less susceptible to noise, unlike weekly returns. Second, since there will be a lack of power in the shorter data series obtained monthly returns and weekly returns are used. Third, there is no clear indication about the length of a bubble, hence we use both of the returns in order to make our results more robust. Further more, Harman and Zuehlke (2004) find evidence of duration dependence is sensitive to the use of monthly versus weekly runs of abnormal returns, and this argument is further proved by Lehkonen (2010).

Because listed stocks varied in different periods, the sample stocks in this research will be chosen on the yearly basis from the data obtained. The sample stocks should have complete information of stock return index data at the end of the month and week t-1 during the testing period. Corresponding market value and dividend yield should also be available at the end of period t-1. The accounting information above is used to calculate nominal stock returns and abnormal returns in the next section.

For the listed stocks, delist or dead companies who have invalid data during the testing periods are excluded in the sample selection. The “zero-yield” stocks, those paying no dividends during the previous month, are also excluded from the sample. Since dividend yields are included in the calculation of abnormal return in the next section, and according to Fama and French (1993), the zero-yield stocks do not conform to any monotonic relation between dividend yield and expected return. Further deletion is applied if the stock data available is less than three months within a year as the data may not be significant for the test. The sample size of the selected stocks is listed in Table 3.2.

Table 3.3 Sample size of selected stocks

Year	Total number of listed stocks	Number of sample stocks	Total % of sample	Year	Total number of listed stocks	Number of sample stocks	Total % of sample
1993	403	334	83%	**2001**	773	395	51%
1994	453	359	79%	**2002**	772	392	51%
1995	480	377	79%	**2003**	766	390	51%
1996	519	395	76%	**2004**	756	401	53%
1997	600	392	65%	**2005**	752	442	59%
1998	633	449	71%	**2006**	737	445	60%
1999	665	397	60%	**2007**	726	436	60%
2000	722	368	51%	**2008**	718	442	62%

3.4.2 Monthly and weekly continuously compounded real returns

Following the studies of McQueen and Thorley (1994), Jaradat (2009), Ali et al. (2009) and Jirasakuldech et al. (2008), continuously compounded real returns are used for this research and that are obtained through the following steps:

3.4.2.1 Nominal return of individual stock

Continuously compounded monthly and weekly nominal returns are created first based on total return index of individual stocks that are collected from DataStream Database. Total return index is adopted instead of closing prices used by prior studies because it is the price level index plus that all dividends and distributions are reinvested. Nominal return for individual stock is calculated by taking the first difference of the nature log of the total return index.

3.4.2.2 Market nominal returns (Value- and Equally-weighted portfolios

Similar to as McQueen and Thorley (1994) and Harman and Zuehlke's (2004) studies, monthly and weekly market rate of returns are constructed for both equally-weighted and value weighted portfolios of HKSE stocks listed on the Main Board.

Equally-weighted market return is the average of the monthly or weekly nominal returns of all individual stocks. The value-weighted market return is a weighted average of all stock returns, with the weights given by the market value (share price times shares outstanding) of the stocks at the end of the previous trading period. Market value (or market capitalization) of all individual stock are obtained directly from the DataStream.

3.4.2.3 Real return of the two portfolios

The monthly and weekly equal-weighed and value-weighted market nominal returns calculated in Section 3.4.2.2 are translated into real returns. To calculate real returns, continuously compounded monthly inflation rates are generated based on Hong Kong Consumer Price Index (CPI), which is collected from DataStream. Continuously compounded monthly inflation rates are calculated by taking the first difference of the nature log of the monthly CPI. Real returns are then calculated by subtracting continuously compounded inflation rates from continuously compounded nominal returns of the two portfolios.

3.4.3 Monthly continuously compounded abnormal returns

The procedure of generating monthly continuously compounded abnormal returns are performed based on McQueen and Thorley (1994), Harman and Zuehlke (2004) and Ali et al.'s (2009) studies.

3.4.3.1 Dividend yield

The dividend yield for a given stock is computed as the sum of dividends per share paid during the previous year divided by the current price. Dividend yield of individual stocks are collected from DataStream. To perform abnormal returns, monthly value-weighted HKSE portfolio's dividend yield is calculated.

3.4.3.2 Term spread

Consistent with Fama and French (1989) and McQueen and Thorley (1994), term spread is the difference in yield-to-maturity between long-term yield and short-term yield. In this study, 2-year Hong Kong Exchange Fund Notes are used as the long-term yield, and 1-month Hong Kong Interbank Rates are used as short-term yield. Both yields are obtained from Hong Kong Monetary Authority.

3.4.3.3 Monthly abnormal returns

The sequence of real monthly abnormal returns is determined by the residuals from the regression of real returns on its first three lags, the term spread, and the dividend yield. Fama and French (1989) argue that the term spread and dividend yield are useful in predicting time-varying risk premia. Both the term spread and the dividend yield are measured at the end of the prior period.

3.4.4 Weekly continuously compounded abnormal returns

Because of the absence of weekly term spread data, construction of sequence of weekly continuously compounded abnormal returns followed the method of Chan et al. (1998) and Harman and Zuehlke (2004). Thus, weekly abnormal returns are defined as the residuals from AR(4) model of weekly real returns. Chan et al. (1998) argue that AR (4) model is preferable to imposing a common mean, because it enables one to control for short-term sources of autocorrelation.

3.5 Data Grouping

3.5.1 Summary statistics

According to the rational speculative bubble model, the evidence of skewness, kurtosis and autocorrelation are examined in summary statistics using all the time-series data. The test is conducted on continuously compounded real monthly and weekly returns for equally- and value-weighted portfolios of stocks, which are obtained from Section 3.4.2. The evidence of the existence of rational speculative bubble is indicated when there are negative skewness, kurtosis and positive autocorrelation of return series observed.

3.5.2 Duration dependence test

Duration dependence test performed on Log- logistic model and Weibull hazard model use the same data. Monthly abnormal returns are obtained according to the procedure discussed in Section 3.4.3, in which the abnormal returns are defined as the residuals from the following two regressions,

$$R_t^{EW} = -0.044 - 0.007TERM_{t-1} + 0.013D/P_{t-1} + 0.311R_{t-1}^{EW} + 0.122R_{t-2}^{EW} - 0.070R_{t-3}^{EW} + \varepsilon_t^{EW} \quad (3.1)$$
$$R_t^{VW} = -0.059 - 0.004TERM_{t-1} + 0.018D/P_{t-1} + 0.185R_{t-1}^{VW} + 0.151R_{t-2}^{VW} - 0.059R_{t-3}^{VW} + \varepsilon_t^{VW} \quad (3.2)$$

where R_t^{EW} and R_t^{VW} are the real continuously compounded monthly returns on the equally- and value-weighted portfolios, respectively. TERM is the term spread obtained from Section 3.4.3.2, D/P is the value-weighted dividend yield of all stocks obtained from Section 3.4.3.1. The regression coefficients are estimated using Eview with monthly real returns, TERM and D/P.

The weekly abnormal returns of value-weighted and equal-weighted portfolios are obtained based on Section 3.4.4, in which the abnormal returns are defined as the residuals from the following two regressions,

$$R_t^{EW} = -0.000625 + 0.080267R_{t-1} + 0.119069R_{t-2} + 0.051340R_{t-3} + 0.021079R_{t-4} + \varepsilon_t^{EW} \quad (3.3)$$
$$R_t^{VW} = 0.000264 - 0.085791R_{t-1} + 0.070772R_{t-2} + 0.04726R_{t-3} + 0.023183R_{t-4} + \varepsilon_t^{VW} \quad (3.4)$$

Both monthly and weekly abnormal returns are used for the whole sample periods, pre-1997 sub-periods and post 1997 sub-periods. However, for the periods of 1999-2001 and 2007-2008, monthly data is not sufficient for the short testing periods, thus, weekly data is used only for these two testing periods. The regression coefficients are estimated using with weekly real returns.

To apply the duration dependence tests, this study follows the method as adopted by Blanchard and Watson (1982), Evan (1986) and McQueen and Thorley (1994), in which abnormal returns are first required to transform into series of run lengths of two data sets , which are positive and negative observed abnormal returns for monthly and weekly data respectively. A run is defined as a sequence of abnormal returns of the same signs. For example, according to Table 3.3, from end of September 1993, the return series equal-weighted portfolio exhibit 1 negative abnormal return followed by 3 positive abnormal returns, then 3 negative abnormal returns and finally 2 positive abnormal returns. The return series are transformed into two data sets: a set for runs of positive abnormal returns with values of 3 and 2, and a set for runs of negative abnormal returns with values of 1 and 3.

Table 3.4 Examples of monthly equally-weighted portfolio abnormal return

Period (as end of)	**Abnormal return**
09/1993	-0.030
10/1993	0.138
11/1993	0.004
12/1993	0.111
01/1994	-0.076
02/1994	-0.077
03/1994	-0.034
04/1994	0.004
05/1994	0.039

The numbers of positive and negative runs of particular length *i* are then counted. Actual run counts do not include the partial runs which may occur at the beginning or at the end of period investigated. The sample hazard rates of runs of positive and negative abnormal returns are estimated based on the formula

$h_i = N_i/(M_i+N_i)$

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. Under the null hypothesis of no bubble or no duration dependence, we should observe a constant hazard rate, which implies that the abnormal returns exhibit a random walk in Hong Kong stock market. On the other hand, a decreasing hazard rate suggests the presence of rational speculative bubbles or duration dependence.

3.6 Testing Models and Hypotheses

3.6.1 Hazard rate (hi) and log-likelihood function

Duration dependence test is implemented by analyzing the hazard rate (*hi)* for runs of positive and negative abnormal returns. The hazard rate is defined as the probability of obtaining a negative innovation given a sequence of i prior positive innovations. If a bubble exists, the hazard rates are expected to be decreased with i in positive runs, that is, $h_{i+1} < h_i$ for all i. However, according to McQueen and Thorley (1994) rational speculative bubbles cannot be negative, the hazard rates should be constant in negative runs. Generally, if there is a negative relationship between the probabilities of positive runs of return to be ended and the length of the run, a more likelihood that the speculative bubbles is presented.

A discrete hazard model for duration is constructed for this study following McQueen and Thorley's (1994) method, and the log-likelihood function for a sequence of N runs is expressed as follows:

$$L(\theta / S_T) = \sum_{i=1}^{N} \left[N_i \mathrm{In} h_i + M_i \mathrm{In}(1 - h_i) \right] \qquad (3.5)$$

Where θ is a vector of parameters

S_T is the set of the data (T is the number of weekly or monthly observations on the random run length)

N_i is the number of completed runs of length i in the sample

M_i is the number of runs with a length greater than i

h_i the sample hazard rate, is the conditional probability of run ending at i, given that it lasts at least until i

To perform a test of duration dependence, a function form must be chosen from the hazard function for h_i. This study employs duration dependence test using both the Log- logistic and Weibull's hazard models for the detection of rational speculative bubbles. Both models will be used in order to ensure that the results are not sensitive to the underlying assumptions of a particular test and that they are not biased. The sample hazard rate for each length *i,* can be estimated from maximizing the log likelihood function of the hazard function

3.6.2 Log-logistic hazard model

Similar to McDonald et al. (1992, 1993, 1995) and McQueen and Thorley (1994), the Log-logistic function is defined as:

$$h_i = \frac{1}{1+e^{-(\alpha+\beta \ln i)}} \qquad (3.6)$$

Where β is the estimated coefficient of run length. This function transforms the unbounded range of α + β In(i) into a (0,1) space of h_i, the conditional probability of ending a run. The duration dependence test for logistic hazard function is performed by substituting Equation (3.6) into (3.5) and maximizing the log likelihood function with respect to α and β.

The dependent variable is 1, if the run ends; or 0, if the run does not end in the next period. The independent variable is the log of the current length of the run. The length of the run is counted in Section 3.5.2. Log-logistic test is an estimation of sample hazard rates and β.

In terms of the model, the following hypothesis is tested:

$H_0 \beta = 0$
$H_1 \beta < 0$

Generally, an estimate of β that is negative and significantly different than zero for positive runs, in conjunction with an insignificant estimate of β for negative runs, is considered evidence of speculative bubbles (Harman and Zuehlke, 2004).

3.6.3 Weibull hazard model

According to Harman and Zuehlke (2004), the Weibull hazard model is defined as:

$$S(t) = \exp(-\alpha t^{\beta t+1}) \quad (3.7)$$

Where *S(t)* is the probability of survival in a state to at least time *(t)*. The corresponding hazard function is:

$$h(t) = \alpha(\beta+1)t^{\beta} \quad (3.8)$$

or in log terms:

$$In\left[h(t)\right] = In\left[\alpha(\beta+1)\right] + \beta In(t) \quad (3.9)$$

Where, α is the shape parameter of the Weibull distribution, α>0

β is the duration elasticity[1] of the hazard function or the estimated coefficients of length of run in accelerate failure, $\beta > -1$

h(t) is defined as the conditional density function for duration of length t, given that duration is not less than t, $t > 0$

The fundamental assumption of the Weibull hazard model is a linear relationship between the log of the hazard function and the log of duration. The duration dependence test for Weibull hazard function is performed by substituting Equation (3.9) into (3.5) and maximizing the log likelihood function with respect to α and β.

In terms of the model, the following hypothesis is tested:

$H_0 \beta = 0$
$H_1 \beta < 0$

The likelihood ratio test (LRT) of $\beta = 0$ is asymptotically distributed χ^2 with one degree of freedom.

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

3.7 Conclusion

This chapter represents the research methodology used in this study, including the data collection, data grouping and testing models. Most data are collected from the DataStream database, except long-term yield and short-term lending yield of Hong Kong are obtained from Hong Kong Monetary Authority.

[1] The duration elasticity is defined as the derivative of In[h(t)] with respect to In(t) and represented graphically as the slope of the log-hazard function.

This study follows the method adopted by McQueen and Thorley (1994) for the monthly data. For the weekly data, the method adopted by Chan et al. (1998) is used in this study. Two test models are used, any number of hazard functions could be used in place of the Weibull or Logistic (Harman and Zuehlke, 2004).

Chapter 4

Results and Discussion

4.1 Introduction

This chapter reports the results of summary statistics for monthly data and weekly data respectively in Section 4.2. The tests are also constructed on two portfolios and five testing periods.

The results of duration dependence tests are also reported based on the Log-logistic hazard model and Weibull hazard model in Section 4.3. Because of the sensitivity of duration dependence test, the results will be compared based on different models, testing periods and the measure of market rate of returns. Finally, Section 4.4 compares the robustness of the value-weighted portfolio and equally-weighted portfolio on the results through sensitivity analysis.

4.2 Summary Statistics

Time series plots of the monthly real return of stocks listed on HKSE are provided in Figure 4.1 and 4.2. Both figures exhibit episodes of deeply downward trend in returns during 1997 and subsequent run-ups in the years 1998-1999 that reveal the burst and boom periods especially during Asian financial crisis. The real returns also experience persistent fluctuation during other periods.

Table 4.1 and 4.2 report the summary statistics for the monthly and weekly real returns respectively, for the two portfolios. There are three panels in each table, in which Panel A refers to the entire sample period, Panel B covers the pre-1997 Asian crisis period and Panel C covers the post 1997 Asian crisis period. According to the mean of real returns, the average monthly and weekly returns are relatively lower during pre-1997 sub-period, indicating that the Hong Kong stock market is affected by Asian financial crisis. However, the standard deviations of equally-weighted monthly real returns are stable among the different sample periods, whereas value-weighted monthly real returns produce a higher standard deviation during pre-1997 period. On the other hand, there is no big variation of standard deviation for weekly real returns. This implies the volatility of Hong Kong stock market is relatively stable all over the sample periods.

For the monthly data in Table 4.1, all the series are negative skewed and have significant excess kurtosis, which are consistent with the rational bubble model. The first-order autocorrelation coefficients are positive and statistically significant except the one value-weighted portfolio during pre-1997 sub-period. However, the negative coefficient with -0.020 is not significant from 0. In addition, the Ljung-Box (1978) Portmanteau test at lag 6 (Q6) and lag 12 (Q12) are positively correlated for all the series, which means the returns are serially correlated and not random. Therefore, the evidence of autocorrelation is also consistent with the existence of rational bubbles.

For the weekly data in Table 4.2, skewness and excess kurtosis provide the similar results as the monthly series. The strong evidence of negative skewness and significant kurtosis coefficients imply the existence of bubbles. All the series returns for equally-weighted portfolio provide positive first-order autocorrelation. Contrary to the equally-weighted portfolio, the value-weighted portfolio returns exhibit negative first-order autocorrelation. However, the Q(6) and Q(12) autocorrelation statistics do not reject the null hypothesis of no autocorrelation.

Overall, the monthly and weekly return series exhibit significant negative skewness and high kurtosis coefficients (or "fat tails" compared to normal distributions) which indicate the possible presence of bubbles. That evidence implies that stock price departures from fundamental values and changes occasionally by large amounts. The high kurtosis coefficients also imply that return may not be normally distributed and this is due to the mixing distribution of the returns associated with bubbles. Tests for serial independence in the different return series are observed with autocorrelation. Most of the first-order autocorrelation create positive autocorrelation coefficients, except one monthly value-weighted return series and all the weekly value-weighted return series produce negative autocorrelation coefficients. However, the Ljung-Box statistics for 6 and 12 lags for all variables show that Q(6) and Q(12) are inflated, implying that the sample autocorrelations are not close to zero and significant linear dependencies exist, which strengthen the likelihood of the presence of bubbles.

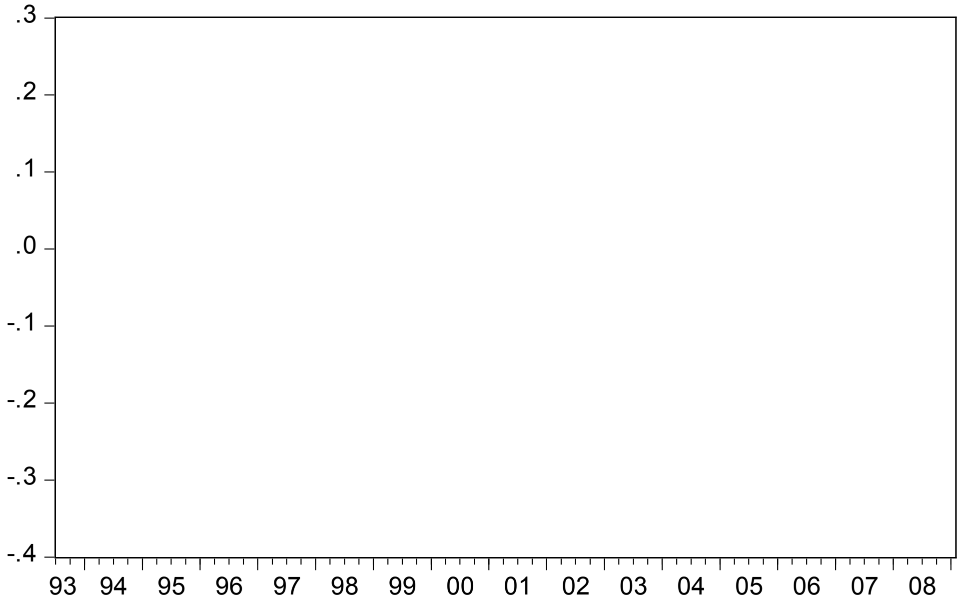

Figure 4.2 Plot of monthly real returns of equal-weighted portfolio from June 1993 to December 2008

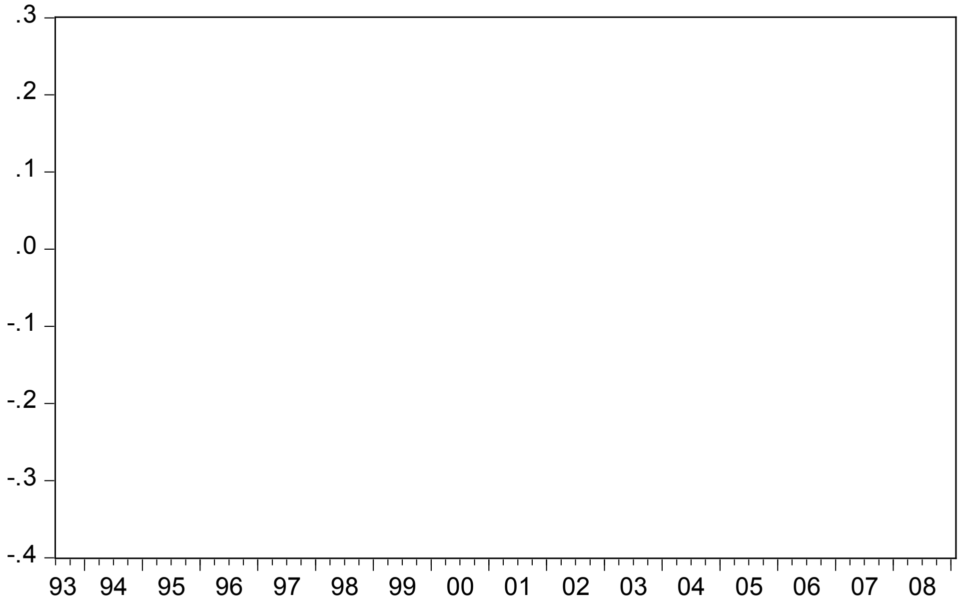

Figure 4.3 Plot of monthly real returns of value-weighted portfolio from June 1993 to December 2008

Table 4.5 Summary Statistics of Monthly Real Returns for Equally- and Value-Weighted Portfolios **Summary Statistics of Monthly Real Returns for Equally- and Value-Weighted Portfolios**

	Panel A: Full sample period (June 1993 – December 2008)		Panel B: Pre-1997 sub-period (June 1993 – December 1997)		Panel C: Post-1997 sub-period (January 1998 – December 2008)	
	Equally-weighted	Value-weighted	Equally-weighted	Value-weighted	Equally-weighted	Value-weighted
T	187	187	54	54	133	133
Mean	-0.004156	0.001517	-0.012567	-0.002428	-0.000741	0.003119
Standard Deviation	0.079768	0.075932	0.076609	0.091446	0.081048	0.068978
Skewness	-1.006836	-0.326334	-1.418490	-0.377386	-0.890109	-0.211317
	(0.179)	(0.179)	(0.333)	(0.333)	(0.212)	(0.212)
Excess Kurtosis	6.624319	5.695971	8.221048	5.439486	6.088919	5.062401
	(0.358)	(0.358)	(0.667)	(0.667)	(0.425)	(0.425)
ρ1	0.274	0.141	0.220	-0.020	0.283	0.253
ρ2	0.144	0.115	0.139	0.205	0.077	0.031
ρ3	-0.009	-0.070	-0.167	-0.127	-0.047	-0.076
ρ4	-0.072	-0.045	-0.058	-0.170	-0.012	0.090
ρ5	0.011	-0.034	-0.104	-0.083	0.041	-0.054
ρ6	0.072	-0.009	-0.127	-0.255	0.106	0.118
ρ12	-0.133	-0.139	-0.152	-0.106	-0.015	-0.007
Q(6)	20.240	7.8848	7.4238	9.7084	13.819	13.141
(P-value)	(0.003)	(0.247)	(0.283)	(0.137)	(0.032)	(0.041)
Q(12)	46.872	31.820	11.072	17.150	23.823	18.187
(P-Value)	(0.000)	(0.001)	(0.523)	(0.144)	(0.021)	(0.110)

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-value is the marginal significance level of the Ljung-Box test.

Table 4.6 Summary Statistics of Weekly Real Returns for Equally- and Value-Weighted Portfolios Summary Statistics of Weekly Real Returns for Equally- and Value-Weighted Portfolios

	Panel A: Full sample period (June 1993 – December 2008)		Panel B: Pre-1997 sub-period (June 1993 – December 1997)		Panel C: Post-1997 sub-period (January 1998 – December 2008)	
	Equally-weighted	Value-weighted	Equally-weighted	Value-weighted	Equally-weighted	Value-weighted
T	818	818	243	243	575	575
Mean	-0.000792	0.000358	-0.002844	-0.000553	7.53E-05	0.000743
Standard Deviation	0.033780	0.038923	0.029566	0.038172	0.035399	0.039262
Skewness	-1.301245	-1.016087	-1.937353	-1.172611	-1.156831	-0.957308
	(0.086)	(0.086)	(0.157)	(0.157)	(0.102)	(0.102)
Excess Kurtosis	13.30515	12.76018	13.38121	8.514470	12.96680	14.34506
	(0.171)	(0.171)	(0.314)	(0.314)	(0.042)	(0.042)
ρ1	0.101	-0.087	0.088	-0.052	0.103	-0.101
ρ2	0.135	0.076	0.241	0.160	0.102	0.047
ρ3	0.076	0.032	0.102	-0.002	0.048	0.033
ρ4	0.048	0.022	0.024	-0.073	0.027	0.033
ρ5	0.122	0.039	0.123	0.084	0.126	0.049
ρ6	0.027	-0.010	-0.007	-0.040	0.032	-0.010
ρ12	-0.039	-0.054	-0.037	-0.051	-0.072	-0.041
Q(6)	42.980	13.565	22.782	10.507	23.755	9.9886
(P-value)	(0.000)	(0.035)	(0.001)	(0.105)	(0.001)	(0.125)
Q(12)	55.798	20.128	36.961	21.137	30.469	15.225
(P-Value)	(0.000)	(0.065)	(0.000)	(0.048)	(0.002)	(0.229)

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-value is the marginal significance level of the Ljung-Box test.

4.3 Duration Dependence test

Tables 4.3 to 4.8 report the results of duration dependence test based on the Log-logistic model, whereas Table 4.9 and 4.10 report the results of duration dependence test based on Weibull hazard model. Each test model is conducted on monthly return series and weekly return series respectively. In order to obtain relatively more robust results, each test model also results for three testing periods and two portfolios.

4.3.1 Log- logistic model

4.3.1.1 Monthly return series

Table 4.3 (equally-weighted) and 4.4 (value-weighted) report the duration dependence test with the log logistic model for runs of monthly excess returns for the full sample period (June 1993 – December 2008). The positive and negative run counts are listed at each horizon. For the equally-weighted portfolio, there are 47 positive runs and 46 negative runs. The longest positive run lasts 9 month. However, the longest negative runs tend to be shorter, which lasts only 6 month. For the value-weighted portfolio, there are 44 runs on each of the positive and negative runs. The longest positive run lasts 8 month. The longest negative run is the same as equally-weighted portfolios. The run counts of the two portfolios suggest that more runs on positive runs tend to be more common in monthly abnormal returns.

Table 4.3 and 4.4 also report the sample hazard rates for the full sample period. The sample hazard rate is defined as $h_i = N_i/(M_i+N_i)$, which estimates the probability that a run ends at i, given that it lasts until i. For example, in Table 4.3, the hazard rate associated with a positive run length of 2 month is 0.5185. This is obtained by dividing the number of runs that last exactly 2 month (14 runs) by the number of runs that last at least 2 months (27 runs). The hazard rate of 0.5185 means that if a positive run persists for two consecutive months, there is a 51.85% probability that the bubble will bust in the next month.

According to the empirical implication of duration dependence, one characteristic of rational speculative bubbles is that the hazard rates should generate a decreasing function in runs of positive abnormal return. Meanwhile, the hazard rates for negative abnormal returns should be constant. However, in Table 4.3, the actual hazard rates tend to increase with run length for positive runs. It is observed that sample hazard rate in run length one is 0.4255, showing that of the 47 runs of positive abnormal returns in equally-weighted portfolio that last at least one month, there is 20 or a 42.55% probability that positive abnormal returns lasting for 1 month will revert to a negative abnormal returns in the second month. Then, of the remaining 27 runs, 14 or 51.85% end in the third month. Next, of the 13 remaining runs, 7 or 53.85% end in the fourth month. The hazard rate suddenly decreases at run length four, but increases again in the subsequent length. We find no increasing or decreasing pattern in the hazard rates of negative runs for equally-weighted portfolio. The increasing pattern of positive abnormal returns is inconsistent with the rational speculative bubble model prediction that does not suggest the presence of rational speculative bubbles for equally-weighted portfolio. In addition, McQueen and Thorley (1994) suggest that bubbles do not generate duration dependence in runs of negative abnormal return. On the other hand, as opposed to equally-weighted portfolio, the hazard rates of value-weighted portfolio in Table 4.4 exhibit different patterns. The hazard rates at horizons 1, 2, and 3 increases slightly for runs of positive abnormal returns (43.18%, 44% and 50%, respectively), and then decreases down to 25% for the following horizons. The positive runs reveal declining hazard rates with run length. The negative runs provide relatively constant hazard rates with run length. The pattern of decreasing hazard rates in positive runs for value-weighted portfolio is consistent with the rational bubble model prediction. However, to confirm the presence of rational speculative bubbles, the coefficient of β and LRT should be further analyzed.

The maximum likelihood estimates of the log-logistic function parameters α and β are reported as well. As shown in Table 4.3, the equally-weighted runs of positive abnormal returns exhibit positive β coefficient (β = 0.106), meaning that the probability of ending a run in positive abnormal returns increases with the length of the run. The positive β coefficient for the positive runs suggests positive duration dependence that is not consistent with the rational bubbles. The negative abnormal returns exhibit negative β coefficient (β = -0.071), which is also inconsistent with the rational bubbles. For the value-weighted portfolio, runs of positive abnormal returns yield negative β coefficient (β = -0.132), meaning that the probability of ending a run in positive abnormal returns decreases with the length of the run. Runs of negative abnormal returns yield positive β (β = 0.281).

The confidence intervals (p-value) are based on the LRT, which is the probability of obtaining the value of LRT or higher under the null hypothesis of no bubble (β =0). In Table 4.3 and Table 4.4, results of the likelihood ratio tests (LRT) of β are insignificant (P value; 0.74; 0.66). As a result, during the full sample period with the monthly data, no bubble hypothesis will not be rejected for the equally-weighted portfolio because of the significantly positive β found in positive runs of abnormal returns. For the value-weighted portfolio, although the estimated β is negative, the evidence based on the LRT makes the negative β coefficient insignificant. Therefore, the no bubble hypothesis is still not rejected.

Table 4.5 reports the results of duration dependence test with log logistic model for runs of monthly excess returns for the two sub periods. The results convey similar information to those of the full sample period. During the pre-1997 and post 1997 sub periods, both equally- and value-weighted portfolio yield positive β coefficients (0.765, 0.208, 0.278, 0.092) in positive runs. In negative runs, the equally-weighted portfolio yields negative β coefficient during pre-1997 period (β = -0.103) and positive β coefficient during post 1997 period (β = 0.174). The value-weighted portfolio yields positive β coefficient during pre-1997 period (β = 1.785) and negative β coefficient during post 1997 period (-0.024). However, both the negative β coefficients are not significant at conventional levels. Estimates of the results for the two sub periods fail to reject the hypothesis of no bubble.

In summary, during the full sample periods and the sub periods, the results do not support the evidence of the existence of rational speculative bubbles in Hong Kong stock market with the log-logistic models with monthly abnormal returns.

Table 4.7 Duration Dependence Test with Log-Logistic Model for Runs of Monthly Excess Equally-Weighted Portfolio Returns for the Full Sample Period

(June 1993 – December 2008)				
Run Length	Positive Runs		Negative Runs	
	Actual Run Counts Total = 47	Sample Hazard Rates	Actual Run Counts Total = 46	Sample Hazard Rates
1	20	0.4255	26	0.5652
2	14	0.5185	9	0.4500
3	7	0.5385	7	0.6364
4	1	0.1667	2	0.2500
5	4	0.8000	0	0.0000
6	0	0.0000	2	1.0000
7	0	0.0000		
8	0	0.0000		
9	1	1.0000		
Log-Logistic Test				
α	-0.217		0.197	
β	0.106		-0.071	
LRT of H0:β=0	0.10		0.03	
(p-value)	(0.74)		(0.86)	

1. A run of length i is a sequence of i abnormal returns of the same sign.
2. Positive and negative excess returns are defined relative to the residual from the regression of real returns on its first three lags, the term spread, and the dividend yield.
3. 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 is runs of length i and M_i is the count of runs with a length greater than i.
4. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the logit regression where independent variable is the log of current length of the run and dependent variable is 1 if the run ends and 0 if it does not end in the next period.
5. 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.
6. 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 4.8 Duration Dependence Test with Log-Logistic Model for Runs of Monthly Excess Value-Weighted Portfolio Returns for the Full Sample Period

(June 1993 – December 2008)				
Run Length	Positive Runs		Negative Runs	
	Actual Run Counts Total = 44	Sample Hazard Rates	Actual Run Counts Total = 44	Sample Hazard Rates
1	19	0.4318	22	0.5000
2	11	0.4400	13	0.5909
3	7	0.5000	5	0.5556
4	2	0.2857	2	0.5000
5	1	0.2000	1	0.5000
6	1	0.2500	1	1.0000
7	0	0.0000		
8	3	1.0000		
Log-Logistic Test				
α	-0.239		0.025	
β	-0.132		0.281	
LRT of H0:β=0	0.20		0.43	
(p-value)	(0.66)		(0.51)	

1. A run of length i is a sequence of i abnormal returns of the same sign.
2. Positive and negative excess returns are defined relative to the residual from the regression of real returns on its first three lags, the term spread, and the dividend yield.
3. 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 is runs of length i and M_i is the count of runs with a length greater than i.
4. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Ln i)}$. β is the hazard rate which is estimated using the logit regression where independent variable is the log of current length of the run and dependent variable is 1 if the run ends and 0 if it does not end in the next period.
5. 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.
6. 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 4.9 Duration Dependence Test with Log-Logistic Model for Runs of Monthly Excess Returns of Both Portfolios for Sub periods

		Positive Runs			Negative Runs		
		α	β	LRT(p-value)	α	β	LRT(p-value)
Equally-Weighted Portfolio	Pre-1997	0.288	0.765	0.54 (0.46)	0.053	-0.103	0.03 (0.87)
	Post 1997	-0.498	0.208	0.33 (0.57)	0.231	0.174	0.09 (0.76)
Value-Weighted Portfolio	Pre-1997	0.492	0.278	0.08 (0.77)	-0.178	1.785	2.59 (0.11)
	Post 1997	-0.691	0.092	0.07 (0.79)	0.050	-0.024	0.002 (0.96)

1. The likelihood ratio test follows the $\chi^2(1)$ distribution. The p-values are given in the brackets.

4.3.1.2 Weekly return series

Table 4.6 (equally-weighted) and 4.7 (value-weighted) report the duration dependence test with the Log -logistic model for runs of weekly excess returns for the full sample period (June 1993 – December 2008). The positive and negative runs for abnormal returns are counted. For the equally-weighted portfolio, a total of 380 runs comprising of 190 positive runs and 190 negative runs. The longest positive return run lasts for 10 months, whereas the longest negative run lasts for 9 months. Meanwhile, for the value-weighted portfolio, there are a total of 384 runs comprising 192 positive runs and 192 negative runs. The longest run for positive and negative abnormal returns last for 8 months. The run counts suggest that the maximum run length is similar for positive and negative abnormal returns in the same portfolio. However, the maximum run length for equally-weighted portfolio is longer than that of value-weighted portfolio.

Weekly sample hazard rates for the full sample periods are estimated in Table 4.6 and 4.7. For the equally-weighted portfolio, neither increasing nor decreasing pattern of hazard rate in positive runs is observed, meaning that the probability of the run ending is independent, regardless of the prior sequence. The hazard rate exhibits a relatively constant pattern in negative runs (see Table 4.6). The similar patterns of hazard rates are also observed in value-weighted portfolio. These patterns are therefore not consistent with rational speculative bubbles (see Table 4.7).

The maximum likelihood estimates of the log-logistic function parameters α and β are then discussed. For the equally-weighted portfolio in Table 4.6, it is noticed that the positive runs have a positive β coefficient (β = 0.086), and the negative runs have a negative β coefficient (β = -0.022). However, the LRT of the null hypothesis of no duration dependence result 58% significance level with the LRT = 0.31 for positive runs and 90% significance level with LRT = 0.02 for negative runs that make both the β coefficients insignificant. Similar findings are also reported with value-weighted portfolio. The β coefficient is 0.082 for positive runs at the 61% significance level with LRT = 0.27. The β coefficient is -0.059 for negative runs at the 74% significance level with LRT = 0.11. The results imply that β = 0 cannot be rejected, in turn indicate no evidence of rational speculative bubbles.

Table 4.8 reports the results when the duration dependence test is performed on two sub periods with log logistic model for runs of weekly excess returns. There is only one negative β coefficient observed in positive runs of return, which occurs in pre-1997 period for equally-weighted portfolio (β = -0.064). But the negative β is not significantly different from 0, and a high p-value of 83% with LRT = 0.05 is observed. In negative runs, two negative β coefficients are observed (-0.103 for the equally-weighted portfolio in post 1997 period and -0.148 for the value-weighted portfolio in pre-1997 period). Thus, the findings in the two sub periods suggest that the null hypothesis of no duration dependence or constant hazard rate cannot be rejected.

As discussed above, if the rational bubble is not found during the post crisis period, we have to test if bubbles exist during the periods between 1999-2001 and 2007-2008 using weekly data. According to Table 4.8, for the period 1999-2001, the negative β coefficients (-0.321 & -0.233) are obtained from both equally-weighted and value-weighted positive returns. However, the weekly results still fail to reject the no rational bubble hypothesis (p-value = 0.30 & 0.53). For the period 2007-2008, the equally-weighted portfolio returns yield negative β (-0.127) but with an insufficient evidence (p-value = 0.77). On the other hand, the value-weighted portfolio returns yield positive β, which does not support the evidence of rational bubbles as well.

In summary, as with the weekly returns, all the results finding in full sample period and sub periods do not exhibit bubble-like tendencies according to the value of β that do not provide the evidence of rational speculative bubbles.

To conclude the results obtained with log-logistic model, although there are slight different trends of hazard rate in various data and sample periods, the entire LRT tests provide low value of the likelihood ratio mean that the corresponding significance level is very high, implying that the β coefficients are not significantly different from zero. Therefore, there is no duration dependence or β = 0, the log logistic model does not imply the existence of rational speculative bubbles in the Hong Kong stock market.

Table 4.10 Duration Dependence Test with Log-Logistic Model for Runs of Weekly Excess Equally-Weighted Portfolio Returns for the Full Sample Period

(June 1993 – December 2008)				
Run Length	Positive Runs		Negative Runs	
	Actual Run Counts Total = 190	Sample Hazard Rates	Actual Run Counts Total = 190	Sample Hazard Rates
1	77	0.4053	96	0.5053
2	58	0.5133	49	0.5213
3	18	0.3273	21	0.46667
4	18	0.4865	14	0.5833
5	8	0.4211	3	0.3000
6	4	0.3636	4	0.5714
7	4	0.5714	1	0.3333
8	1	0.3333	1	0.5000
9	1	0.5000	1	1.0000
10	1	1.0000		
Log-Logistic Test				
α		-0.319		0.032
β		0.086		-0.022
LRT of H0:β=0		0.31		0.02
(p-value)		(0.58)		(0.90)

1. A run of length i is a sequence of i abnormal returns of the same sign.
2. Positive and negative excess returns are defined relative to the residual of the AR(4) model.
3. 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.
4. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Ln i)}$. β is the hazard rate which is estimated using the logit regression where independent variable is the log of current length of the run and dependent variable is 1 if the run ends and 0 if it does not end in the next period.
5. 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.
6. 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 4.11 Duration Dependence Test with Log-Logistic Model for Runs of Weekly Excess Value-Weighted Portfolio Returns for the Full Sample Period

(June 1993 – December 2008)				
Run Length	Positive Runs		Negative Runs	
	Actual Run Counts Total = 192	Sample Hazard Rates	Actual Run Counts Total = 192	Sample Hazard Rates
1	81	0.4219	100	0.5208
2	56	0.5045	45	0.4891
3	23	0.4182	19	0.4043
4	11	0.3438	15	0.5357
5	10	0.4762	6	0.4615
6	4	0.3636	5	0.7143
7	4	0.5714	1	0.5000
8	3	1.0000	1	1.0000
Log-Logistic Test				
α	-0.272		0.040	
β	0.082		-0.059	
LRT of H0:β=0	0.27		0.11	
(p-value)	(0.61)		(0.74)	

1. A run of length i is a sequence of i abnormal returns of the same sign.
2. Positive and negative excess returns are defined relative to the residual of the AR(4) model.
3. 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.
4. The log-logistic function is $h_i = 1/1 + e^{-(\alpha+\beta Lni)}$. β is the hazard rate which is estimated using the logit regression where independent variable is the log of current length of the run and dependent variable is 1 if the run ends and 0 if it does not end in the next period.
5. 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.
6. 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 4.12 Duration Dependence Test with Log-Logistic Model for Runs of Weekly Excess Returns of Both Portfolios for Sub period

		Positive Runs			Negative Runs		
		α	β	LRT(p-value)	α	β	LRT(p-value)
Equally-Weighted Portfolio	Pre-1997	-0.032	-0.064	0.05 (0.83)	-0.139	0.174	0.28 (0.60)
	Post 1997	-0.410	0.126	0.48 (0.49)	0.106	-0.103	0.23 (0.63)
	1999-2001	-0.202	-0.321	1.07 (0.30)	0.142	0.599	1.09 (0.30)
	2007-2008	-0.177	-0.127	0.08 (0.77)	0.271	-0.718	2.90 (0.09)
Value-Weighted Portfolio	Pre-1997	-0.377	0.089	0.10 (0.76)	-0.039	-0.148	0.23 (0.63)
	Post 1997	-0.233	0.086	0.20 (0.65)	0.065	0.005	0.00 (0.98)
	1999-2001	0.100	-0.233	0.39 (0.53)	0.248	-0.291	0.51 (0.47)
	2007-2008	-0.361	0.479	0.89 (0.35)	-0.337	0.265	0.29 (0.59)

1. The likelihood ratio test follows the $\chi^2(1)$ distribution. The p-values are given in the brackets.

4.3.2 Weibull hazard model

4.3.2.1 Monthly return series

Besides the Log- logistic hazard model, this research also employs the Weibull hazard model as a hazard function for duration dependence test. Results of the Weibull hazard model are presented in Table 4.9 for runs of monthly excess returns of the two portfolios. As discussed earlier, under the null hypothesis, β = 0, and β<0 under the alternative hypothesis. In Table 4.9, for the equally-weighted portfolio, all the β coefficients generated are positive in positive runs, in conjunction with high significant level, which means the β coefficients are not significantly different from zero. Negative β coefficients are obtained in negative runs for the full sample period and pre-1997 period, but not significantly different from zero. In addition, the value-weighted portfolio does not reject the null hypothesis of β=0 in full sample periods, as well as pre-1997 sub period and post 1997 sub period.

Table 4.13 Duration Dependence Test with Weibull Hazard Model for Runs of Monthly Excess Returns of Both Portfolios

		Positive Runs			Negative Runs		
		α	β	LRT (p-value)	α	B	LRT (p-value)
Equally-Weighted portfolio	Full sample period	0.424	0.054	0.10 (0.75)	0.570	-0.035	0.03 (0.85)
	Pre-1997	0.391	0.399	0.78 (0.38)	0.545	-0.057	0.03 (0.87)
	Post 1997	0.341	0.114	0.31 (0.58)	0.512	0.084	0.11 (0.74)
Value-Weighted portfolio	Full sample period	0.478	-0.077	0.20 (0.66)	0.473	0.069	0.43 (0.51)
	Pre-1997	0.560	0.105	0.09 (0.76)	0.321	0.55	3.59 (0.06)
	Post 1997	0.315	0.060	0.07 (0.79)	0.519	-0.013	0.003 (0.96)

1. The likelihood ratio test follows the $\chi^2(1)$ distribution. The p-values are given in the brackets.

4.3.2.2 Weekly return series

Table 4.10 reports the result of duration dependence test conducted on the Weibull hazard model for runs of weekly excess returns of the two portfolios. The weekly results convey similar information to those of the monthly results. For the equally-weighted portfolio, the estimated of β coefficient is positive (0.048) in positive runs, and negative (-0.011) in negative runs in full sample period. In sub periods, the β coefficient is negative (-0.032) in positive runs and positive (0.094) in negative runs in pre-1997 period. The β coefficient is also positive (0.073) in positive runs and negative (-0.049) in negative runs in post 1997 period. However, all the β coefficients are not different from zero because of the high significance level along with low LRT, regardless of whether the β coefficients are positive or negative. For the value-weighted portfolio, the β coefficients are positive in positive runs of returns (0.045, 0.052, 0.046) in all of the full sample period and sub periods. Negative coefficients (-0.031, -0.082) are obtained in negative runs of returns in full sample period and pre-1997 period, and post period coefficient is close to zero (0.002). Thus, for weekly abnormal returns, the null hypothesis of no bubbles cannot be rejected at the traditional significant level during all the testing periods.

Similar to the Log-logistic model, Table 4.10 shows the results of the bubble tests during 1999-2001 and 2007-2008 using the Weibull hazard model with weekly data. Both equally- and value-weighted positive returns yield negative β coefficients (-0.217 & -0.130) for the period 1999-2001, but the result is insignificant (p-value = 0.28 & 0.51). For the period 2007-2008, although the equally-weighted positive returns yield negative β (β = -0.082; p-value = 0.76), the estimated β is not significantly different from 0. The value-weighted positive returns yield positive β (0.240). Therefore, the results contradict the rational bubble hypothesis.

As a comparison to the results of the Log-logistic model, the Weibull hazard model presents similar results. The results indicate that there is no possibility of the existence of rational speculative bubble using Weibull hazard model, as the β coefficients for positive runs are not significantly different from zero implying constant hazard rates. In addition, the results do not exhibit significant duration dependence in runs of negative abnormal returns as well. Thus, the rational speculative bubble is not detected with the Weibull hazard model.

Table 4.14 Duration Dependence Test with Weibull Hazard Model for Runs of Weekly Excess Returns of Both Portfolios

		Positive Runs			Negative Runs		
		α	β	LRT (p-value)	α	β	LRT (p-value)
Equally-Weighted portfolio	Full sample period	0.402	0.048	0.30 (0.58)	0.514	-0.011	0.02 (0.90)
	Pre-1997	0.508	-0.032	0.04 (0.83)	0.424	0.094	0.30 (0.59)
	Post 1997	0.372	0.073	0.48 (0.49)	0.553	-0.049	0.23 (0.64)
	1999-2001	0.584	-0.217	1.19 (0.28)	0.426	0.253	1.18 (0.28)
	2007-2008	0.450	-0.082	0.10 (0.76)	1.173	-0.489	3.54 (0.06)
Value-Weighted portfolio	Full sample period	0.414	0.045	0.27 (0.61)	0.527	-0.031	0.11 (0.73)
	Pre-1997	0.387	0.052	0.10 (0.76)	0.535	-0.082	0.24 (0.62)
	Post 1997	0.423	0.046	0.20 (0.65)	0.515	0.002	0.00 (0.98)
	1999-2001	0.607	-0.130	0.43 (0.51)	0.682	-0.166	0.60 (0.44)
	2007-2008	0.333	0.240	0.88 (0.35)	0.354	0.163	0.33 (0.56)

1. The likelihood ratio test follows the $\chi^2(1)$ distribution. The p-values are given in the brackets.

4.4 Sensitivity analysis

The sensitivity analysis is conducted to measure the robustness of the results given by the equally-weighted portfolio and value-weighted portfolio, based on the strength of the p values.

Tables 4.11 and 4.12 summarize the results of the duration dependence test on log-logistic test and Weibull test, respectively. In Table 4.11, for the same sample period, although the result is sensitive to the choice of monthly versus weekly returns and different portfolios, the β coefficients are all insignificant because of the high level of p values. In Table 4.12, the Weibull test provides similar results of β coefficients compared with log-logistic test, which suggests that the results are not sensitive to the choice of the two models for the Hong Kong stock market. Moreover, given the high level of p values, all the β coefficients are not significant.

Overall, there is no difference between the robustness of the results tested on the equally-weighted and the value-weighted portfolio in the Hong Kong stock market, supported by high level of p values with low LRT. The evidence suggests that the β coefficients are not significantly different from 0, which is consistent with the null hypothesis of $\beta = 0$.

Table 4.15 Sensitivity Analysis of the Log-Logistic test for Duration Dependence

			Equally-weighted		Value-weighted	
			Positive	Negative	Positive	Negative
Monthly	Full sample	β	0.106	-0.071	-0.132	0.281
		LRT	0.10	0.03	0.20	0.43
		(p)	(0.74)	(0.86)	(0.66)	(0.51)
	Pre-1997	β	0.765	-0.103	0.278	1.785
		LRT	0.54	0.03	0.08	2.59
		(p)	(0.46)	(0.87)	(0.77)	(0.11)
	Post 1997	β	0.208	0.174	0.092	-0.024
		LRT	0.33	0.09	0.07	0.002
		(p)	(0.57)	(0.76)	(0.79)	(0.96)
Weekly	Full sample	β	0.086	-0.022	0.082	-0.059
		LRT	0.31	0.02	0.27	0.11
		(p)	(0.58)	(0.90)	(0.61)	(0.74)
	Pre-1997	β	-0.064	0.174	0.089	-0.148
		LRT	0.05	0.28	0.10	0.23
		(p)	(0.83)	(0.60)	(0.76)	(0.63)
	Post 1997	β	0.126	-0.103	0.086	0.005
		LRT	0.48	0.23	0.20	0.00
		(p)	(0.49)	(0.63)	(0.65)	(0.98)
	1999-2001	β	-0.321	0.599	-0.233	-0.291
		LRT	1.07	1.09	0.39	0.51
		(p)	(0.30)	(0.30)	(0.53)	(0.47)
	2007-2008	β	-0.127	-0.718	0.479	0.265
		LRT	0.08	2.90	0.89	0.29
		(p)	(0.77)	(0.09)	(0.35)	(0.59)

Table 4.16 Sensitivity Analysis of the Weibull test for Duration Dependence

			Equally-weighted		Value-weighted	
			Positive	Negative	Positive	Negative
Monthly	Full sample	β	0.054	-0.035	-0.077	0.069
		LRT	0.10	0.03	0.20	0.43
		(p)	(0.75)	(0.85)	(0.66)	(0.51)
	Pre-1997	β	0.399	-0.057	0.105	0.55
		LRT	0.78	0.03	0.09	3.59
		(p)	(0.38)	(0.87)	(0.76)	(0.06)
	Post 1997	β	0.114	0.084	0.060	-0.013
		LRT	0.31	0.11	0.07	0.003
		(p)	(0.58)	(0.74)	(0.79)	(0.96)
Weekly	Full sample	β	0.048	-0.011	0.045	-0.031
		LRT	0.30	0.02	0.27	0.11
		(p)	(0.58)	(0.90)	(0.61)	(0.73)
	Pre-1997	β	-0.032	0.094	0.052	-0.082
		LRT	0.04	0.30	0.10	0.24
		(p)	(0.83)	(0.59)	(0.76)	(0.62)
	Post 1997	β	0.073	-0.049	0.046	0.002
		LRT	0.48	0.23	0.20	0.00
		(p)	(0.49)	(0.64)	(0.65)	(0.98)
	1999-2001	β	-0.217	0.253	-0.130	-0.166
		LRT	1.19	1.18	0.43	0.60
		(p)	(0.28)	(0.28)	(0.51)	(0.44)
	2007-2008	β	-0.082	-0.489	0.240	0.163
		LRT	0.10	3.54	0.88	0.33
		(p)	(0.76)	(0.06)	(0.35)	(0.56)

4.5 Conclusion

This chapter discusses the results obtained from simple diagnostic test and duration dependence test to answer the objectives of this research.

According to the summary statistics, the evidence of skewness, kurtosis and autocorrelation are found. Consistent the presence of bubbles, the market generally has significant negative skewness in returns, the return series are leptokurtic and positive autocorrelation in returns are found for both monthly and weekly returns on the equally-weighted and the value-weighted portfolio and during the full sample period and pre-1997 and post 1997 sub periods. The result of diagnostic test is similar with the result of Chan et al. (1998), showing the possibility that bubbles could exist in the Hong Kong stock market. However, the evidence is not conclusive because the results could still be generated by other factors that are unrelated to bubbles

The duration dependence test on the Log-logistic model illustrates that rational speculative bubbles are not found in the Hong Kong stock market. A major characteristic of the maximum likelihood estimates of the hazard function show that almost all the β coefficients have quite p value along with the small LRT test, regardless whether the β is positive or negative. This characteristic of LRT test is consistent with the results of Yu and Sze (2003), demonstrating that the β coefficients are not significantly different from zero. To extend the study of Chan et al. (1998) and Yu and Sze (2003), the results from the Log- logistic test of this study do not reject the null hypothesis of no bubbles confirming the results of their studies that the Hong Kong stock market is not subject to rational speculative bubbles.

The duration dependence test on the Weibull hazard model strongly supports the results obtained from the Log-logistic model. This study fails to reject the null hypothesis of no rational speculative bubble (β=0) at the traditional significant levels in positive runs for the full sample period and pre-1997 and post 1997 sub periods. Additionally, the result also confirms with the implication of rational speculative bubble model by McQueen and Thorley (1994), where there is no evidence of rational speculative bubbles in the negative runs of returns, the rational speculative bubbles cannot occur in runs of negative abnormal returns.

The results of the post 1997 period indicate that there is no rational speculative bubbles exist in the Hong Kong stock market after the Asian financial crisis. However, based on the trend of Hang Seng Price Index in Figure3.1, there are several episodes revealing the bubble suspicion. Chan et al. (1998) state that the duration dependence bubble tests lacks the power to detect bubbles if only one bubble occurred during the sample period. In other words, the duration dependence tests may avoid the "data snooping" problems (see Lo and Mackinlay, 1990b) associated with the periods the bubbles are suspected. Therefore, we conduct further rational bubbles tests for the period 1999-2001 and 2007-2008 using weekly data, because weekly returns yields more observations than the monthly returns. Neither of the models suggests that the rational bubbles present in the Hong Kong stock market.

McQueen and Thorley (1994) suggest that the equally-weighted portfolio is more robust than the value-weighted portfolio. The value-weighted portfolio is less robust and is sensitive to the method used. However, in this study, there is no difference of the robustness of the results between the two portfolios, according to the insufficient evidence of p values.

Chapter 5
Conclusion, Limitations and Future Research Direction

5.1 Introduction

This chapter summarizes the findings of this study on the detection of rational speculative bubbles in the Hong Kong stock market. Section 5.2 describes an overview of the study. Section 5.3 discusses the results and implications of the study. The conclusion of the study is provided in Section 5.4 and Section 5.5 infers the policy implication according to the results. Limitations of the research are discussed in Section 5.6. Finally, Section 5.7 gives the recommendation for future research.

5.2 Overview of the study

There has been persistent interest on the bubbles in stock markets. Researchers find that stock prices that exhibit high volatility are difficult to be explained by movements in fundamental variables, such as earning, dividends and interest rates (see Shiller, 1981). Therefore, speculative bubbles are introduced to explain the empirical features of the stock returns (see Flood and Hodrick, 1986; Camerer, 1989). Rational speculative bubbles are also considered as one of the reasons for poor market performance during the past few years (Moosa, 2003; Fox, 2001). Thus, reliable empirical evidence of bubble tests can provide investors as well as policy-makers to better understand the stock market behavior.

There have been a number of studies on the test for speculative bubbles in the stock markets, but the results are ambiguous and the bubble detection is difficult because of the shortcomings of the traditional tests (Gürkaynak, 2008). This study uses the duration dependence test developed by McQueen and Thorley (1994) to further test the rational speculative bubbles in the Hong Kong stock market. Duration dependence test is unique for rational speculative bubbles and has been widely used in financial markets. Differing from traditional tests, it does not require the identification of underlying fundamental factors.

The purpose of this study is to detect the existence of rational speculative bubbles in Hong Kong stock market from 1993 - 2008. Four research objectives are addressed in this study. Objective Ones of this research tests whether rational speculative bubbles exist in the Hong Kong stock market from the evidence of skewness, leptokurtosis and autocorrelation. Objective Two applies the duration dependence test using log logistic model to detect rational speculative bubbles in the Hong Kong stock market. Objective Three applies the duration dependence test using Weibull hazard model to detect rational speculative bubbles in the Hong Kong stock market. Objective Four compares the performance of the results as tested by value-weighted stock portfolios and equally-weighted stock portfolios.

This research employs both Log-logistic and Weibull hazard models, value-weighted and equally-weighted portfolios of returns and both monthly and weekly data as a robustness check and a sensitivity test for the duration dependence test. This study uses continuous compounded real returns computed as the first difference of the natural log of total return index (nominal return) subtract the first difference of the natural log of the Hong Kong CPI (inflation rate). The residuals from the regression of monthly real returns on its first three lags, the term spread, and the dividend yield are then generated for monthly abnormal returns. Following this, weekly abnormal returns are generated from the residuals from AR(4) model of weekly real returns. Monthly and weekly abnormal returns are further classified into positive and negative runs for the calculation of hazard rates. Duration dependence test are then implemented when maximizing the log likelihood function of the hazard function to obtain β coefficients. The likelihood ratio test (LRT) of $\beta = 0$ is asymptotically distributed χ^2 with one degree of freedom. In order to analyze the robustness of the results tested on equally-weighted and value-weighted portfolio, a sensitivity analysis is established based on the measurement of p value.

5.3 Results of this study and implication

5.3.1 Result for objective one and implication

The characteristics associated with skewness, leptokurtosis and autocorrelations conform to the strong evidence that is consistent to the rational speculative bubble model. We observe statistically significant negative skewness, excess kurtosis and positive autocorrelations on both monthly and weekly real returns for all the testing periods.

The evidence of negative skewness and kurtosis imply that there are small positive returns when bubbles are continuous but large negative returns when the bubbles collapse. The excess kurtosis implies that there is small variance in the positive returns compared to the total variance of observations. In addition, compared to normal distribution, the returns exhibit "fat tails", as indicated by the significant kurtosis coefficient. Fat tails of stock market returns imply that stock price departures from fundamental values and price changes occasionally deviate by large amounts, which induce higher variance. Positive autocorrelations imply the nonnormality of returns.

The evidence of diagnostic test is consistent with the finding of Chan et al. (1998) and partially consistent with Yu and Sze (2003) on the results of skewness (weekly series only) and kurtosis (both monthly and weekly data series).

However, the attributes of skewness, leptokurtosis and autocorrelations are not sufficient condition to demonstrate the presence of rational speculative bubbles. Hence the results are not statistically significant and have low statistical power in the detection of the rational bubbles. Many other factors that are not directly related with bubbles can affect the market returns as well.

5.3.2 Result for objective two and three and implication

The duration dependence tests yield different results. Estimates of the duration dependence test on the Log-logistic model provide evidence against the presence of rational speculative bubbles for both monthly and weekly data over a period between 1993 and 2008, where almost all β coefficients are positive in the positive runs of abnormal returns. The positive beta coefficients indicate that the probability the positive abnormal returns will end increases with the length of the run, which is contradictory to the rational bubbles theory. However, the positive beta coefficients are not significant because of the high p value. In addition, the hazard rates do not exhibit either increase or decrease hazard rates with run length. Therefore, the hazard function is indicated to be independent of the length of the positive abnormal returns. When the study split the period into two sub-periods, pre-1997 Asian crisis and post 1997 Asian crisis, the results still do not support the presence of rational speculative bubbles in the Hong Kong stock market. In order to avoid "snooping" biases for the long testing period, years of 1999-2001 and 2007-2008 which are suspected to have bubbles are still involved for the further test. However, the results fail to reject the no rational bubble hypothesis.

Similar results are also found when Weibull hazard model is employed in this study. The existence of bubbles is strongly rejected, supported by nondecreasing hazard function. These findings imply that rational speculative bubbles do not exist in stock price of Hong Kong stock market. The results of duration dependence test are consistent with the study of Chan et al. (1994) and Yu and Sze (2003).

5.3.3 Result for objective four and implication

Harman and Zuehlke (2004) conclude the sensitivity of the duration dependence test for different data and models. However, we find that sensitivity of duration dependence test does not apply to Hong Kong stock market significantly.

According to the results in Tables 4.11 and 4.12, we find that the β coefficients (positive or negative β) is similar between Log- logistic model and Weibull hazard model for the same testing period and return portfolio. In addition, there is also no distinct difference between the results of monthly data and weekly data on the same model. Further more, although the results of positive or negative of β coefficients between equally-weighted and value-weighted portfolios are slightly different in some area for the same model and same data series, the high level of p value with low LRT makes all the β coefficients are insignificant and close to zero.

Therefore, based on the sensitivity analysis, duration dependence test is not sensitive to the use of different models and data series. McQueen and Thorley (1994) state that equally-weighted portfolio is more robust than value-weighted portfolio to obtain the results in the US stock market. However, this conclusion is not applicable to the Hong Kong stock market because of the relative high marginal significance level (p- value) for all the likelihood ratio, which is in line with the p value in the likelihood ratio test in Yu and Sze's (2003) study.

5.4 Conclusion

In conclusion, although the results of the diagnostic test are consistent with the existence of rational speculative bubbles, the duration dependence tests did not show any evidence to support rational speculative bubbles in the Hong Kong stock market, and the results do not differ between the different models and return portfolios and data series.

The duration dependence test of this study conform to the result of Chan at al. (1998) and Yu and Sze (2003), but contradict the findings of Yu and Sze (2003) using specification test and co-integration test, in which the existence of asset price bubble in the Hong Kong stock market is confirmed. However, the co-integration test mainly rely on expectations of future steams of dividends, it utilizes linear rational expectation model of stock price and assumes that the expected real return of stock equals a constant required real rate of return, but does not account for volatility of stock prices (Diba, 1985; Leroy and Porter, 1981; Shiller, 1981). On the other hand, the problem of specification test arises from observing rational bubbles separately from the market fundamentals of the asset price (Diba, 1985). Due to the lack of co-integration test and specification test, duration dependence test is considered more reliable to obtain robust results.

The rational speculative bubble is not found in the Hong Kong stock market may due to the following reasons. The Hong Kong stock market experiences several fluctuations, evidenced by Hang Seng Price Index shown in Figure 5.1. According to the characteristics of rational speculative bubbles, if the bubble periods are rational, the returns are not only high, but also explosive, and accompanied with a suddenly crash associated with the bubbles. In Figure 5.1, it is noticed that during the year 1997 and 2000-2001, there is an increase in stock prices, but the run-up is not followed by a sharp and persistent crash as indicated by the trend of price index. For example, the Hang Seng Index in Figure 5.1 reached the highest level at the beginning of August 1997, and then lost momentum after September 1997. Further, the index climbs up for a short period in October before falling down again. It appears that the crash does not conform to the instantaneous crash according to the theory of rational bubbles.

This implies that even when the bubble exists in the Hong Kong stock market, the bursts are relatively slow, which is uncharacteristic of rational speculative bubble. In fact, Chan at el. (1998) conduct an anecdotal test for the suspected bubble period in the Hong Kong stock market. The anecdotal evidence indicates increasing and explosive returns that is consistent with bubbles, but not instantaneous crash as required by the rational bubble theory. Second, besides the rational speculative bubble model, there are broader concepts of bubbles including the fads model proposed by Summers (1986), manias and panics proposed by Kindleberger (1989) and random speculative bubble by Weil (1987). There is possibility that the Hong Kong stock market is characterized by other types of bubbles rather than rational speculative bubbles.

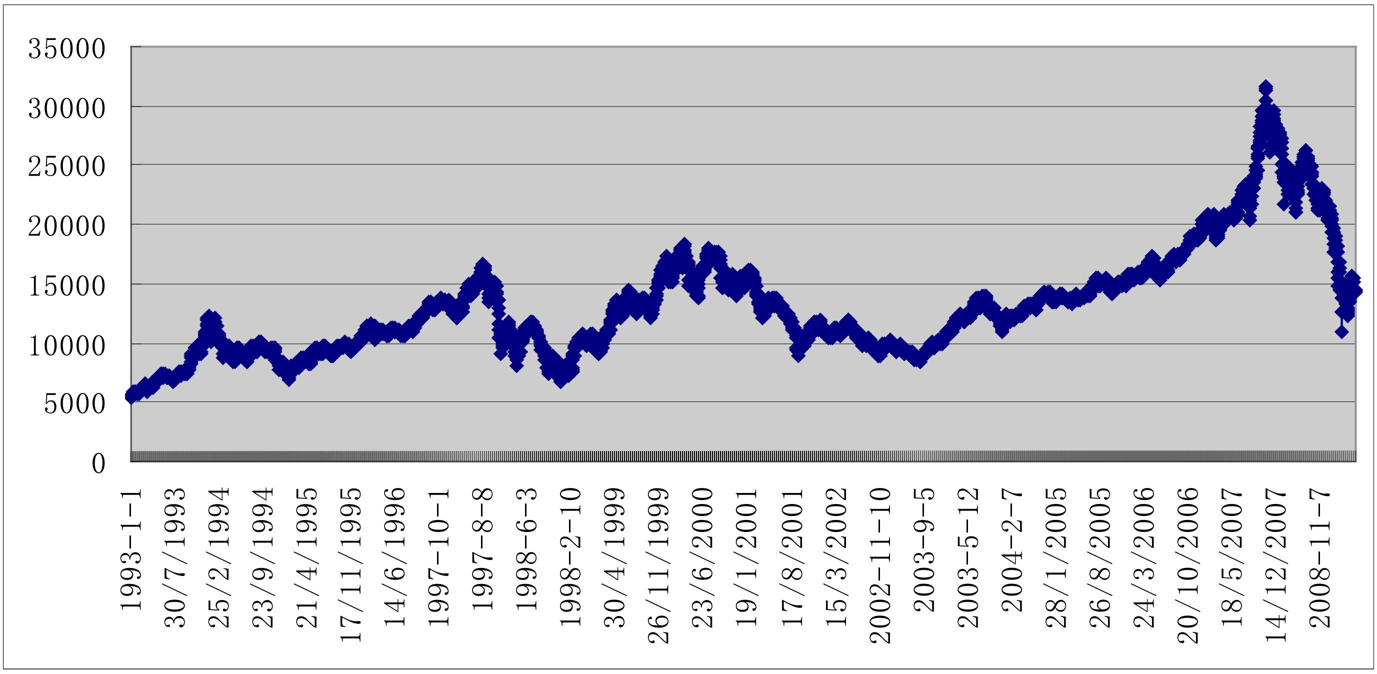

Figure 5.1 Hang Seng Price Index (Daily)

5.5 Policy Implication Inferred by the Results

Kim and Mei (2001) conclude that political developments in Hong Kong have a significant impact on market volatility and returns, that is, the unexpected returns jump in the market are associated with political news. The results of this study provide several implications to policymakers on the efficiency of the Hong Kong stock market so the policymakers would provide guidance to the investors to act rationally by adjusting the share prices in the future.

Bernanke and Gertler (1999) point out that it is important in the first step to distinguish between fundamental and non-fundamental fluctuation in asset prices. This study shows that there is no empirical evidence on the existence of rational speculative bubbles in the Hong Kong stock market for the year 1993 until 2008. According to the inference of Kroszner (2003), the result implies that the stock prices could be the reflection of the "fundamentals", but not "irrational" behavior of the investors. Chan et al. (2003) explicate that if rational bubbles are not present, the fluctuation of stock prices do not accord with market fundamentals which are attributed to the misspecification of market fundamentals. Thus, it is only necessary for policy makers to manage the market fundamentals because the stock prices are measured with error in the market and the policymakers should filter the new information about the firm's prospects quickly embedded into its price (Kroszner, 2003; Tetlow and Muehlen, 2005).

In the context of policy controlling market fundaments on the protection of market efficiency, there are several aspects that the policy makers should pay attention to. First, Bernanke and Gertler (1999) suggest that the best policy framework to achieve price and financial stability is maintaining flexible inflation. Thus, this target induces policy makers to adjust interest rate to off set incipient inflationary or deflationary pressure. To reduce the share price bubbles, interest rate is raised as asset prices rise and interest rate is reduced when asset prices fall (Bernanke and Gertler, 1999 & Mokhtar et al., 2006). In addition, Yu and Sze (2003) and Kroszner (2003) also mention that enhancing the transparency of the equity market would make the information easily accessible to investors that are able to reduce information asymmetry to prevent bubbles. Finally, the development of financial infrastructure such as the payment systems and the constructing derivative products based on price jumps may help hedge the political risk (Kim and Mei, 2001; Yu and Sze, 2003).

However, it is still difficult for policy makers to determine if the asset prices are exhibiting bubbles or reflecting market fundamental. Accurate and reliable research models are still required for the further studies of the stock market behavior.

5.6 Limitations

5.6.1 Length of sample period

The sample period of this study covers from June 1993 to December 2008, which is 15 years. The length of the sample period is limited by one of the original data source (2-year Exchange Fund Notes issued in May 1993) to calculate the monthly abnormal return. The period of 15 years is shorter than the study of Chan et al. (1998) and Yu and Sze (2003) which conduct duration dependence test from 1974-2002 and 1975-1994 respectively, although their studies still do not show evidence of rational speculative bubbles in Hong Kong stock market.

However, compared with the previous studies, this study has extended the test period to year 2008 and this is the first study to test the behavior of individual stock instead of Hang Seng Index, which is the main contribution of this study. Moreover, this is also the first study to test the behavior of Hong Kong stock market on the reflection of government handover and Asian financial crisis simultaneously.

5.6.2 Number of stocks

First, the sample stocks used in this research is obtained from DataStream database. However, due to the limitation of the data source in DataStream, it does not involve every stock listed on Hong Kong stock exchange. As in 2010, there are around 1100 stocks listed on Main Board of Hong Kong stock exchange, but only around 700 stocks data are obtained from DataStream. However, the percentage of the collected stocks over the total amount of stocks is high enough to convince the results. Therefore, the results of this study won't be affected even though the whole amount of stocks is collected.

Second, this study employs the stocks listed on Main Board of Hong Kong Stock Exchange. However, there is another market which is Growth Enterprise Market (GEM) which is established in 1999. The stocks listed in GEM are not included in this study as the history of GEM is short and not involved in the 1997 Asian financial crisis. Further, the availability of GEM stocks is limited in the DataStream, only few stocks are found in the database. Therefore, for future study, the sample size after 1999 could be increased by expanding the sample stocks including all the stocks listed on both of the Main Board and GEM.

5.6.3 The lack of duration dependence test

Duration dependence test is applied in this study with discrete hazard model. However, Sichel (1991) argues that a discrete hazard model may not be appropriate as the underlying durations are continuous in fact. The author suggests using continuous hazard model because it accounts for the errors in the measurement of duration. In Harman and Zuehlke's (2004) study, three types of hazard models are employed for the duration dependence test including continuous hazard model, interval hazard model and discrete hazard model. Their study concludes that the results are sensitive to the choice for discrete and continuous duration in the US stock market. Further studies can test if the authors' results are different when applying continuous hazard model.

Furthermore, duration dependence test is not sufficient to investigate the beginning and bursts of the bubbles when the bubbles are found in the stock markets. Chan et al. (1998) point out that the bubble literature is silent about how and why rational bubbles begin and why and when they end.

5.7 Future Research Directions

Based on the limitations, there are some recommendations for future research direction. First, multiple data source and longer research period could be applied to improve the sample size. Since the calculation of abnormal return in this study is based on the residual of real return, TERM and dividend yield, the testing period is limited by the source and availability of data. If the research period is expected to expand or obtain more comparable results, other types of returns could be considered in the test such as excess returns based on in-sample mean of returns adopted by Chan et al. (1998), Yu and Sze (2003) and Rangel and Pillay (2007) and nominal returns used by Lehkonen (2010), but nominal returns eliminate the influence of CPI.

Second, the major problem of testing rational speculative bubbles using duration dependence test in the Hong Kong stock market shows the β coefficients to be statistically insignificance. In addition, the results show that for the Hong Kong stock market, duration dependence tests are not sensitive to the different models, monthly versus weekly data and equally- and value- weighted returns. Therefore, it would be preferable to employ another method for the bubbles together with the duration dependence test such as variance bounds test, integration/cointegration based test or fractional integration test.

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