

**This is an electronic reprint of the original article.
This reprint *may differ* from the original in pagination and typographic detail.**

Author(s): Lehtonen, Heikki

Title: Bubbles in China

Year: 2010

Version:

Please cite the original version:

Lehtonen, H. (2010). Bubbles in China. *International Review of Financial Analysis*, 19(2), 113-117. <https://doi.org/10.1016/j.irfa.2010.01.005>

All material supplied via JYX is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of the repository collections is not permitted, except that material may be duplicated by you for your research use or educational purposes in electronic or print form. You must obtain permission for any other use. Electronic or print copies may not be offered, whether for sale or otherwise to anyone who is not an authorised user.

Bubbles in China

Heikki Lehkonen*

School of Business and Economics, University of Jyväskylä, Po-Box 35, 40014
Jyväskylä, Finland

Abstract

This study examines rational bubbles in Chinese stock markets and China-related share indices in Hong Kong. A duration dependence test is employed for both monthly and weekly abnormal market returns of the Shanghai and Shenzhen A- and B-markets as well as for the Hong Kong China Enterprises and China Affiliated Corporations indices. The test results are mixed, as weekly data demonstrate bubbles for all of the Mainland Chinese stock markets, but monthly data do not show bubbles for any of the examined markets. Neither of the datasets indicates bubbles in the Hong Kong markets. Results indicate that, in terms of bubbles, segmentation does not play a significant role in bubble existence and that the stock markets of Mainland China behave similarly but cannot be compared to the more developed markets of Hong Kong. In the light of the results, the argument that duration dependence test is sensitive to the use of weekly versus monthly data, can also be generalized to emerging markets. Thus for consistent bubble results, it is recommendable to employ the duration dependence test to both weekly and monthly data together with fractional integration test.

JEL classification: G14; C41; C52

Keywords: Duration dependence; Rational bubbles; Chinese stock market

* Tel. +358 14 260 2956

E-mail address: heikki.lehkonen@jyu.fi

1. Introduction

China's stock market has been under an intensive investigation during the last decade. Its ever-growing size and importance to the world's capital markets and especially to the development of East Asia as well as its unique characteristics have gained the interests of both scholars and practitioners. This research studies the presence of stock market bubbles in Chinese stock markets by examining both of China's stock exchanges, Shanghai and Shenzhen, and their A- and B-share markets. For the comparison, also the China-related share indices of Hong Kong are studied. Using of weekly and monthly dataset works both as a robustness check and simultaneously as a sensitivity test for duration dependence method that is used for bubble testing.

Since the founding of the stock markets of China at the beginning of 1990s, they have experienced, together with China's economy, a tremendous growth. The number of stocks has increased from 13 in 1990 to 1434 in 2006 and the market capitalization has grown from \$1.3 billion to more than \$1000 billion during the same time. When measured with market capitalization, China is the second biggest economy in Asia-Pacific region after Japan and the most important emerging market in the world. An explosive growth of China's stock markets between 2005 and 2007 led investors to suspect of an existence of a bubble in the markets. However, a steep decline between 2007 and 2008 wiped away these suspicions. So far there has not been a systematic study on whether the bubble really burst or was there still air in the prices after the decline. This paper aims to clarify this situation.

For academics, China's stock markets create an interesting research environment since they have several unique characteristics. Due to historical reasons, until year 2006, a typical firm's shares were split into state shares, legal-entity shares and tradable shares from which only tradable shares, which accounted about 30% of all shares, were tradable in stock exchanges. The stock exchanges themselves, located in Shanghai and Shenzhen, are segmented into A- and B-share classes which are all studied in this research. A- and B-shares are similar in the sense that they have the same voting rights and earn the same dividends, however A-shares cost about four times more than B-shares (Fernald and Rogers, 2002). A-stocks were originally intended only for the Mainland Chinese while B-stocks were meant for foreigners. The boundaries have afterwards diminished, since in 2001 the Mainland Chinese were allowed to invest in B-stocks and in 2002 a Qualified Foreign Institutional Investor program was established allowing certain foreign institutions to invest in A-shares. However, there still exist differences between the stock classes. For example, Tan et al. (2008) report that the A-share markets are dominated by domestic individual investors who typically lack the knowledge and experience in investing while the B-markets are dominated by more sophisticated foreign institutional investors. In addition, Jacobson and Liu (2008) have found that an A-share stock market can be better categorized as a developed market than as an emerging market, while the results for B-shares are the opposite. For this comparison, the China-related indices from Hong Kong's more efficient and more developed stock markets are also studied. Eun and Huang (2007) mention also that the stock markets of China are claimed to be chaotic, rather irrational and inefficient. Thus the environment is suitable for a development of a bubble and due to the short selling prohibition, the bubble bursting would cause losses to

all investors and the effects could also reach the countries under China's influence, especially Asia's emerging markets.

The last contribution of the study is related to bubble testing. This paper employs the duration dependence test developed by McQueen and Thorley (1994) which has gained prominence in bubble testing during the last decade and has been used, for example, by Zhang (2008). By using weekly and monthly data, both, the robustness of the results and the sensitivity of the test to the data choices can be examined.

So far, market bubbles in China have been studied with daily (Ahmed et al., 2006), weekly (Zhang, 2008) and monthly (Ling et al., 2007; Sarno and Taylor, 1999) data, and the results have been rather similar: a bubble has developed in Chinese stock markets. While the time period for the previous studies is mostly limited to the 1990s, with Zhang (2008) reaching 2001, this study extends the data period from the beginning of 1990s all the way to the end of 2008, and thus takes into account the steady decrease in the market in the beginning of the 21st century, the explosive growth that followed, and the steep decline of the indices after October 2007 mainly resulting from the global economic crisis.

At the moment, many existing bubble tests have one thing in common: they are not very good at detecting bubbles (Gürkaynak, 2008). The duration dependence test can overcome most of the criticisms laid against the traditional bubble tests; its advantages are that it is unique to bubbles, it addresses nonlinearity and it does not require the correct identification of the observable fundamental variables. However, Harman and Zuehlke (2004) have examined the method using securities data from the New York and the American Stock Exchanges and recognize several sensitivities resulting from the specification decisions of the test. They have found inconsistency in the results obtained using weekly and monthly data. Thus, in order to increase the robustness of the results and also to study the sensitivity of the duration dependence method in an emerging market, this research studies bubbles using both weekly and monthly data. Zhang (2008) also uses both datasets, but does not report the duration dependence results of monthly data at all.

The results of the bubble tests are mixed. For weekly data, bubbles can be found in both of the Mainland Chinese stock exchanges' share classes. However, monthly data do not confirm these results, as they fail to find bubbles in any of the studied markets. Neither dataset reveals bubbles in the Hong Kong Stock Exchange. Though the results leave the question of bubbles in China still open, they provide evidence that the segmentation of the markets does not play a significant role in bubble existence. It can also be concluded that China's stock markets have not yet reached the efficiency level of the Hong Kong stock exchange and neither of their share classes can be categorized as developed when categorizing is done according to the existence of bubbles. In addition, the results expand the conclusions of Harman and Zuehlke (2004), regarding the sensitivity of the duration dependence test for the use of different data periods, to also concern emerging markets. Thus the duration dependence test should be used carefully and the results should be confirmed by using at least both, weekly and monthly data. It is preferable to use another promising bubble method, fractional integration test, together with the duration dependence test as Hassan and Yu (2007) have done.

Remainder of this study is organized as follows: The second section presents a rational bubble model and the duration dependence test, which is used to test for the existence of

bubbles. The third section presents the data and the test results, and the fourth section concludes.

2. Rational bubble model and duration dependence test

The rational bubble model allows the stock prices to diverge from the fundamental value, even though investors are not irrational. This kind of bubble arises if investors realize that the stocks are overpriced but are prepared to pay the higher price, expecting that other investors will pay an even higher price. Thus, the risk that the bubble will burst is compensated for by higher positive returns.

A simple efficient market model suggests that the expected return of an asset is equal to the required return

$$E_t[R_{t+1}] = r_{t+1}, \quad (1)$$

where E_t denotes mathematical expectations given the information set at time t , r_{t+1} is the time-varying required rate of return and R_{t+1} is the return of an asset at time $t+1$,

$$R_{t+1} = \frac{p_{t+1} - p_t + d_{t+1}}{p_t}. \quad (2)$$

A rearrangement of equation (2) leads to the implication that the current price of a stock equals the sum of expected future price and dividends discounted at the return required by investors,

$$p_t = \frac{E_t[p_{t+1} + d_{t+1}]}{(1 + r_{t+1})}. \quad (3)$$

Calculating this forward k periods yields the semi-reduced form

$$p_t = E_t \left[\sum_{i=1}^k \left(\frac{1}{1 + r_{t+i}} \right)^i d_{t+i} \right] + E_t \left[\left(\frac{1}{1 + r_{t+k}} \right)^k p_{t+k} \right]. \quad (4)$$

In order to obtain a unique solution to the equation (4), it is assumed that the expected discounted value of the stock in the indefinite future converges to zero:

$$\lim_{k \rightarrow \infty} E_t \left[\left(\frac{1}{1 + r_{t+k}} \right)^k p_{t+k} \right] = 0. \quad (5)$$

With this assumption, a fundamental value of the asset can be solved from the equilibrium condition

$$p_t^* \equiv E_t \left[\sum_{i=1}^{\infty} \left(\frac{1}{1 + r_{t+i}} \right)^i d_{t+i} \right]. \quad (6)$$

However, as Blanchard and Watson (1982) among many others note, abandoning the convergence assumption leads to an infinite number of solutions. Any price of the form

$$p_t = p_t^* + b_t, \quad (7)$$

where

$$E_t[b_{t+1}] = (1 + r_{t+1})b_t, \quad (8)$$

is also a solution for the given equation. Equation (7) states that the market price of an asset can deviate from the fundamental value by a bubble factor b_t if on average the factor grows at the required rate of return. Equation (7) also rules out negative bubbles since they would have to grow more negative over time, yet total stock prices will never be negative.

The rational speculative bubble model allows for unexpected price changes $\varepsilon_{t+1} \equiv (R_{t+1} - r_{t+1})p_t$ from two unobservable sources: unexpected changes in the fundamental value,

$$\mu_{t+1} = p_{t+1}^* + d_{t+1} - (1 + r_{t+1})p_t^*, \quad (9)$$

and unexpected changes in the value of the bubble,

$$\eta_{t+1} = b_{t+1} - (1 + r_{t+1})b_t. \quad (10)$$

The observable unexpected price change, $\varepsilon_{t+1} = \mu_{t+1} + \eta_{t+1}$, equals the sum of the fundamental and bubble changes,

$$\varepsilon_{t+1} = \begin{cases} \mu_{t+1} + \frac{(1-\pi)}{\pi} ((1 + r_{t+1})b_t - a_0), & \text{with probability } \pi, \\ \mu_{t+1} - (1 + r_{t+1})b_t + a_0, & \text{with probability } (1 - \pi). \end{cases} \quad (11)$$

As required by the efficient market condition, the expected value of total price innovation is zero. However, the probability of a positive innovation or an abnormal return increases if the fundamental innovations are symmetric around zero. This is due to the inherent skewness of the bubble innovations.

As the bubble component grows, it begins to dominate the fundamental component—i.e., that portion of the stock price determined by the discounted value of future cash flows. The bubble's innovation is positive and small relative to an infrequent but large negative innovation if it bursts. The asymmetry of bubble innovations results in observed abnormal returns that tend to be a positive while the bubble continues, causing autocorrelation and longer runs of positive abnormal return than expected from a temporally independent series. This is the logic behind the duration dependence test for rational speculative bubbles.

The duration dependence test developed by McQueen and Thorley (1994) has gained prominence in testing for rational bubbles. Duration dependence is a characteristic of the hazard function for duration times. If f_i denotes the density function for duration times and F_i the corresponding distribution function, then the hazard function h_i is defined as the conditional density function for duration of length i , given that duration is not less than i ; that is, $h_i = f_i / (1 - F_i)$. The hazard function exhibits positive (negative) duration dependence if h_i is increasing (decreasing) in i . If prices contain bubbles, the runs of positive abnormal returns will exhibit negative duration dependence; i.e., the conditional probability of a run ending, given its duration, is a decreasing function of the duration of the run. The duration dependence test requires that returns are transferred into a series of run lengths on positive and negative observed abnormal returns and the numbers of runs of particular length i are then counted. A run is defined as a sequence of abnormal returns of the same sign. Formally, the examined data consist of a set, S_T , of T

observations on the random run length. Tests for duration dependence are implemented by examining the hazard rate h_i for positive and negative runs. The hazard rate is defined as the probability of obtaining a negative return ($\varepsilon_t < 0$) given a sequence of i prior positive returns ($\varepsilon_{t-i} > 0$). In the presence of a rational bubble, the hazard rate $h_i = P(\varepsilon_t < 0 | \varepsilon_{t-1} > 0, \varepsilon_{t-2} > 0, \dots, \varepsilon_{t-i} > 0, \varepsilon_{t-i-1} < 0)$ decreases with i —i.e., $h_{i+1} < h_i$ for all i . Since bubbles cannot be negative, a similar inequality does not hold for runs of negative abnormal returns. Thus bubbles generate duration dependence in runs of positive, but not negative, abnormal returns.

The sample hazard rate for each run length i is computed as $\hat{h}_i = N_i / (M_i + N_i)$, which is derived from maximizing the log likelihood function of the hazard function with respect to h_i

$$L(\theta | S_T) = \sum_{i=1}^{\alpha} N_i \ln h_i + M_i \ln(1 - h_i) + Q_i \ln(1 - h_i), \quad (12)$$

where N_i is the number of completed runs of length i in the sample, and M_i and Q_i are the numbers of completed and partial runs with lengths greater than i , respectively. The term containing Q_i in the log likelihood (equation 12) is included to incorporate information contained in partial runs and may be ignored in large samples.

To test the null hypothesis of no rational bubbles, it is necessary to choose a proper functional form for hazard function. The duration dependence in this paper are based on the logistical transformation of the log of i :

$$h_i = \frac{1}{1 + e^{-(\alpha + \beta \ln i)}}. \quad (13)$$

The log-logistical function changes the unbounded range of α and $\beta \ln i$ into the (0,1) space of h_i , which is the conditional probability of ending a run. The null hypothesis of no bubbles suggests that positive and negative abnormal returns occur randomly—i.e., the probability of a run's ending is independent of prior returns. Therefore, the null hypothesis of no duration dependence is $H_0 : \beta = 0$, which means a constant hazard rate. The alternative bubble hypothesis suggests that the probability of a negative abnormal returns occur randomly but a positive run's ending should decrease with the run length, which means that the value of the slope parameter β is negative ($H_1 : \beta < 0$, decreasing hazard rate). The duration dependence test is performed by substituting Equation (13) in Equation (12) and maximizing the log likelihood function with respect to α and β . The parameters of the hazard function are estimated via a logit regression where the independent variable is the log of the current run length and the dependent variable is 1 if the run ends in the next period and 0 if it does not. Under the null hypothesis of no bubble ($\beta = 0$), the likelihood ratio test (LRT) is asymptotically distributed χ^2 with one degree of freedom: $LRT = 2 [\text{Log unrestricted} - \text{Log restricted}] \sim \chi_1^2$.

3. Duration dependence and Chinese stock markets

This study focuses on investigating the price indices of both Mainland China and Hong Kong. The starting dates of the indices are January and March 1992 for Shanghai A (SHA) and B (SHB), October 1992 for Shenzhen A (SZA) and B (SZB), and January and July 1993 for the Hong Kong China Enterprises (HKE) and China Affiliated Corporations (HKA) indices, respectively. To add robustness to the results, both monthly and weekly returns are examined. There are several reasons for this. First, the bubble theory gives no indication of the typical length of a bubble, though practical literature implies that bubbles may build up over a number of months and even years. Second, monthly returns may be appropriate, since a high signal-to-noise ratio in weekly returns could cause bubble-related runs to be interrupted by noise, making bubble detection difficult. However, taking into account the relatively short data series of the research, monthly returns may lack the power and thus weekly returns may be more appropriate. The use of two datasets also helps to investigate the sensitivity of the duration dependence test for the use of monthly versus weekly abnormal returns.

The data pertaining to the monthly indices are based on the closing prices for the 15th of each month. The duration dependence tests for weekly data are conducted using weekly data for Wednesday closing prices. In the event that the Wednesday is a holiday or a non-trading day, that Tuesday's close is used. If Tuesday's data are also unavailable, that Monday's close is used. In the rare case where the Monday close is also unavailable, the returns for the week are combined with those for the following week. All price indices are expressed in local currencies, except for Shanghai B and Shenzhen B, which are denominated in US and Hong Kong dollars, respectively. The data are available in Datastream. The prices are transformed into continuously compounded returns, $R_t = 100 * (\ln P_t - \ln P_{t-1})$, where P_t is the index closing price for period t , and P_{t-1} is the price for the preceding period. All tests are conducted on nominal returns.

To provide general understanding of the nature of the different Chinese stock markets, Table 1 presents some stylized evidence regarding stock market behavior using weekly data. The table contains the number of return observations for the stock indices and statistics, testing the null hypothesis for return series independence. The descriptive statistics for the returns are the mean, standard deviation, skewness and kurtosis for the stock returns of each market. In addition, Ljung-Box Q-statistics for the autocorrelation are also presented.

Table 1 here

The rational speculative bubble model implies negative skewness in returns. This can be observed from Hong Kong but not from Mainland China. All of the market returns are leptokurtotic—i.e., they have "fat tails," which is also consistent with the presence of bubbles (greater standard deviations as the bubble grows). According to the rational speculative bubble model, stock returns should be autocorrelated, since returns tend to be positive as the bubble grows. Thus, the independence of the returns series needs to be investigated. The Ljung-Box portmanteau test statistics for five lags (denoted by Q(5)) indicate that all of the markets except Shenzhen A have significant autocorrelation, which is consistent with rational bubbles. For monthly returns, the skewness and kurtosis results are quite similar, but significant autocorrelation can be found only in SHA and HKA.

One characteristic of a rational bubble is that the hazard rate should be a declining function of positive runs; otherwise, a bubble cannot be sustained. The sample hazard rates can be used to determine the probability that a specific positive run lasts for a particular length of time i , given that the run has lasted until i . The no-bubble null hypothesis implies a constant hazard rate ($\beta = 0$), and the bubble alternative suggests that the probability of a positive run's ending should decrease with the run length; i.e., the value of the slope parameter is negative ($\beta < 0$), which signifies decreasing hazard rates. Tables 2 and 3 present the results of duration dependence test for weekly and monthly returns, respectively, by showing the numbers of returns and the maximum likelihood estimates of the log-logistic function parameters of Equation (13). Weekly runs are created using the sign of the error term from an AR(4) model of weekly returns and for the monthly returns, positive and negative abnormal returns are defined relative to the in-sample mean.

Table 2 here

Table 3 here

From tables 2 and 3, it can be seen that for weekly data the Shanghai A-share index has a significant negative β_{sha} coefficient of -0.620 for the sample period. The likelihood ratio test (LRT) of the null hypothesis of no duration dependence or constant hazard rate ($H_0 : \beta = 0$) is rejected at the 1% significance level with the LRT=20.4731. Similar findings are also reported for Shanghai B- and Shenzhen A- and B-indices. As for runs of negative abnormal returns the constant hazard rate is not rejected for any of the markets, the results imply existence of bubbles in all of the Mainland Chinese stock markets. However, monthly data lead to different conclusions. For Shenzhen B, the point estimate β_{szb} is negative, but the coefficient is not significant. For the rest of the markets, β is positive. Thus, the null hypothesis of no bubbles cannot be rejected in any of the markets. The results for HKE and HKA show no evidence of rational speculative bubbles. The empirical findings from weekly data indicate that rational bubbles can be found in all of the Mainland China markets. These results are consistent with the results obtained by previous studies (Ahmed et al., 2006; Sarno and Taylor, 1999; Zhang, 2008), which have usually used the 1990s as their time period. However, the monthly data question these results as they fail to yield evidence of bubbles in any of the markets. The stock indices in the more developed markets of Hong Kong show no evidence of bubbles with either dataset.

The results confirm the conclusions of Harman and Zuehlke (2004) that the duration dependence test is sensitive to the use of weekly versus monthly results. Thus, the reliability of duration dependence test for bubble detection is questionable.

4. Conclusions

Rapid growth in Chinese stock markets during 2006 and 2007 led to bubble suspicions among investors, but the steep decline of the indices that followed changed situation to be more unclear. This study attempts to shed light on these issues by investigating bubbles

from both of China's stock exchanges, using weekly and monthly datasets ranging from the beginning of 1992 to October 2008. The main econometric method employed is the duration dependence test, and the results are compared to the ones obtained from the China-related indices of the Hong Kong Stock Exchange. The use of two datasets has two functions: it adds robustness to the results and simultaneously works as a sensitivity test for the duration dependence test.

Descriptive statistics indicate the possible existence of bubbles, since some autocorrelation and nonnormality of returns, which are consistent with the bubble model, can be found in most of the markets. However, the duration dependence test yields mixed results. For weekly data, it shows bubbles in all of the Mainland Chinese markets, but monthly data do not support this, as they fail to find bubbles from any of the markets. Although the results do not give a clear answer to the bubble question, they dampen bubble suspicions and at the same time, lead to the conclusion that the laws and regulations of Chinese stock markets have not yet reached the same level as the ones in Hong Kong, where neither of the datasets show bubbles. It can also be concluded that even though the A-shares are dominated by individual and B-shares by more sophisticated institutional investors, there are no differences in bubble existence. Thus the segmentation does not have a significant effect in bubble development. The results also question the conclusions of Jacobsen and Liu (2008) by suggesting that neither of China's stock exchanges and neither of their stock classes are comparable with developed markets when the comparability is measured by the existence of bubbles. Interesting future research topics would include investigating the means of improving the efficiency of Chinese stock markets as well as the cointegration between the share indices of Mainland China and Hong Kong.

The uncertainty about the bubble existence weakens the investors' confidence to China's stock markets. Due to the prohibition of short selling it is impossible to benefit from declining prices and thus investors should be extra careful when deciding whether to invest to China or not. In addition, as the short selling restriction has not been able to prevent the development of strong bubble suspicions, its effectiveness as a bubble preventing measure is dubious.

The results support the conclusion made by Harman and Zuehlke (2004) about the duration dependence test's sensitive to the use of weekly versus monthly returns. As the results from China support this conclusion the finding can be generalized to include emerging markets as well. This has to be taken into account when using the duration dependence test and in order to get more consistent results the bubble existence should be studied at least with both weekly and monthly data. Bubbles can also be studied by using another promising method, the fractional integration test, which is used for example by Cuñado et al. (2005) and Koustas and Serletis (2005). The most preferable option is to use both, the duration dependence and fractional integration tests, as Hassan and Yu (2007) have done.

References

Ahmed, E., Li, H. and Barkley Rosser, J, 2006. Nonlinear bubbles in Chinese stock markets in the 1990s. *Eastern Economic Journal* 32, 1-18.

- Blanchard, O.J. and Watson, M.W., 1982. Bubbles, rational expectations and financial markets. In: Watchel, P. (Ed.), *Crisis in the Economic and Financial System*. Lexington Books, MA, 295-315.
- Cuñado, J., Gil-Alana, L.A. and Perez de Gracia, F., 2005. A test for rational bubbles in the NASDAQ stock index: A fractionally integrated approach. *Journal of Banking & Finance* 29, 2633-2654.
- Eun, C.S. and Huang, W., 2007. Asset pricing in China's domestic stock markets: Is there a logic?. *Pacific-Basin Finance Journal* 15, 452-480.
- Fernald, J. and Rogers, J.R., 2002. Puzzles in the Chinese stock market. *The Review of Economics and Statistics* 84, 416-432.
- Gürkaynak, R.S., 2008. Econometric tests of asset price bubbles: Taking stock. *Journal of Economic Surveys* 22, 166-186.
- Harman, Y.S. and Zuehlke, T.W., 2004. Duration dependence testing for speculative bubbles. *Journal of Economics and Finance* 28, 147-154.
- Hassan, K.M. and Yu, J-S., 2007. Rational Speculative Bubbles: An Empirical Investigation of the Middle East and North African Stock Markets. *Networks Financial Institute Working Paper No. 2007-WP-31*.
- Jacobsen, B.J. and Liu, X., 2008. China's segmented stock market: An application of the conditional international capital asset pricing model. *Emerging Markets Review* 9, 153-173.
- Koustas, Z. and Serletis, A., 2005. Rational bubbles or persistent deviations from market fundamentals?. *Journal of Banking & Finance* 29, 2523-2539.
- Ling, W., Bo, L. and Gao-feng, Z., 2007. Test and analyses for bubbles on Chinese stock market in merger & acquisition. *Paper presented in IEEE International Workshop on Intelligent data acquisition and advanced computing systems: Technology and applications, 6-7 September 2007, Dortmund, Germany*.
- McQueen, G. and Thorley, S., 1994. Bubbles, stock returns and duration dependence. *The Journal of Financial and Quantitative Analysis* 29, 379-401.
- Sarno, L. and Taylor, M.P., 1999. Moral hazard, asset price bubbles, capital flows, and the East Asian crisis: the first tests. *Journal of International Money and Finance* 18, 637-657.
- Tan, L., Chiang, T.C., Mason, J.R. and Nelling, E., 2008. Herding behavior in Chinese stock markets: An examination of A and B shares. *Pacific-Basin Finance Journal* 16, 61-77.
- Zhang, B., 2008. Duration dependence test for rational bubbles in Chinese stock market. *Applied Economics Letters* 15, 635-639.

Table 1. Descriptive statistics of weekly returns

Share index	N	Mean	SD	Skewness	Kurtosis	Q(5)-statistics
SHA	865	0.208	6.165	2.05	26.05	20.87 (0.0009)
SHB	856	-0.031	5.571	0.24	5.65	23.33 (0.0003)
SZA	824	0.069	5.266	0.19	10.7	9.51 (0.0903)
SZB	824	0.053	5.477	0.67	9.95	39.80 (0.0001)
HKE	825	0.051	5.652	-0.17	5.44	12.79 (0.0255)
HKA	797	0.062	5.547	-0.41	6.75	19.03 (0.0019)

Table 2. Duration dependence test results for weekly returns

Market	SHA	SHB	SZA	SZB	HKE	HKA
Number of returns						
Positive	208	198	201	183	191	203
Negative	208	199	202	184	191	204
Total	416	397	403	367	382	407
Positive run test						
A	0.290**	0.194	0.228*	0.091	0.003	-0.192
B	-0.620***	-0.396**	-0.462***	-0.385**	-0.264*	-0.021
LRT	20.473***	6.056**	8.916***	6.258**	2.974*	0.019
(p-value)	(0.0001)	(0.014)	(0.003)	(0.012)	(0.085)	(0.891)
Negative run test						
A	-0.068	-0.324**	-0.089	-0.131	-0.087	0.157
B	0.023	0.121	0.069	-0.241*	0.164	0.073
LRT	0.020	0.595	0.161	3.009	0.788	0.135
(p-value)	(0.888)	(0.440)	(0.689)	(0.083)	(0.375)	(0.714)

Notes: The duration dependence test is performed on monthly nominal returns. Positive and negative abnormal returns are defined relative to the sign of the error from a weekly AR(4) model. Actual run counts do not include the partial runs which may occur at the beginning or at the end of period investigated. Total runs are the number of total positive and negative runs. β is the hazard rate which is estimated using a logit regression where the independent variable is the log of current length of runs and dependent variable is 1 if a run ends and 0 if it does not end in the next period. The likelihood ratio test (LRT) of the null hypothesis of no duration dependence or constant hazard rate ($H_0 : \beta = 0$) is asymptotically distributed χ^2 with one degree of freedom. p-value is the marginal significance level, which is the probability of obtaining the value of the LRT or higher under the null hypothesis. ***, ** and * indicate significance at 1%, 5% and 10% levels.

Table 3. Duration dependence results for monthly returns

Market	SHA	SHB	SZA	SZB	HKE	HKA
Number of returns						
Positive	42	46	45	44	37	44
Negative	42	47	46	45	37	44
Total	84	93	91	89	74	88
Positive run test						
A	-0.316	-0.199	-0.047	0.235	-0.619**	-0.789***
B	0.299	0.364	0.142	-0.014	0.277	0.781**
LRT	0.626	0.898	0.137	0.001	0.719	4.637**
(p-value)	(0.429)	(0.343)	(0.711)	(0.974)	(0.397)	(0.031)
Negative run test						
α	-0.471	-0.330	-0.240	-0.301	-0.436	0.306
β	-0.016	0.178	0.044	-0.163	0.152	-0.417
LRT	0.003	0.266	0.017	0.296	0.175	1.241
(p-value)	(0.959)	(0.606)	(0.896)	(0.587)	(0.675)	(0.265)

Notes: The duration dependence test is performed on monthly nominal returns. Positive and negative abnormal returns are defined relative to the in-sample mean. Actual run counts do not include the partial runs which may occur at the beginning or at the end of period investigated. Total runs are the number of total positive and negative runs. β is the hazard rate which is estimated using a logit regression where the independent variable is the log of current length of runs and dependent variable is 1 if a run ends and 0 if it does not end in the next period. The likelihood ratio test (LRT) of the null hypothesis of no duration dependence or constant hazard rate ($H_0 : \beta = 0$) is asymptotically distributed χ^2 with one degree of freedom. p-value is the marginal significance level, which is the probability of obtaining the value of the LRT or higher under the null hypothesis. ***, ** and * indicate significance at 1%, 5% and 10% levels.