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The efficiency of the Chinese stock market and the role of market liberalization

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Abstract

This article tests for the random walk hypothesis in the four Chinese stock markets of Shanghai "A," Shanghai "B," Shenzhen "A," and Shenzhen "B" and explores the impact of the market liberalization that occurred in 2001 on the efficiency of these markets. Empirical results show that the market liberalization in 2001 has a significant effect on the efficiency of Chinese stock markets.

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1. Introduction

China's main stock exchanges, the Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZE), were established on November 26 and December 1, 1990, respectively, and started operations on December 29, 1990, and June 3, 1991, respectively. The SSE trades mostly shares of large corporations and state-run enterprises, while the SZE trades entities belonging to large corporations and export-oriented companies. Both exchanges trade in "A" and "B" shares—the former is traded in renminbi exclusively by mainland Chinese investors and the latter, in U.S. dollars (in Hong Kong dollars on SZE) exclusively by foreign investors.

Investors in A shares are mostly individuals, while those in B shares are foreign institutional investors. Due to the language barrier and accounting conventions, foreign investors may encounter difficulty in grasping the financial information of Chinese corporations, thus leading to information asymmetries between market participants trading in markets for A and B shares, respectively. This situation suggests the possibility of a difference in market efficiency between markets for A and B shares. According to the efficient market hypothesis (EMH), all information on a specific asset is reflected in the price of that asset (Fama, 1970). Based on this theory, all usable information is reflected in the share price, and rationally formed share prices can be accomplished only through new information. Since new information is not predictable, share price movements are random and predictions are impossible according to the theory. In markets where the EMH is born out, share prices therefore follow a random walk.

The efficiency of China's stock markets has been analyzed in research using random walk test. Laurence *et al*. (1997) implemented serial correlation test based on daily data from 1993 until 1996. The results show the market for A shares to be efficient and that for B shares to be inefficient. Liu *et al*. (1997) implemented unit root test using daily data from 1992 until 1995. On the basis of the results, it was asserted that both the Shanghai and Shenzhen markets are efficient. Lima and Tabak (2004) implemented variance ratio (VR) tests using daily data from 1992 until 2000. The results, it was asserted, demonstrated that the market for A shares was efficient, while that for B shares was not.

This paper tests the EMH using daily data from the China's stock markets. This paper has two specific features. First, it analyzes the EMH through VR tests using daily data of the Shanghai and Shenzhen stock markets for A and B shares from 1992 until 2010. Second, occasioned by China's market liberalization in 2001, foreign investors and investors from mainland China have since been able to trade in A and B shares respectively. This paper examines the effect of this liberalization on the efficiency of stock markets.

2. Empirical Techniques

2.1 Variance Ratio Test

Denote by P_t the stock price at time t and define X_t as the natural logarithm of P_t ($X_t = \ln(P_t)$). Our maintained hypothesis is given by the recursive relationship as follows:

$$X_t = \mu + X_{t-1} + \varepsilon_t, \quad , \qquad t = 1, 2, \cdots, T \tag{1}$$

or

$$\Delta X_t = \mu + \varepsilon_t, \qquad t = 1, 2, \cdots, T \tag{2}$$

where $\Delta X_t = X_t - X_{t-1}$ and $E[\varepsilon_t] = 0$.

The VR test of Lo and MacKinlay (1988) is based on the property that the variance of $(X_t - X_{t-q})$ is q times the variance of $(X_t - X_{t-1})$. Therefore, the random walk hypothesis (RWH) can be checked by comparing $1/q$ times the variance of $(X_t - X_{t-q})$ to the variance of $(X_t - X_{t-1})$. Then, the VR, $VR(q)$, is defined as

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)} \tag{3}$$

where $\sigma^2(q)$ is $1/q$ times the variance of $(X_t - X_{t-q})$ and $\sigma^2(1)$ is the variance of $(X_t - X_{t-1})$. The null hypothesis is that $VR(q)$ is equal to one.

Consider the following estimators for the unknown parameters μ, $\sigma^2(1)$, and $\sigma^2(q)$:

$$\hat{\mu} = \frac{1}{T}\sum_{t=1}^{T}(X_t - X_{t-1}), \tag{4}$$

$$\hat{\sigma}^2(1) = \frac{1}{T}\sum_{t=1}^{T}(X_t - X_{t-1} - \hat{\mu})^2, \tag{5}$$

$$\hat{\sigma}^2(q) = \frac{1}{qT}\sum_{t=1}^{T}(X_t - X_{t-q} - q\hat{\mu})^2. \tag{6}$$

Thus, the corresponding VR estimator is given by

$$\hat{VR}(q) = \frac{\hat{\sigma}^2(q)}{\hat{\sigma}^2(1)}. \tag{7}$$

Lo and MacKinlay show that the VR test statistic given by

$$Z(q) = \frac{\hat{VR}(q) - 1}{\sqrt{\hat{s}^2(q)}} \tag{8}$$

is asymptotically $N(0,1)$. Note that we have[1]

$$\hat{s}^2(q) = \sum_{j=1}^{q-1}\left(\frac{2(q-j)}{q}\right)^2 \frac{\sum_{t=j+1}^{T}(X_{t-j} - X_{t-j-1} - \hat{\mu})(X_t - X_{t-1} - \hat{\mu})}{\sum_{t=j+1}^{T}(X_t - X_{t-j} - \hat{\mu})^2}. \tag{10}$$

[1]Under the assumption that ε_t is iid, we have $\hat{s}^2(q) = \frac{2(2q-1)(q-1)}{3qT}$.

2.2 Multiple Variance Ratio Test

Chow and Denning (1993) extend the conventional VR test introduced by Lo and MacKinlay (1988) and propose a multiple VR test. Consider a set of VR estimates, $\{VR(q_i)\,|\,i=1,2,\cdots,L\}$, corresponding to a set of predefined number of lags $\{q_i\,|\,i=1,2,\cdots,L\}$. Chow and Denning (1988) propose a multivariate VR (MVR) test for the joint null hypothesis $H_0: VR(q_i)=1$ for $i=1,2,\cdots,L.$ against the alternative hypothesis that $H_A: VR(q_i)\neq 1$ for some q_i. The test statistic is of the form:

$$Z^*(q)=\max_{1\le i\le L}|Z(q_i)|. \tag{11}$$

The null hypothesis is rejected at α level of significance if $Z^*(q)$ is greater than the $[1-\alpha^*/2]$th percentile of the standard normal distribution where $\alpha^*=1-(1-\alpha)^{1/L}$. In this research, $q=2,4,8,16$ are used to calculate VR estimates and test statistics. Thus, $\{q_i\,|\,i=1,2,3,4\}$ such that $q_1=2, q_2=4, q_3=8,$ and $q_4=16.$

Kim (2006) proposed a wild bootstrap approach to improve the small sample properties of VR tests. His approach involves computing the Lo-MacKinlay and Chow-Denning test statistics on samples of *T* observations formed by weighting the original data by mean 0 and variance 1 random variables and using the bootstrap distribution of the test statistics.

3. Data

This paper uses daily index data for A and B shares from the SSE and SZE. The data source is Thomson Financial DataStream. The sample period of each stock market is as follows:

Shanghai A shares: January 2, 1991–April 27, 2010
Shanghai B shares: February 21, 1992–April 27, 2010
Shenzhen A shares: October 5, 1992–April 27, 2010
Shenzhen B shares: October 5, 1992–April 27, 2010

A shares are traded in renminbi exclusively by mainland Chinese investors and B shares, in U.S. dollars—in Hong Kong dollars on the SZE—exclusively by foreign investors. Since 2001, foreign institutional investors have been able to transact in A shares and investors from mainland China, in B shares. To examine the effects of this liberalization, a period split was set at the year 2001. For each subsample period, we analyze the efficiency of each market using variance ratio tests.

4. Empirical Results
4.1 Total sample

Table 1 demonstrates the VR estimates and test statistics of the RWH for the entire period based on the methodology of the conventional VR test by Lo and MacKinlay (1988). Note that we report two p-values; one is based on the asymptotic normality and the other is based on the wild bootstrap developed by Kim (2006). Kim (2006) demonstrates that the wild bootstrap tests have desirable size properties and exhibit higher power than their alternatives. According to Table 1, the null hypothesis that the VR is equal to one is statistically accepted at all number of q's at the 1% significance level for the A board, while the null hypothesis is rejected at any number of q's for the B board. Thus, the RWH is accepted for the A board but not for the B board.

Test statistics based on the methodology of the multiple VR test by Chow and Denning (1993) are also reported in Table 1. The null hypothesis that the VR is equal to one is statistically accepted for the A board but is rejected for the B board. Thus, the empirical results of the individual VR test are reinforced by the empirical results of the multiple VR tests.

4.2 Role of Market Liberalization

Domestic investors were excluded from B stock markets before 2001 but were admitted after 2001. It is likely that market liberalization would have significant effects on the efficiency of the market. We go on to examine whether the efficiency was affected when the B market was liberalized to domestic investors.

The results of the conventional VR test after dividing the entire study period into two subsample periods are presented in Tables 2 and 3. Table 2 shows the empirical results up to the end of 2000, while Table 3 shows the empirical results from the beginning of 2001.

For the first subsample, the empirical results of Table 2 are consistent with the results of Table 1. The null hypothesis that the VR is equal to one is statistically accepted at all number of q's at the 1% significance level for the A board, while the null hypothesis is rejected at any number of q's for the B board. Thus, the RWH is accepted for the A board but not for the B board for the first subsample.

For the second subsample, the empirical results of Table 3 are different from the results of Table 1. The null hypothesis that the VR is equal to one is statistically accepted at all number of q's at the 1% significance level not only for the A board but also for the B board. Thus, the RWH is accepted for A as well as B boards for the second subsample.

Test statistics based on the methodology of the multiple VR test by Chow and Denning (1993) are also reported in Tables 2 and 3. For the first subsample, the null hypothesis that the VR is equal to one is statistically accepted for the A board but is rejected for the B board. For the second subsample, the null hypothesis that the VR is equal to one is statistically accepted not only for the A board but also for the B board. Thus, the empirical results of the individual VR test are reinforced by the empirical results of the multiple VR tests. We find that efficiency tended to be favorably affected when markets were liberalized.

5. Some Concluding Remarks

This paper examined the market efficiency of China's stock markets. The markets were analyzed for A and B shares on the SSE and SZE, using MVR test. In particular, the effects of the liberalization of investment in B shares by domestic investors since 2001 were examined. The main results of the analysis are as follows.

(1) The results of the analysis for the entire period bear out the EMH, as prices of A shares on the Shanghai and Shenzhen stock markets did follow a random walk. By contrast, since prices of B shares did not follow a random walk, the EMH was shown not to hold.

(2) The results of the analysis for the period before the market liberalization of 2001 bear out the EMH, as A shares on the SSE and SZE followed a random walk. By contrast, since prices of B shares did not follow a random walk, the EMH was shown not to hold.

(3) The results of the analysis for the period before the market liberalization of 2001 showed the EMH to hold, as both A and B shares on the SSE and SZE followed a random

walk. Hence, it was demonstrated that the liberalization in 2001 that allowed domestic investors to trade in B shares had a positive effect on the efficiency of the market for B shares.

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Table 1 Results of Variance Ratio Tests: Total Sample

	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai A	2	1.029	1.134	(0.257)	(0.279)
	4	1.101	1.867	(0.062)	(0.070)
	8	1.179	2.024	(0.043)	(0.040)
	16	1.202	1.620	(0.105)	(0.101)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	2.024	(0.161)	(0.107)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai B	2	1.127	5.293	(0.000)	(0.000)
	4	1.215	4.935	(0.000)	(0.000)
	8	1.332	4.970	(0.000)	(0.000)
	16	1.490	5.224	(0.000)	(0.000)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	5.293	(0.000)	(0.000)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen A	2	1.009	0.386	(0.699)	(0.707)
	4	1.059	1.255	(0.210)	(0.237)
	8	1.142	1.914	(0.056)	(0.059)
	16	1.180	1.743	(0.081)	(0.079)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	1.914	(0.205)	(0.136)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen B	2	1.107	3.870	(0.000)	(0.000)
	4	1.222	4.443	(0.000)	(0.000)
	8	1.404	5.331	(0.000)	(0.000)
	16	1.612	5.792	(0.000)	(0.000)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	5.792	(0.000)	(0.000)		

Note:
p-value[a]: probability value based on the asymptotic normality.
p-value[b]: probability value based on the wild bootstrap.

Table 2 Results of Variance Ratio Tests: Before the Market Liberalization

	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai A	2	1.038	1.203	(0.229)	(0.237)
	4	1.130	1.946	(0.052)	(0.058)
	8	1.225	2.039	(0.041)	(0.039)
	16	1.244	1.578	(0.115)	(0.116)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	2.039	(0.156)	(0.116)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai B	2	1.177	5.071	(0.000)	(0.000)
	4	1.296	4.714	(0.000)	(0.000)
	8	1.401	4.122	(0.000)	(0.000)
	16	1.527	3.886	(0.000)	(0.000)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	5.071	(0.000)	(0.000)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen A	2	0.995	-0.165	(0.869)	(0.881)
	4	1.058	0.900	(0.368)	(0.377)
	8	1.158	1.531	(0.126)	(0.124)
	16	1.173	1.218	(0.223)	(0.229)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	1.531	(0.416)	(0.265)		
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen B	2	1.144	3.198	(0.001)	(0.000)
	4	1.299	3.726	(0.000)	(0.000)
	8	1.477	3.975	(0.000)	(0.000)
	16	1.637	3.839	(0.000)	(0.001)
	Joint Test				
	Test Statistic	p-value[a]	p-value[b]		
	3.975	(0.000)	(0.001)		

Note:
p-value[a]: probability value based on the asymptotic normality.
p-value[b]: probability value based on the wild bootstrap.

Table 3 Results of Variance Ratio Tests: After the Market Liberalization

	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai A	2	0.997	-0.114	(0.909)	(0.906)
	4	0.996	-0.088	(0.930)	(0.933)
	8	1.022	0.283	(0.777)	(0.777)
	16	1.070	0.602	(0.547)	(0.546)
	Joint Test				
	Test Statistic		p-value[a]		p-value[b]
	0.602		(0.958)		(0.852)
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shanghai B	2	1.062	1.944	(0.052)	(0.067)
	4	1.075	1.295	(0.195)	(0.183)
	8	1.178	1.984	(0.047)	(0.048)
	16	1.299	2.345	(0.019)	(0.018)
	Joint Test				
	Test Statistic		p-value[a]		p-value[b]
	2.345		(0.074)		(0.055)
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen A	2	1.040	1.495	(0.135)	(0.118)
	4	1.064	1.253	(0.210)	(0.205)
	8	1.120	1.499	(0.134)	(0.123)
	16	1.214	1.841	(0.066)	(0.053)
	Joint Test				
	Test Statistic		p-value[a]		p-value[b]
	1.841		(0.238)		(0.139)
	Individual Tests				
	Period (q)	Variance Ratio	Test Statistic	p-value[a]	p-value[b]
Shenzhen B	2	1.053	1.700	(0.089)	(0.099)
	4	1.074	1.294	(0.196)	(0.217)
	8	1.180	2.019	(0.044)	(0.036)
	16	1.209	1.642	(0.101)	(0.085)
	Joint Test				
	Test Statistic		p-value[a]		p-value[b]
	2.019		(0.163)		(0.093)

Note:
p-value[a]: probability value based on the asymptotic normality.
p-value[b]: probability value based on the wild bootstrap.