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A comparison of variance ratio tests of random walk: A case of Asian emerging stock markets

Hafiz A.A.B. Hoque [a], Jae H. Kim [b,*], Chong Soo Pyun [c]

[a] *Department of Finance, University of Dhaka, Bangladesh*
[b] *Department of Econometrics and Business Statistics, Monash University, Australia*
[c] *Fogelman College of Business and Economics, University of Memphis, Memphis, TN 38152, USA*

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Abstract

This study re-examines the random walk hypothesis for eight emerging equity markets in Asia: Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. The hypothesis is tested with two new variance ratio tests–Wright's rank and sign and Whang–Kim subsampling tests–as well as the conventional Lo–MacKinlay and Chow–Denning tests. We found that (i) the stock prices of the eight Asian countries do not follow random walk with the possible exceptions of Taiwan and Korea and (ii) the accelerated opening of the eight stock markets to foreign investors following the Asian financial crisis in 1997 has not significantly altered the mean-reversion patterns of stock price vis-à-vis relative market efficiency. Our study affirms that Wright's and Whang–Kim's tests yield far less ambiguous results as compared to Lo–MacKinlay and Chow–Denning tests.

JEL classification: G14; G15; C14
Keywords: Stock market efficiency; Mean reversion; Variance ratio test; Non-parametric tests; Subsampling

1. Introduction

Since the pioneering work of Lo and MacKinlay (1988), variance ratio (VR) tests have been by far the most widely used econometric tools for testing the random walk hypothesis (RWH) in emerging equity markets.[1] The crux of VR tests is that if a stock's return is purely random, the variance of k-period return is k times the variance of one-period return. Hence, the VR, defined as the ratio of $1/k$ times the variance of the k-period return to the variance of the one-period return, should be equal to 1 for all values of k.

Chow and Denning (1993) modify Lo–MacKinlay's VR test so that a set of multiple VRs over a number of holding periods can be tested to determine whether the multiple VRs are jointly equal to one. Thus, for the purpose of testing a

* Corresponding author. Tel.: +61 3 99031596; fax: +61 3 99032007.
E-mail address: Jae.Kim@BusEco.monash.edu.au (J.H. Kim).

[1] As shown in Appendix A, 18 published studies are identified as those that dealt with RWH in emerging stock markets. Of the 18, 16 studies used Lo–MacKinlay or Chow–Denning variance ratio tests along with other tests, such as ARIMA, GARCH, unit root and runs tests.

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null hypothesis, Lo–MacKinlay VR test is an individual test while the multiple VR test of Chow and Denning is a joint test.[2] Even though the multiple VR test is quite powerful testing for homoscedastic or heteroscedastic nulls (Smith, Jefferis, & Ryoo, 2002), it is critical to note that the multiple VR test as well as its forerunner–Lo–MacKinlay VR tes–are asymptotic tests in that their sampling distributions are approximated by their limiting distributions.[3] Recently, Wright (2000) and Whang and Kim (2003), respectively, have proposed two alternatives to conventional asymptotic VR tests—Wright with his "rank and sign" VR tests and Whang and Kim with their "subsampling" version of the Chow and Denning (1993) test. Wright's (2000) tests are exact tests whose sampling distributions do not resort to asymptotic approximations. Although the validity of Whang and Kim (2003) test is based on asymptotic arguments, it is important to note that its critical values (p-values) are not obtained from asymptotic approximation to the sampling distribution: they are obtained from a small sample approximation.

To the best of our knowledge, Buguk and Brorsen (2003) is the only study that employs Wright's (2000) rank and sign VR tests in evaluating the RWH for the Istanbul Stock Exchange. Wright's tests have not been applied to Asian emerging markets; while Whang and Kim's (2003) subsampling test has never been used in the evaluation of the RWH in any emerging stock markets.

Three motivations for our study are indicated. Firstly, emerging stock markets in Asia have become increasingly important to the safety and vitality of the global financial markets as shown in recent studies (see Al-Khazali & Pyun, 2004; Khil & Lee, 2000; Lima & Tabak, 2004). Secondly, since the Asian financial crisis in 1997, the structure and operations of Asian stock markets have been markedly strengthened and improved, and there has been a renewed interest on Asian emerging stocks among investors for higher returns through a global portfolio diversification.[4] Lastly, findings on the RWH in Asian emerging markets to date are still tentative, often fraught with conflicting statistical inferences. For instance, Chang and Ting (2000) show that while the RWH cannot be rejected for the Taiwan Stock Exchange with monthly, quarterly and annual data, it is rejected with weekly returns. Huang (1995) reports the rejection of the RWH for the markets of Korea, Malaysia, Hong Kong, Singapore and Thailand while Ayadi and Pyun (1994), Malliaropulos and Priestley (1999), and Ryoo and Smith (2002) confirm that the stock prices of these Asian emerging markets are on balance mean-reverting.[5]

The purpose of this paper is twofold: (i) to compare inferential outcomes of Wright's and Whang–Kim VR test results with those of Lo–MacKinlay and Chow–Denning VR tests for the evaluation of the RWH in eight Asian emerging equity markets (Hong Kong, Indonesia, South Korea (hereinafter Korea), Malaysia, the Philippines, Singapore, Taiwan, and Thailand); and (ii) to ascertain any changes in the random walk patterns of stock prices at the eight individual Asian markets following the Asian crisis with the two new VR tests of Wright (2000) and Whang and Kim (2003).

Our findings show that the stock prices of the eight emerging markets are mean-reverting, which means that these markets are not weak-form efficient with the possible exceptions of Taiwan and Korea, and that the accelerated opening of their respective stock markets to foreign investors in the aftermath of the Asian financial crisis in 1997 has not significantly altered the random walk patterns of stock price vis-à-vis market efficiency in the emerging market on balance. Our findings also support the notion that Wright's rank and sign and Whang–Kim's subsampling VR tests

[2] The Wald test of Richardson and Smith (1991) is an alternative joint VR test. However, we do not consider the Wald test in this study because it is derived under the assumption that the underlying time series does not exhibit conditional heteroskedasticity. This assumption is too restrictive for our study, given the evidence of strong conditional heteroskedasticity in stock returns.

[3] For example, the limiting distribution of the Lo–MacKinlay test statistics is the standard normal, and the critical values associated with the standard normal distribution are used for statistical inference for finite samples.

[4] For instance, practically all vestige of ownership restrictions of domestic stocks by foreigners have been lifted literally overnight in Korea and Thailand under the terms of the International Monetary Fund loans to these countries in 1998. The large influx of foreign portfolio investment into the two countries followed to take advantage of not only the opening of the markets but also asset prices in these markets, which had been severely depressed under the crisis environment. The result is that the transaction volume and trading frequency of many stocks in these countries increased measurably in the recent years.

[5] Results are also mixed for emerging markets in Middle East and Africa. El-Erian and Kumar (1995) find that the Turkish market and the Jordanian market are weak-form inefficient. However, Antoniou and Ergul (1997) find that the Turkish stock market is weak-form efficient only for stocks with high trading volume.