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The importance of using a test of weak-form market efficiency that does not require investigating the data first

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ABSTRACT

Are financial markets efficient? There are multiple tests for answering this question. Forming a hypothesis and testing should be done before looking at the data, i.e. without data snooping. However, the parameters used in the tests of the efficient market hypothesis are often not decided independent of the data. This paper investigates the consequences of not only this form of data snooping but also the issue of looking at multiple tests. The specific tests compared in this paper are the runs test, the autocorrelation test, and the variance ratio test.

1. Introduction

Economists have always argued that prices are always right, which means that the asset prices already reflect all information. In the stock market, stock prices are the final result of the interactions between supply (sellers) and demand (buyers) at each point in time. In essence, economists believe that market prices are usually an unbiased result of fundamental factors. This belief was formalized by Samuelson (1965) in his published paper entitled "Proof that properly anticipated prices fluctuate randomly;" he delved into the details to propose and explain the Random Walk Hypothesis, which argues that the price of the securities in a market fluctuates randomly, a condition for martingale. Working independently, Fama (1970) further crystallized the idea by proposing the efficient market hypothesis (EMH), and further broke it down into three forms; namely, weak, semi-strong, and strong.

Ever since the theory of efficient market hypothesis was developed, numerous studies (for example: Borges, 2010; Gilmore & McManus, 2003; Gupta & Basu, 2007; Hoque, Kim, & Pyun, 2007; Kim, Shamsuddin, & Lim, 2011; Omran & Farrar, 2006; Robinson, 2005; Smith, 2012; Urquhart & Hudson, 2013) have been conducted to prove, or in some cases disprove, the theory. Where it is evident that prices indeed follow random walk or drunkard's walk, then it means that it is virtually impossible to anticipate future prices and make a profit from them. On the other hand, if the result is contra the aforementioned, then there exists a chance of profit-making just by studying the past behavior of a security price. That is why this subject is very interesting to economists and the world of investors at large.

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When performing a test on weak-form EMH, just as with every other statistical test, tests for weak-form EMH have a chance of making an error. The researcher could make the mistake of either rejecting the null hypothesis when it is true—type I error—or the chance of failing to reject the null hypothesis when it is false—type II error. Typically, the researcher sets the alpha (probability of type I error) equal to 0.05 for a single test. The runs test, which is commonly used to test if the market is weak-form efficient, does not require any parameters, as with other tests and thus has a type I error rate of alpha. Tests that require the investigation of the data first are biased by data snooping (Lo & MacKinlay, 1990; Romano & Wolf, 2005; White, 2000) and thus the alpha is not an accurate representation of the type I error rate. For example, the Ljung–Box tests (autocorrelation test) require the researcher to input the lag period when calculating the test statistic. Another example is the LoMac test (variance ratio test), which requires a holding period in order to calculate the test statistic. Looking at the ACF (Autocorrelation Functions) and PACF (Partial Autocorrelation Functions) charts, modeling the indices of interest, and then determining the parameters for these tests constitute data snooping (White, 2000). Many papers not only investigate the data before determining the parameters of the test but also use multiple tests for testing the weak-form EMH (Abeysekera, 2001; Hoque et al., 2007; Khan & Vieito, 2012; Omran & Farrar, 2006).

Thus, between data snooping (Romano & Wolf, 2005) and running multiple tests, clearly the probability of a type I error is much higher than the stated alpha. This research focuses on the runs test, autocorrelation test, and variance ratio test, which are three of the most prominent tests for the weak-form EMH. This paper takes a different view on testing the weak-form EMH and thus investigates something different when considering these tests—the bias of the "formalized" data snooping used for some of the tests (Romano & Wolf, 2005). Finally this paper also discusses the implications of using multiple tests to test the weak-form EMH on a single data set.

2. Literature review

There is a great deal of research related to testing stock market weak-form efficiency (for example: Borges, 2010; Dicle, Beyhan, & Yao, 2010; Gilmore & McManus, 2003; Gupta & Basu, 2007; Hamid, Suleman, Shah, & Akash, 2010; Lee, 1992; Omran & Farrar, 2006; Robinson, 2005; Smith, 2012; Urquhart & Hudson, 2013; Yu, Nartea, Gan, & Yao, 2013). Based on the present literature review, it can be seen that the most common methods used to test stock market weak-form efficiency are the runs test (Bradley, 1968; Wallis & Roberts, 1956), the autocorrelation test (Durbin & Watson, 1951; Ljung & Box, 1978), the variance ratio test (Lo & Mackinlay, 1988), and the unit root test (Dickey & Fuller, 1979). The null hypothesis for the unit root test is against the weak-form efficiency hypothesis, whereas the null hypothesis for the other three tests supports the weak-form efficiency. For these reasons, the authors compared the three typical methods, which are the runs test, autocorrelation test, and variance ratio test.

2.1. Runs test

The runs test is one of the most popular methods used to test the EMH. A run basically means having a series of changes in the price of an asset moving in the same direction. This will result in three possible outcomes: positive for upward price movement, zero for no price change, and negative for downward price movement.

Sharma and Kennedy (1977) conducted a study involving stocks listed on the Bombay Stock Exchange, New York Stock Exchange, and London Stock Exchange, using monthly stock prices for a ten year period (1963–1973), and they concluded that the stocks on the Bombay Stock Exchange obeyed a random walk. Abeysekera (2001) studied the Colombo Stock Exchange for the period of 1991–1996 and the results showed that the stock prices on the Colombo Stock Exchange were not consistent with the weak-form of the EMH. Robinson (2005) studied the daily returns of all stocks on the Jamaican Stock Exchange between 1992 and 2001, and the conclusion was that the JSE-listed stocks did not follow a random walk. Omran and Farrar (2006) used data from the Stock Market Indices of Egypt, Jordan, Morocco, Turkey, and Israel. The conclusion was that Egypt and Morocco rejected the Random Walk Hypothesis (RWH), and Turkey and Jordan presented weaker evidence for the rejection of the weak-form EMH, whereas the Israel stock market followed the RWH. Hamid et al. (2010) conducted tests in Asia Pacific countries for the period 2004–2009 and arrived at the conclusion that those markets rejected the Random Walk Hypothesis. Thomas and Kumar (2010) conducted a study on the Indian stock market and concluded that the market was weak-form inefficient, a scenario that presents an opportunity for excess returns. Aumeboonsuke (2012) investigated six stock markets in ASEAN (Malaysia, Indonesia, the Philippines, Thailand, Singapore, and Vietnam) during 2001–2012 and the results were not consistent with the weak-form of the EMH, although in the later period, the markets in Thailand and Singapore were more consistent with the weak-form hypothesis.

2.2. Autocorrelation test

Autocorrelation refers to the cross-correlation of a signal against itself. It measures how similar observations are when taken as a function of the time lag between them. It can be taken as a mathematical tool used for finding repeating patterns. If the market is indeed efficient, then the null hypothesis of zero autocorrelation should prevail. If the result is negative, then it means that there is a tendency of mean reversion, and if it is positive, then the null hypothesis is rejected.

Mookerjee and Yu (1999) concluded that the Chinese markets were not efficient since there was no randomness in the behavior of stock prices during their testing period. Abeysekera (2001) studied the Colombo Stock Exchange for the period of 1991–1996 and found results against the weak-form EMH. Robinson (2005) investigated all of the stocks on the Jamaica Stock

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