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Efficiency Tests in European Equity Markets

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Abstract

The evidence of week form efficiency in European stock markets is some-what mixed. Therefore, the objective of this paper is to reassess the week form efficiency of major European equity markets. In order to serve this purpose, the runs test, the variance ratio test and two different unit root tests are applied. The empirical analysis reveals that the prices in the selected European security markets do not follow a random walk implying that these markets are not week form efficient.

Keywords: *Efficient Market Hypothesis, Week Form Efficiency, Runs Test, Unit root test.*

1. Introduction

The efficient market hypothesis (EMH) assumes that market prices fully reflect all the available information about the value of the traded assets. That is, testing market efficiency verifies whether specific investment schemes can earn excess profits by using the available information. Fama (1970) outlines three different versions of EMH: weak, semi-strong and strong. The weak form EMH asserts that current prices reflect the information contained in the past prices. The semi-strong form EMH affirms that current prices reflect all publicly available information including non-market information. The strong form EMH assumes that current prices reflect all information, public as well as private.

Numerous empirical studies test the week form efficiency of different stock markets. For example, Chan, Gup and Pan (1997) conclude that stock prices in the major Asian markets and the U.S. are weak form efficient individually. Seiler and Rom (1997) examine the degree of random walk in daily stock prices for all stocks listed on the NYSE from February 1885 through July 1962 and find that historical stock prices follow a random walk. While investigating the market efficiency in developing countries, Dickinson and Muragu (1994) report that Nairobi stock market is week form efficient.

However, Lo and MacKinlay (1988) employ a variance ratio test for investigating the non-stationarity of CRSP indices and conclude that stock prices are not random. Moreover, applying the variance ratio test to analyze the weak form efficiency of the NASDAQ composite index, Gu (2004) also suggests that the daily returns do not follow a random walk. In addition to these studies, Kim and Shamsuddin (2008) verify the week form efficiency of a number of Asian markets and document that the markets of Indonesia, Malaysia and Philippines are not efficient.

The evidence of week form efficiency in European stock markets is some-what mixed. For example, Borges (2010) documents that the prices in the UK, Greece, France and Portuguese equity markets do not follow a random walk, while the German and Spanish stock markets are found to be weak-form efficient. In addition, Guidi, Gupta and Maheshwari (2011) investigate the weak-form EMH using the stock prices from several Central and Eastern Europe equity markets. The findings report that some of these markets are weak-form inefficient.

In the present study, we make an attempt to reassess the weak-form EMH of four different European stock markets such as the UK, Germany, France and Italy. In doing so, we utilize the runs test, the variance-ratio test, the augmented Dickey-Fuller test and the Phillips and Perron test to examine market efficiency. Our sample period ranges from January 1998 to December 2014. Using the monthly data, we document that the selected markets are not week form efficient. The rest of the paper will be structured as follows. Section 2 summarizes the

data and the methodologies. Section 3 discusses the outcomes. Section 4 involves concluding comments.

2. Data and Methodology

We obtain the monthly price index of Indian stock market from Datastream. The sample period varies from January 1998 to December 2014. Table 1 reports the descriptive statistics for the different return (computed from the price indexes) series. For example, consider the UK security market. Table 1 then indicates that the returns vary from -14 to 9% with a reported standard deviation of 4%. In addition, the returns are negatively skewed and the kurtosis amounts to 3.92. Moreover, the mean return is 0.2%.

Table 1: Descriptive Statistics

Markets	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis
UK	-0.14	0.09	0.002	0.04	-0.79	3.92
Germany	-0.29	0.20	0.004	0.07	-0.93	5.82
France	-0.19	0.13	0.002	0.05	-0.60	3.67
Italy	-0.18	0.19	-0.001	0.06	-0.21	3.71

2.1 Runs Test

The runs test is applied to investigate the null hypothesis that the successive price changes do not depend on each other. By detecting the number of runs, that is, the successive price changes with the same sign, in a sequence of successive price changes, we test the null hypothesis of a random walk. We consider the mean return of the period under study as the threshold value. We have a positive sign each time the return exceeds the mean and a negative sign each time the return is less than the mean. Now let X indicate the actual number of runs and μ_X be the expected number of runs. Then the runs test assumes that X equals its expected value if the price changes follow a random walk. However, the runs test is a distribution free test, i.e. it does not require the normality assumption.

Let m and n denote the numbers of positive and negative returns respectively. Also let $N = m + n$ be the sample size. For a large N, the test statistic, given below, approximately follows a normal distribution with mean zero and unit variance.

$$Z = \frac{X - \mu_X}{\sigma_X} \qquad (1)$$

Here, $\mu_X = \frac{2mn}{N} + 1$ and $\sigma_X = \sqrt{\frac{2mn(2mn-N)}{N^2(N-1)}}$.

2.2 Unit Root Tests

One of the popular unit root tests is the augmented Dickey-Fuller (ADF) test which is used to verify whether the prices in the stock market are random. For an illustration, consider the following regression model:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \beta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{it-i} + \epsilon_{it} \qquad (2)$$

Within this framework, y_t denotes the price at time *t*, $\Delta y_t = y_t - y_{t-1}$, t refers to the trend term, and α_0, α_1, β and γ_i's are the model parameters. Now testing $H_0: \beta = 0$ is equivalent to testing the null hypothesis of a random walk.

Since the ADF test requires that the errors are conditionally homoscedastic, we consider applying the Phillips- Perron (PP) test as an alternative. The PP test also verifies whether the β in equation (2) is significant. However, the PP test has the disadvantage of being less powerful than the ADF test.

2.3 Variance Ratio Test

The variance ratio test, proposed by Lo and MacKinlay (1988), is based on the property that the variance of increments of a random walk, say y_t, is linear in its data interval. Let r_t denote the return at time *t*, where *t* varies from 1 to *T*. Also let σ_q^2 be $1/q$ the variance of the q-th difference and σ_1^2 indicate the variance of the first difference. Then the variance ratio test suggests that under the null hypothesis of a random walk, $VR(q) = \frac{\sigma_q^2}{\sigma_1^2}$ approaches unity.

3. Empirical Findings

Table 2 presents the results from the runs test. These findings suggest that the total number of runs and the expected number of runs are not equal which infers that price changes do depart from a random walk. The *p*-value in each case also concludes the same. We, therefore, document that each of these markets is weak-form inefficient.

Table 2: Results of the Runs Test

Markets	Threshold Value	X	μ_X	m	n	*p*-value
UK	0.002	110	98	125	79	0.002
Germany	0.004	121	101	90	114	0.001
France	0.002	112	90	114	80	0.000
Italy	-0.001	118	100	120	84	0.000

Table 3 displays the empirical findings of the augmented Dickey-Fuller test as well as the Phillips- Perron test. Both tests draw the same conclusions. We reject the null hypothesis that price changes are random as all the β's are found significant in our analysis. These results are consistent with those documented by previous studies.

Table 3: Results of Unit Root Tests

Markets	Test statistic	p-value
Panel A: ADF Test		
UK	-13.39	0.00
Germany	-13.03	0.00
France	-12.31	0.00
Italy	-13.59	0.00
Panel B: PP Test		
UK	-12.42	0.00
Germany	-12.89	0.00
France	-11.27	0.00
Italy	-12.61	0.00

The results of variance ratio test are presented in Table 4. The test is conducted using the specified lags of 2, 4, 8 and 16. Moreover, we run this test under the assumption of heteroscedasticity. Scrutinizing Table 4 suggests that the variance ratio test is highly significant and hence the null hypothesis of a random walk is rejected implying that the stock markets under study are weak-form inefficient. These results are consistent with those documented by Borges (2010) and Guidi, Gupta and Maheshwari (2011).

Table 4: Results of Variance Ratio Test

Period	z-statistic	p-value
Panel A: UK		
2	-5.31	0.00
4	-5.06	0.00
8	-3.74	0.00
16	-2.77	0.00
Panel B: Germany		
2	-5.01	0.00
4	-4.75	0.00
8	-3.66	0.00
16	-2.79	0.01
Panel C: France		
2	-4.66	0.00
4	-4.61	0.00
8	-3.71	0.00
16	-2.76	0.00
Panel D: Italy		
2	-3.98	0.00
4	-3.69	0.00
8	-3.13	0.00
16	-2.39	0.00

4. Conclusions

A growing body of empirical research investigates the week form efficiency of different equity markets. However, the evidence of week form efficiency in European stock markets is conflicting. In this paper, we try to reassess whether the major European security markets are week form efficient. In order to reach the goal, we employ two different unit root tests, the runs test and the variance ratio test in our empirical investigation. Our findings report that prices in the selected equity markets are not random and hence these markets are week-form inefficient.

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