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The Stock Market of Infrastructure Sector: A Weak-Form EMH Test

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Abstract: ***Infrastructure is one of important aspects in economic growth. Several policies made by the government of Indonesia is believed to be able to generate a positive sentiment on this sector and make this sector enthused by the investors. This research aims to test the weak-form Efficient Market Hypothesis (EMH) on Infrastructure Sectoral Stock Price Index (IHSS INFRA). EMH testing is important to undertake because it can help investors in making the right investment decision. The weak-form EMH testing on IHSS INFRA is conducted through unit root test, autocorrelation test, and runs test. The result of runs test shows that IHSS INFRA is efficicent at weak-form. Meanwhile, the result of unit root test and autocorrelation test indicate that IHSS INFRA is inefficient at weak-form. Therefore, it can be said that IHSS INFRA tends to be inefficient at weak-form.***

Keywords: developing country, infrastructure, random-walk, stock market, weak-form efficient market hypothesis

1. Introduction

Infrastructure is one of important aspects in economic growth. Infrastructure of Indonesia, as a developing country, still ranks the 56th in the world and still relatively falls behind other ASEAN countries such as Singapore, Malaysia, Thailand, and Brunei Darussalam (KEMENKEU 2015). In order to catch up in this matter, the government of Indonesia has made several policies. Several policies made by the government of Indonesia is believed to be able to generate a positive sentiment on this sector. Positive sentiment on this sector is believed to be able to drive the economy faster. Besides, the movement of IHSS INFRA that is relatively stable during the past five years makes this sector an interesting choice for rational investor. The investment objective of an investor is to gain profit. An investor or investment manager must be able to predict the stock movement well so as to obtain the expected return. According to EMH which is developed by Eugene Fama, in an efficient stock market, stock movement cannot be predicted and there will be no one who can defeat market (Bodie *et al*. 2013). The importance of EMH implication has caused many researchers to conduct research regarding EMH on various stock markets in the past twenty years (Gilani *et al*. 2014). Most developed markets are found to be weak-form efficient. Developing markets, on the contrary, are found to be weak-form inefficient (Shiller & Radikoko 2014). EMH implication is important because it can help investor in making the right investment decision (Ananzeh 2016). Therefore, this research aims to test weak-form EMH on IHSS INFRA. According to Groenewold & Kang (1993) and Aatola *et al*. (2010), weak-form EMH testing need to be conducted before testing the other form.

2. Data

The data used in this research are secondary data, namely daily return (processed from index data) of IHSS INFRA in the period of January 2013 to December 2015 (five working days) with the number of observation amounts to 783. The data are obtained from Indonesian Capital Market Electronic Library (ICAMEL) which is currently called The Indonesia Capital Market Institute (TICMI).

3. Methodology

The methods utilized in this research to test the weak-form EMH on IHSS INFRA are as follows: 1) unit root test; 2) autocorrelation test; and 3) runs test. The first step undertaken is calculating the return of IHSS INFRA. It is calculated using this following equation:

$$RT_t = Ln\left(\frac{Pr_t}{Pr_{t-1}}\right)$$

Where:
RT_t : return in period *t,*
Ln : natural logarithm,
Pr_t : adalah close index of IHSS INFRA in period *t,*
Pr_{t-1} : close index of IHSS INFRA in period *t*-1.

Based on Shiller and Radikoko (2014), natural logarithm is utilized so that the return values are more likely to be distributed normally and to dismiss parts of linear dependency between the current and the past return. The result of return calculation is used in the next step to test the weak-form EMH.

Unit root test is undertaken to test the data stationarity (Büyükşalvarci & Abdýoðlu 2011). It is conducted through Augmented Dickey-Fuller (ADF) test. According to Ghimire *et al.* (2016), ADF is the most popular stationarity test. Data stationarity test through ADF is conducted using this following equation:

$$\Delta RT_t = \mu + \alpha_1 T + \gamma RT_{t-1} + \rho_i \sum_{i=1}^{q} \Delta RT_{t-i} + \varepsilon_t$$

Where:
Δ : first difference,
μ : intercept,
γ and : the coefficients that will be estimated,
q : the number of lags used,

T : trend,
α_1 : coefficient of trend that will be estimated,
ε_t : assumed as white noise.

Hypotheses of data stationarity test using ADF namely:
H0 data contains unit root ($\gamma = 0$).
H1 data does not contain unit root.

The lags used in this research is ten and the criteria used is Schwarz Info Criterion (SIC). If the probability value of ADF statistic is less than the α used, then the data does not contain unit root which means that the data is stationary and does not follow random walk, so that the return of IHSS INFRA is inefficient at weak-form.

Autocorrelation test is carried out to measure the correlation level between the current and the past return (Jayakumar & Sulthan 2013). The lags used in this research is ten. Correlation level between the current and the past return of IHSS INFRA can be calculated using this following equation:

$$\rho_k = \sum_{t=1}^{n-k}(RT_t - \overline{RT})(RT_{t+k} - \overline{RT}) \Big/ \sum_{t=1}^{n}(RT_t - \overline{RT})^2$$

Where:
ρ_k : correlation level between the current and the past return of IHSS INFRA,
$\overline{RT}$: average RT,
n : the number of data observed,
k : the lags used.

Autocorrelation test approach is conducted using correlogram Q statistics (Ljung–Box). The value of Q is calculated using this following equation:

$$Q_{LB} = n(n+2)\sum_{t=1}^{k}({\rho_t}^2/n - t)$$

Where:
k : the number of lags used,
n : the sample size used.

Hypotheses of the autocorrelation test using correlogram Q statistics (Ljung–Box) are as follows:
H0 There is no autocorrelation on the first k lags ($\rho_1 = \rho_2 = \cdots = \rho_n$).
H1 There is autocorrelation on the first k lags.

If the probability value of Q statistic is less than the α used, then H0 is rejected which means that there is autocorrelation on the first k lags, so that IHSS INFRA is inefficient at weak-form. In addition to the Ljung-Box approach, autocorrelation test is also conducted using serial correlation LM (Breusch-Godfrey). Hyptheses of autocorrelation test using serial correlation LM (Breusch-Godfrey) are as follows:
H0 There is no serial autocorrelation.
H1 There is serial autocorrelation.

If the probability value of Chi-Square is less than the α used, then H0 is rejected which means that there is serial autocorrelation. If there is autocorrelation on the return of IHSS INFRA, then the return of IHSS INFRA does not follow random walk, so that IHSS INFRA is inefficient at weak-form.

Runs test is undertaken to test the dependency or randomness of a sequence of data (Nikita & Soekarno 2012). Runs test, which is a non-parametric test, is also known as Wald–Wolfowitz test or Geary test (Akber & Muhammad 2014). A run is defined as a recurring event of a variable with the same value or category. It is indexed with two parameters, namely the type of the run and the length of the run. Cut point of the runs test used in this research is zero (0.00), so that the type of the run can have a positive value (more than zero) or negative value (less than zero), while the length of the run is how often the type of the run happens sequentially. The expected average value of a run ($E(R)$) is calculated using this following equation:

$$E(R) = \frac{n + 2n_A n_B}{n}$$

Where:
n : the number of data observed,
n_A : the number of the first run cycle,
n_B : the number of the second run cycle.
Meanwhile, the value of standard deviation (σ_R) is calculated using this following equation:

$$\sigma_R = \sqrt{\frac{2n_A n_B(2n_A n_B - n)}{n^2(n-1)}}$$

Statistical test is carried out by comparing z-value with its critical value. Z-value can be calculated using this following equation:

$$Z = \frac{R - E(R)}{\sigma_R}$$

Where:
R: the number of runs
Hypotheses of the runs test are as follows:
H0 The data is random.
H1 The data is not random.

If the value of Asymp. Sig. (2-tailed) is less than the α used, it means that the data is not random. If the return of IHSS INFRA is not random, then it does not follow random walk, so that IHSS INFRA is inefficient at weak-form.

4. Empirical Result

The result of unit root test using ADF (lags = 10, criteria = SIC) can be seen in Table 1. Table 1 shows that in ADF implementation whether with intercept, trend and intercept, or without trend and intercept, its value of ADF statistic is more negative than its critical value at the α of 1%, 5%, and 10%, with the P-value of 0.0000, so that the H0 is rejected and it can be concluded that the data does not contain unit root. It means that the return of IHSS INFRA is proven to not follow random walk. Based on unit root test, it can be concluded that IHSS INFRA is inefficient at weak-form.

Table 1: The result of unit root test using ADF

Include in test equation	*Test Statistic*	*Critical Value* 1%	5%	10%	*Critical P-value*
Intercept	-18.98	-3.43	-2.86	-2.56	0.00
Trend and intercept	-19.00	-3.96	-3.41	-3.13	0.00
None	-18.99	-2.56	-1.94	-1.61	0.00

Source: Author calculation

Autocorrelation test using Ljung-Box Q statistic is conducted to check the strength and correlation direction between the return of IHSS INFRA and its lags, namely lag 1 to lag 10. The result of correlation test using Ljung-Box Q statistic shows that there is a significant autocorrelation on lag 3 to lag 10 with a different direction or correlation, namely negative on lag 3 to lag 5 and positive on lag 6 to lag 10. The strongest correlation is seen on lag 3 and lag 4 with negative direction, namely with the autocorrelation value of -0.141 and -0.094. The complete result of autocorrelation test using Ljung-Box Q statisticsis portrayed in Table 2.

Table 2: The result of autocorrelation test using Ljung-Box Q

AC	*PAC*	*Lag*	*AC*	*PAC*	*Q-Stat*	*Prob*
.| |	.| |	1	0.004	0.004	0.0112	0.916
.| |	.| |	2	-0.054	-0.054	2.3110	0.315
*| |	*| |	3	-0.141	-0.141	17.928	0.000
*| |	*| |	4	-0.094	-0.099	24.823	0.000
.| |	.| |	5	-0.012	-0.030	24.932	0.000
.| |	.| |	6	0.000	-0.032	24.933	0.000
.| |	.| |	7	0.044	0.014	26.439	0.000
.| |	.| |	8	0.053	0.039	28.705	0.000
.| |	.| |	9	0.019	0.016	28.983	0.001
.| |	.| |	10	0.052	0.066	31.156	0.001

Source: Author calculation

Aside from the autocorrelation test using Ljung-Box Q statistic, this research also conducts autocorrelation test using Breusch-Godfrey serial LM to check the correlation of the residuals on the lags used, namely with lags of ten. The value of F-statistic, Obs*R-squared, and their probability can be seen in Table 3. The null hypothesis on Breusch-Godfrey serial LM test is that there is no autocorrelation of the residuals on the lags used. The result indicates that the null hypothesis is rejected, so that it can be concluded that there is autocorrelation of the return of IHSS INFRA's residuals on the first ten lags.

Table 3: The result of autocorrelation test using serial LM

F-statistic	*Prob. F(10,770)*	*Obs*R-squared*	*Prob. Chi-Square(10)*
3.2422	0.0004	31.5974	0.0005

Source: Author calculation

According to the autocorrelation test using Ljung-Box Q statistic and Breusch-Godfrey serial LM, it can be concluded that the return of IHSS INFRA does not follow random walk. The conclusion of autocorrelation test result is that the IHSS INFRA is inefficient in weak-form.

The result of runs test with the number of observation of 783 and cut point of zero (0.00) shows that the number of runs is 381 and the z-value is -0.399. The value of runs shows the number of sign change of the series of IHSS INFRA's return. The null hypothesis of the runs test is that the data is random. The result shows that the null hypothesis cannot be rejected because the value of Asymp. Sig. (2-tailed) is more than the α = 5%, so that it can be concluded that the movement of IHSS INFRA's return is random. The result of runs test can be seen in Table 4. According to the runs test, the return of IHSS INFRA follows random walk, so that IHSS INFRA is efficient at weak-form.

Table 4: The result of runs test

Test Value(a)	*Total Cases*	*Number of Runs*	*Z*	*Asymp. Sig. (2-tailed)*
.000	783	381	-.399	.690

Source: Author calculation

5. Conclusion

Although the result of runs test shows that IHSS INFRA is efficient at weak-form, but the result of unit root test and autocorrelation test shows that IHSS INFRA is inefficient at weak-form. Therefore, it can be concluded that IHSS INFRA tends to be inefficient at weak-form. The implication from IHSS INFRA that is proven to be inefficient at weak-form is that investor can predict the movement of infrastructure stock using technical analysis. Return of IHSS INFRA as the reflection of market can be referred by investor who wants to invest in this sector, for instance by undertaking diversification in portfolio formation to minimize risk. In addition to technical analysis, fundamental analysis and additional relevant public information can be harnessed for a better prediction. Investor has the opportunity to obtain abnormal return. Inefficiency of IHSS INFRA is probably good for investor who targets abnormal return. However, for regulators, exchange managers, and issuers, it is not a good thing because it means that not all investors obtain the same information and access and not all investors can fully and quickly react using the information.

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