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Examining the Efficiency of American Stock Exchange NASDAQ: An empirical analysis of the Market Efficiency Hypothesis

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Abstract
This research paper is examining the efficiency of the NASDAQ Stock Market via applying the financial economics model "Market Efficiency Hypothesis." The study is covering the latest weekly dataset of NASDAQ Stock Market and testing its efficiency after the global financial crisis to date. Our data set consists of the period of Dec 2009 to Dec 2017, and it is retrieved from the Yahoo finance portal. We applied two econometrics techniques to check that whether the stock exchange index is following random walk hypothesis or not. These techniques include autocorrelation test and Runs test. The empirical analysis of our study postulating that the NASDAQ Stock Market of America is not following the random walk hypothesis and investors can achieve the abnormal returns via predicting the future trends based on the previous stock movements.

Keywords: NASDAQ Stock Market, Random Walk Hypothesis, Market Efficiency Hypothesis, Runs test
JEL Codes: H54, D61

I. Introduction

Stock exchange market is a marketplace where the exchange of companies' stocks and equities take place. If any company needed the finance to run a new or existing project, they would issue their company's shares in the stock exchange market that investors can buy to invest. There are two fundamental ***views of the stock exchange market*** of an economy; the first one is Beauty Contest Theory while the other one is Efficient Market Hypothesis. The ***Beauty Contest model*** of the Stock Market is given by ***John M. Keynes*** in 1936. According to this model, the investment in an economy is depended on the expectations about what the other investor thinks rather than what you expect about the investment. Keynes claims that because people sell their shares to others, so they are more interested in the other people opinions rather than their own. In technical language, he said that the stock price swings often representing the irrational waves of pessimism and optimism, which he gave the name of "***animal spirit of investors***." In a nutshell, the stock market indices are not truly reflecting the economic position of the country.

"Whether the stock market is efficient or not" is the most important question about the financial markets of an economy. Market Efficiency means whether the stock exchange index is reflecting the all available information about the economy. To put in simple words, when the prices fully represent the all available realities and info is discounted immediately, the market is said to be proficient (Darushin, & Lvova, 2015). The ***efficient market hypothesis*** means that the all stocks in the financial market are perfectly representing their true worth. Moreover, if any new information about the company becomes available, the stock index will change quickly to reflect this info. The stock exchange market efficiency totally depends on the ***predictability*** of the future price movements. To keep our discussion simple, the movement of the stock prices should follow an important financial econometric concept "the ***random walk*** hypothesis". This model is presented by the ***Eugene Fama in 1970s***.

Efficient Market Hypothesis have three prime types which are; 1) Weak, 2) Semi-strong, and 3) Strong Efficient Market Hypothesis. Some assumptions must be held to make this model applicable to a financial market. These assumptions include a large number of sellers and buyers, people have rational expectations, and availability of the perfect information about the economy. The model has ***strong implications*** because if the stock prices are predictable, then everyone would be a billionaire. So, the efficiency of the market required that the stock should be unpredictable are following the random walks hypothesis (Gilson, & Kraakman, 2014). In order to assess the efficiency of stock marekts around the world, there are plenty of studies conducted by the researchers. In our study, we will examine the efficiency of the American stock exchange market after the global financial crises 2008 to date. That is why we take the data from 2009 to 2017. In this study, we will try to find out the answers to our ***research questions***:

- Whether the American stock exchange (NASDAQ Stock Market) is efficient or not?
- Is the NASDAQ Stock Market is following the random walk hypothesis theory?

This paper consists of four different sections including, Literature Review, Data and Methodology, Results and conclusion.

II. Literature Review

A plethora of research is available which deals with the measurement of stock exchange markets. In this section, we will try to cover some important previous studies that related to the stock exchange efficiency and market index movements. Fama (1970) postulates that the stock exchange markets are following the efficient market hypothesis which means their fluctuations are random and unpredictable. He supported his study via providing the empirical results about three different categories of random walk hypothesis model; 1) Weak, 2) Semi-strong, and 3) Strong Efficient Market Hypothesis. Furthermore, Fama and French (1988) conducted a study about the analysis of portfolio data of industry covering the period of 1926 to 1985, and the results of autocorrelation concluded a U shaped pattern against increasing return. Another prominent study conducted by the Lo and McKinley (1988) on NYSE: AMEX covering the period of 1962-1985. Their results claims the rejection of the random walk hypothesis during the understudy time period. Urrutia (1995) examine the random walk hypothesis for the Latin American stock exchanges based on monthly data. He used the variance ratio test that rejected the random walk hypothesis. Gu (2004) investigate the efficiency of NASDAQ composite index for the period of 1971-2001 and found that the NASDAQ daily returns are not weak form efficient.

III. Data and Methodology

To test the efficiency of an American stock exchange "NASDAQ Stock Market," we applied two prominent econometric tests on our data. The first test is known as ***Runs test*** which is used to check the random walk hypothesis for the NASDAQ Stock Market. First of all, we convert our data to binary in Microsoft excel then find the number of runs in data. To understand the idea of test, consider the following downward and upward changes in the index

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A positive sign means that the index is increasing while the negative means that the stock price is decreasing. So there are twelve observations with seven runs. Then we find the number of zeros and number of ones in binary series. Then we find the expected value of Runs, variance, standard deviation, Z-value, and p-value. The whole calculations of the paper is conducted with the help pf using Microsoft Excel Add-Ins. The second test we apply to our data set is the ***autocorrelation test***. The purpose of this test is to examine the hypothesis that our data series is independently and identically distributed. If autocorrelation results are found significant, then our NASDAQ index do not follow a random walk, and the stock exchange will be considered as inefficient. The data we used in our research paper is ***NASDAQ Composite Weekly Index 2009-2017*** which is retrieved from the ***Yahoo Finance*** website. Then we run two different models; one is without taking the log of the series while other is after taking the log of the series. In later model, we convert our index into a natural log with a one period lag and our final index obtained via dividing current log value to previous period log value. The basic objective of ***taking the log*** of the time series is to make sure that our data is ***not a non-stationary*** because the non-stationary data can cause misspecification of the model.

IV. Results

Our result section consists of five parts which include the descriptive analysis, Runs Test without Log, Runs Test with Log, Autocorrelation Test, and graphical analysis of the data.

Descriptive Analysis Chart

Table 1

Descriptive Analysis	
Mean	3993.33915
Standard Error	62.77592674
Median	4062.52002
Standard Deviation	1284.991173
Sample Variance	1651202.314
Kurtosis	-0.975222953
Skewness	0.335578741
Range	4844.792969
Minimum	2091.790039
Maximum	6936.583008

This table is presenting the descriptive statistical analysis of the NASDAQ index. These analyses are used to describe some prominent statistical features of our NASDAQ index time series. According to the table, the highest value of the NASDAQ index during 2009 to 2017 weekly data remain 6936.58, and the lowest value of the NASDAQ index is 2091.79. The index continues to change weekly during the specified period 3999.33 on average. The dispersion in the NASDAQ index data is measured by the standard deviation which is 1285 in this case. To put in simple ways, the average distance of each data point from the mean is 1285 statistical points. Similarly, we can analyze our whole table of descriptive statistics one by one where Kurtosis is used to check the peakedness of the distribution of our data while the range is the difference between largest and smallest value of the index.

Runs Test without Log

Table 2

Run Test Without Log	
R	2
n0	206
n1	213
N	419
E(R)	210.4415274
Variance (R)	104.4409375
Standard Deviation (R)	10.2196349
Z Value	-20.39618141
p-value	9.03973E-93
p-value (two sided)	0.00

As we mentioned earlier that the Runs test is used to check the randomness of a data series. To put in simple words, it is used to test that whether the random walk hypothesis theory applies to the understudy dataset or not. Table number 2 is showing the output of Runs test without taking the log of the NASDAQ index. The probability value of the test is 0.00 and is significant at the confidence interval of 95 %. To keep our discussion simple, a probability value is less than 0.05 which means that the NASDAQ index is not following the randomness over time.

Runs Test after taking log

Table 3

Run Test With Log	
R	129
n0	198
n1	221
N	419
E(R)	209.8687351
Variance (R)	103.8690903
Standard Deviation (R)	10.19161863
Z Value	-7.934827431
p-value	1.05394E-15
p-value (two sided)	0.00

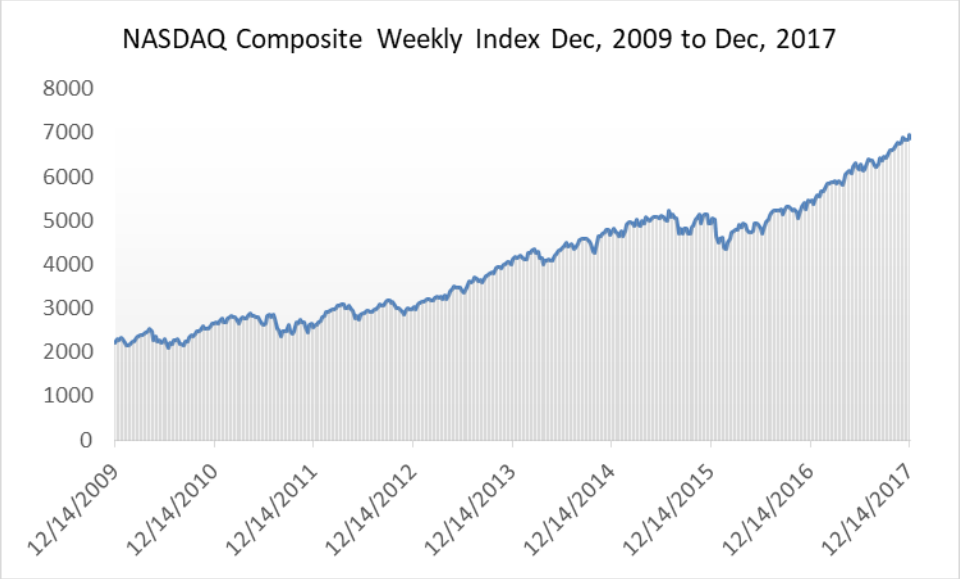
Table number 3 is showing the output of Runs test with taking the log of the NASDAQ index. The probability value of the test is 0.00 and is significant at the confidence interval of 95 %. Similar to previous, probability value is less than 0.05 which means that the NASDAQ index is not following the randomness over time. The purpose of taking the log of the index is to make sure that our time series is a stationary.

Autocorrelation Test

Table 4

Lag	Autocorrelation	Std. Error	Box-Ljung Statistic		
			Value	Df	Sig.
1	.071	.018	16.258	1	.000
2	-.032	.018	19.573	2	.000
3	-.008	.018	19.781	3	.000
4	.019	.018	20.954	4	.000
5	-.028	.018	23.406	5	.000
6	-.062	.018	35.626	6	.000
7	.021	.018	36.995	7	.000
8	.044	.018	43.192	8	.000
9	.039	.018	48.033	9	.000
10	.017	.018	48.956	10	.000
11	-.023	.018	50.638	11	.000
12	-.004	.018	50.687	12	.000
13	.015	.018	51.402	13	.000
14	.038	.018	55.948	14	.000
15	-.014	.018	56.588	15	.000
16	.000	.018	56.588	16	.000

To further confirm our results of the Runs test, we applied the autocorrelation test on the data and output of this test is presented in Table number 4. This test is consisted of 16 lag periods, and the output lag by lag is provided in above table. The 1st lag of the table is showing .071 autocorrelation with SE 0.018 and BL value 16.258. This postulating that the weekly NASDAQ index of the stock exchange is not following the Random walk theory. Similarly, almost seven values showing the negative autocorrelation and the p-value is 0.000 and significant at 5 % level of significance. In a nutshell, the NASDAQ index is not exhibiting randomness.



Graph 1

Our whole empirical analysis can be confirmed form the above-given graph which we obtained from plotting NASDAQ index on vertical axis and time on the horizontal axis. This graph is showing that there is a positive slope of the weekly NASDAQ index which means there is no randomness is found in the data.

V. Conclusion

There are so many studies have been conducted to investigate the efficiency of stock markets. Our study is also an attempt to examine the NASDAQ Stock Market via applying the financial economics model Market Efficiency Hypothesis. First of all, we study the alternative views of stock exchange markets like Keynes Beauty Contest and

Market Efficiency Hypothesis. Then we reviewed the previous researchers to examine the previous findings of other scholars. Then we took the data on NASDAQ Stock Market index and applied some test to check the randomness of time series. Our results are showing that the NASDAQ Stock Market index is not showing any randomness. We plot its weekly index during the understudy period and found that the data is showing a positive trend since the global financial crises.

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