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Testing of Dubai Financial Market for Weak Form of Efficiency

Jihad Yuzbashev

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By
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Testing of Dubai Financial Market for weak form of efficiency

By

Jihad Yuzbashev

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ABSTRACT

Testing of Dubai Financial Marker for weak form of efficiency.

By:

Jihad Yuzbashev

The following research paper is the first research to concentrate its focus primarily on the testing of the Dubai Financial Market (DFM) for weak form of efficiency. In order to obtain best results, the Random Walk model is be used to determine whether closing prices in the DFM are reflecting historical prices. The Autocorrelation Test, Runs Test and Variance Ratio Test will be used to determine whether the Random Walk theory is applicable to the DFM General Index. A number of research studies that have focused on detecting weak forms of efficiency have used the Random Walk model and the previously mentioned tests. In order to obtain best results this study used similar models and tests. Data that is used in this research work consists of daily closing prices from the time period of 8/14/2008 to 7/24/2014. Results of the following research indicate that Dubai Financial Market General Index is weakly inefficient.

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HYPOTHESIS QUESTION.

"Is Dubai Financial Market efficient in the weak form?"

Autocorrelation Test

H_0: *the time series are randomly distributed*

H_a: *the time series are not randomly distibuted*

Runs Test

H_0: *the sequence was produced in random manner*

H_a: *the sequence was not produced in a random manner*

Variance Ratio Test

H_0: *the time series are random, if* $VR(q) = 0$ *for each integer* q

H_a: *the time series are not randomly distibuted, if* $VR(q) \neq 0$ *for each integer* q

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CHAPTER 1

INTRODUCTION

The capital markets play major roles in the market economy, due to the fact it can be an intermediary unit of the economy and can turn savings into investments. Also, it is important to remember that capital markets provide liquidity to investors and improve the efficient allocation of resources. Knowing these facts, the question that needs to be answered is just how efficient a particular capital market is. Answering this question is very important for investors and policymakers who are working with emerging equity markets. In order to obtain an answer for this question they need to obtain results of testing of efficiency of this financial market.

The Dubai Financial Market (DFM) was established on March 26, 2000 in Dubai, Arab Emirates. The following research is focused on testing the DFM for weak form of efficiency. This research will add additional information to the body of knowledge of previous studies that were testing weak form of efficiency of the United Arab Emirates Financial Markets by Squalli (2005) and Moustafa (2004). This includes studies of the DFM that were conducted prior to 2008, and due to this, previous studies did not include testing of the DFM General Index that was established in 2008. The following study will have the most recent data and will provide results that are current. The presence of weak form efficiency in the DFM will indicate that future stock prices cannot be predicted on the basis of past stock prices. Following this train of thought, the presence of weak-form efficiency suggests that technical analysis will be ineffective, and if past stock prices cannot be used to predict future stock prices, there is no need to pay close attention to fluctuations of stock charts.

Currently there are 66 companies listed in this financial market, however not all of the companies that are listed in Dubai Financial Market originated in Dubai. Some of the companies are originally from other Middle Eastern and Northern African countries (MENA), and therefore these companies are listed both on Dubai Financial Market and their country of origin market. The majority of stocks that are traded of DFM are publicly traded and allow outsiders to invest in them. Originally the DFM was established as a public institution having its own independent legal entity. However, in 2005 the Dubai Financial Market was transformed into a public shareholding company, and initial capital was equal to 8 billion Arab Emirate Dirhams (AED). Eight billion Arab Emirate Dirhams is equivalent to US $2,177,996,800; which was broken down into 8 billion shares. Approximately 20% (1.6 billion) of these shares were available for the Initial Public Offering, and at that moment the Dubai Financial Market was the United Arab Emirates first stock exchange to offer an IPO. The number of subscriptions for this IPO was much larger than predicted. The amount was equal to AED 201 billion, which is the equivalent to US $54,723,661,020.00 (Dubai Financial Markets Investors Handbook 2012).

DFM is currently governed and regulated by the legal entity known as the Securities and Commodities Authority. All of the laws and standards are enforced by this legal entity and complied by Dubai Financial Market. The primary concern of the Securities and Commodities Authority is to guarantee investors and brokers that all the regulations are followed by the DFM, as well as to defend rights of companies that are listed on this financial market. It is also important to understand that Dubai Financial Market functions in accordance with Islamic Law (Sharia), which has a particular set of laws and regulations for Islamic banking. According to the Director-General of Dubai Financial Market, Essa Kazim (2010), the primary reason for the modifications in the DFM was high demand from both local and international investors. The DFM is the first stock market that decided to comply with the laws of Sharia, and therefore has made them more attractive for the large scale of local and international companies that would prefer to participate in a market that follows Islamic law. The profit that will be made from trading will be divided into two groups; conventional, which includes any stocks that are preferred by investors and Sharia obedient. The Sharia obedient group excludes earnings on stocks of companies in industries that produce alcoholic beverages, cigarettes, pork products and defense equipment. In order to efficiently comply with trading that follows Islamic law, Dubai Financial Market will have to keep two distinct account journals each for particular type of return. Details of journal entries will be discussed with current investors consistently in order to sustain a policy of transparency.

The Dubai Financial Market is considered to be the fastest growing financial market in the region, Essa Kazim (2013). This financial market is involved in secondary market trading that focuses on securities issued by public shareholding companies, bonds issued by Dubai's federal or local governments, local public institutions, and mutual funds as well as other local or foreign financial instruments that are approved by DFM.

The increasing interest in investment opportunities in the emerging economy of Dubai has raised an important question about the efficiency of the Dubai Financial Market. The primary reason for identification of efficiency in this particular market is to define the relationship between changing prices in financial markets and their trading history. In this case, if the market is considered to be weakly efficient, then the prices that are paid for stocks in this market reflect new information. Market efficiency reduces the probability of market distortions. An efficient financial markets to support and stimulate an economy, as it provides a means for companies and governments to nurture financial needs for infrastructural improvements. This brings up the most significant question of this research, "Is the Dubai Financial Market efficient in the weak form?" There were similar studies that were focused on the wider picture, such as a study by Squallli (2005) who was discussing and testing UAE financial markets consisting of two financial markets (the Abu Dhabi Securities Market (ADSM) and the Dubai Financial Market (DFM)) for weak form efficiency. In this study, the emphasis is primarily focused on the testing of Dubai Financial Market for weak form of efficiency.

CHAPTER 2

LITERATURE REVIEW

The Efficient Market Hypothesis takes an important position in the financial economics world, and also highly depends on the efficient use of data that is provided to the majority of players in this field. An asset market can be considered efficient if the price of some particular asset complies with the information provided in the market. This statement indicates that if in fact this theory is correct, participants in efficient markets will be limited from attaining abnormal profits. The Efficient Market Hypothesis was developed by Eugene F. Fama and Paul A. Samuelson in the 1960s, and ever since then this model has been a stepping stone for empirical studies covering prices of financial securities as well as giving fundamental understandings on the price-discovery process. Although the core of the Efficient Market Hypothesis was born through the contributions of Eugene F. Fama and Paul A. Samuelson, there were further contributions by Lo and MacKinlay (1988), who found that under the Random Walk Hypothesis (RWH) variance growth was faster than linearly with increase of the holding period. This indicated positive serial correlation in weekly returns. French and Roll (1986) also documented the interesting phenomenon that during weekends and stock exchange holidays, stock return variance will turn out to be much lower than return variance over the same amount of days when the market is operating. Furthermore, some of the other contributions of EMH include Fisher (1963), Solnik (1973) who both supported the random walk model, and Cooper (1982) who also conducted a study that included 36 world stock markets to test the accuracy of Random Walk Hypothesis. Cooper (1982) received results of the study that supports the validity of the Random Walk Hypothesis in the U.S. and U.K. These results, however, were rejected in other financial markets. Also studies conducted by Harvey (1995) and Khababa (1998) indicated that the financial status of developing and less developed countries are not weakly efficient. However, when looking at studies that were focused on testing weak form of efficiency for emerging markets, different results were found. Studies by Cheung and Coutts (2001) indicated signs of weak form of efficiency. It is important to note that these results are not true for all of the emerging markets, and according to the study by Lee (2001) and Smith (2002) there is evidence of predictability of stock prices in some emerging markets. Alam Hasan and Kadapakkam (1999) tested Asian financial markets for RWH hypothesis, including Sri Lanka, Taiwan, Hong Kong, Bangladesh and Malaysia. The results stated that almost all of the above mentioned countries' index returns follow the trail of random walk. Sri Lanka's index was the only index that rejected the random walk hypothesis. Some other studies had similar results and rejected the random walk hypothesis. These include the Poshakwale (2002) study of the Indian financial market and the Darrat and Zhong (2000) test of the Chinese financial market. A study by Hoque, Kim and Pyun (2007) tested eight Asian emerging market for the random walk hypothesis, and the results of their study indicate that closing prices of most of the financial markets in Asian developing countries do not follow the random walk hypothesis. The only two exceptions in their study were Korea and Taiwan that showed presence of a random walk.

Paul Samuelson (1965) contributed a great amount of knowledge to the study of efficient market hypothesis through his article "Proof That Properly Anticipated Prices Fluctuate Randomly." In this article, Samuelson discussed unforeseeable price changes, purely based on information that is provided in the market and the expectations of participants of this market. One of the primary motivators for Samuelson's study was his interest the mechanics and kinematics of prices, through which he was able to find answers for dynamic and consumption saving problems, warrant and option pricing analysis. The kinematics mentioned by Samuelson is focused on the geometry of motion, which includes position, velocity and acceleration of stock prices.

On the other hand, Eugene F. Fama's seminal papers (1965) were mostly focused on researching statistical properties of stock prices and looking for the solution of debates of technical analysis to fundamental analysis. He was one of the first economists to use a computer to form empirical studies in finance. Fama's research led him to important methodological and empirical contributions, and his studies provided a better understanding of single and multi-factor linger asset pricing models as well as host of empirical regularities and anomalies in financial markets.

Looking over the concept of efficient market hypothesis, it is clear that the efficiency of the market requires randomized price changes in this market. Furthermore the market with a weak form of efficiency is considered to have price changes that cannot be linked to past prices. This kind of price behavior could seem to be a coincidence that repeats over and over again. In reality, however, this kind of behavior of a market can be linked to participants who are trying to use their information to obtain abnormal returns. Even the slightest additional information can be seen as an opportunity to increase return by any market participants, and this information is not something solely available to them. By using it, they fix the market prices to newly available information and abolish the chance to gain that additional return.

Referring back to the study by Fama (1970), there are three key models to help better understand efficiency of the market:

I. The Fair Game Model

II. The Submartingale Model

III. The Random Walk Model

In order to obtain desired results, all of the above mentioned models are discussed in this study in following order:

2. 1 The Fair Game Model

The Fair Game, by definition, presents a scenario of competition in which all contestants tend to break even in the long run due to reliance on laws of probability rather than external factors. In the financial world, fair game indicates a state with zero risk premium, and furthermore, no chance of using market information to obtain higher than average return. In Fama's (1970) discussion of the theory of efficient capital market, his concern is to provide a formal representation of the intuitive notion that prices fully reflect available information. This general implication can be converted into the formation and notation shown in equation 3.1. In addition, "most of the available work is based on the assumption that the conditions of market equilibrium can be stated in terms of expected returns" (Fama 1970 p.384). The expected return theory is formulated in the following equation:

$$E(\tilde{P}_{j,t+1}|I_t) = [1 + E(\tilde{r}_{j,t+1}|I_t)]P_{j,t} \qquad 2$$

Where

- E is the expected value operator, and $E(\tilde{P}_{j,t+1}|I_t)$ is the equilibrium expected return at time t+1 on the basis of information set I_t
- $P_{j,t}$ is the price of security j at time t
- $r_{j,t+1}$ is the one-period return
- I_t is a set of information

Fama presented the fair game model by following equations

$$x_{j,t+1} = P_{j,t+1} - E(\tilde{P}_{j,t+1}|I_t) \qquad 2.2$$

And

$$z_{j,t+1} = r_{j,t+1} - E(\tilde{r}_{j,t+1}|I_t) \qquad 2.3$$

Then

$$E(\tilde{x}_{j,t+1}|I_t) = E(\tilde{z}_{j,t+1}|I_t) = 0 \qquad 2.4$$

Where

$x_{j,t+1}$, is the difference between actual market price and the conditionally expected market price or excess market value of security. *j* at time *t+1*. $z_{j,t+1}$, is the difference between actual market return and the conditionally expected market return. If the property of equation 3.4 is satisfied, stochastic process $\tilde{x}_{j,t}$ with the condition on information set I_t is fair game. In other words, the excess return and excess market value are zero.

2.2 The Submartinagale Model

The Submartingale Model is a kind of stochastic process. The expected value of next period's value is estimated on the basis of the current period's information is greater than or equal to the current period's value. This statement can be mathematically formulated as the following inequality:

$$E(\tilde{P}_{j,t+1}|I_t) \geq P_{j,t} \qquad 2.5$$

This statement also holds equivalently in return of security as shown in the following:

$$E(\tilde{r}_{j,t+1}|I_t) \geq r_{j,t} \qquad 2.6$$

If inequalities (2.5) and (2.6) are held, then price sequence follows a martingale. The submartingale model has important empirical implication. In order to better understand this model, one needs to take into consideration "one security and cash" trading rules. This implies that the systems that focus on individual securities further determine the circumstances in which an investor would decide to hold or short given security or would prefer to hold cash instead at any given time *t*. Furthermore, it's important to refer to the assumption that was used in equation *(2.6)*. According to this equation the expected returns are conditional on I_t are positive, which points out that given trading rules are built solely on given information I_t. Therefore, expected returns are not able to achieve higher expected profits than the policy of consistent buying and holding throughout future periods. Moreover, tests of this rules are a crucial part of the empirical evidence of the EMH (Fama 1970, p.386).

2.3 The Random Walk Model

The efficient market is a market in which prices change in accordance with the available information. Looking at the stock market, it becomes clear that in order to measure the intrinsic value of shares, an individual needs to take into consideration the future discounted value of cash flow that will be accrued by investors. If the stock market is thought to be efficient, its stock prices must change in accordance with all the available information that provides feedback on the company's future performance. This supports the statement that the market price of any given share has to be identical to this shares intrinsic value. A supply of new information that is expected to affect company's future performance will instantly affect the share prices of that company. Due to these factors, the efficient market's immediate change in prices of any given stocks can be caused only by the supply of new information. New information is supplied chaotically which causes random change and fluctuations in stock prices. The model below provides complete understanding of the Random Walk theory.

$$P_{t+1} = P_t + e_{t+1} \qquad 2.8$$

P_{t+1} -Indicates price of particular share at time of *t+1*

P_t -Indicates price of particular share at time of *t*

e_{t+1} - Indicates random error with zero mean and finite variance

Looking at the model, the value of a particular share at period of *t+1* is equivalent to the value of this share at period of *t* with the addition of fresh information that will arrive in the period somewhere between *t* and *t+1*. Therefore, it can be determined that fluctuations of prices are not dependent on changes in the value of stock in the past.

Looking over the random walk hypothesis, it stipulates that if the stock prices follow The Random Walk, then changes in prices that occur are white noise. Testing the financial market returns to determine whether these returns are white noise or not, is relative to the testing of the financial market to determine whether the market is following The Random Walk. According to Fama (1970), the empirical test of the Random Walk Model is far more supportive of the efficient market hypothesis rather than his previous fair game model. Following Fama's thinking, this research is mostly based on the theory of The Random Walk. Furthermore, Fama (1970) segregates efficient market hypothesis in three subgroups; weak, semi-strong and strong form of efficient market hypothesis. In the following sections these three forms are discussed, with the biggest emphasis on the weak form of efficient market testing.

2.4 The weak form of The Efficient Market Hypothesis

The weak form of market efficiency indicates past stock prices have no effect on current market prices. Therefore, it can't be used as a tool for achievement of abnormal returns. Also, according to the weak form of efficient market hypothesis, technical analysis cannot provide additional information that could assist investors in the prediction of future fluctuations in stock prices. Conversely, if the current market prices can be affected by the relative information in the market such as; financial information on the firm's money supply, interest rates, and exchange rates, this kind of market is considered to have Semi-Strong Efficiency. Furthermore, if some information is not publicly available, the market participants are not able to make any abnormal returns. This market would be considered as Strong Efficiency. Looking at a market with strong efficiency, it is notable that current market prices reflect all the public information that is available in the market and all private not publicly available information.

Reviewing several empirical studies that focus on testing of a weak form of efficiency on emerging stock markets, it becomes apparent that even though this subject originated over 40 years ago, the majority of studies still continue to debate over the efficient market hypothesis. It is important to note that the weak form of efficiency indicates current prices do not reflect past price, and therefore the stock prices in weak efficiency market change unpredictably. This can be linked to the random walk theory. In order to determine weak efficiency of the market, the past and the present prices need to be tested for correlation. There are several common tests that are used for revealing of Random Walk. One such is the Runs test, which was used in research studies by

Karemera (1999), Barnes (1996) and Abraham (2002). After testing past and present price for correlation, the next step for defining weak form of market efficiency is to test for serial correlation, which can be tested through a Q-test used in order to verify significances of a set of coefficients. This method to test for serial correlation was used in studies by Moorkerjee and Yu (1999), Abeysekera (2001) and Fawson (1996). After testing the prices for serial correlation, the Variance ratio test can be used to verify random walk. The Variance ratio test was used in studies by Alam (1999), Chang and Ting (2000) and Karemera (1999). This study will test DFM General Index for 1. Correlation of past and present prices; 2. Serial correlation using Q-test to verify coefficient significance; and 3. The Variance ratio test to verify RWH. Applying these three tests to the Dubai Financial Market General Index will provide information as to whether or not the DFM has a weak form of efficiency through the Random Walk Hypothesis.

CHAPTER 3

MATERIALS AND METHODS

Variables

The daily market returns are used as an individual time-series variable for the research. According to Dickinson and Muragu (1994), limitation on systematized database of the exchange is a cause of a significantly limiting effect on the market studies in developing countries. However, there is a solution to this issue. According to Sharma and Kennedy (1977), it is very helpful to use a market index that is published and comes free or at a lower cost.

The data used in this study consists of daily price series of the Dubai financial market general index from June 13, 2004 to June 13, 2014. The information is obtained through Stocknod.com, which is publically available. The natural log alternation is conducted to produce a time series of continuously compounded returns, which is calculated through following formula:

$$r_t = log(p_t) - log(p_{t-1}) = log\left(\frac{p_t}{p_{t-1}}\right) \qquad 3.1$$

p_t- Is stock price at time *t*

p_{t-1}- Is stock price at time *t -1*

3.1 Autocorrelation Test

The autocorrelation test is a first step towards identifying the random walk of stock price in the Dubai Financial Market. Autocorrelation testing compare stock returns in past and present periods and provides better understanding of correlation between these two stock returns. For the given autocorrelation test null hypothesis and alternative hypothesis is stated as following:

$$H_0: \textit{the time series are randomly distributed}$$

$$H_a: \textit{the time series are not randomly distibuted}$$

With the assumption that the critical value of testing is following chi squared distribution with α significance level and p degrees of freedom. If $Q > X^2_{1-a,h}$, the null hypothesis would be rejected. In other words, it indicates that time series are not randomly distributed.

The Autocorrelation test is formulated as following:

$$p_k = \frac{\sum_{t-1}^{N-K}(r_{t+k} - \check{r})}{\sum_{t=1}^{N}(r_t - \check{r})^2} \qquad 3.2$$

p_k-Serial correlation coefficient of given stock returns lag

N- Number of observations

r_t -Stock return over given period of time t

r_{t+k} -Stock return over given period of time $t+k$

r- Sample mean of given stock return

k - Lag of the given period

The model above is used to verify the difference of a given serial correlation coefficient from zero. Ideally, in order to detect weak form efficiency in the Dubai Financial Market, stock returns are not supposed to be serially correlated, and therefore p_k is close to zero. In order to proceed with testing of joint hypothesis to prove that all the provided autocorrelations are corresponding to zero, the LJung-Box test will be used. The Ljung-Box test is employed for the first p lags at 99% confidence interval, where p represents the number of lags being tested. LJung-Box Test with 15 lagged autocorrelation is widely used by Engle (2001). Similar testing was done by Victor K. Gimba (2012) to test the Nigerian Stock Market for weak- form of efficiency, Abdul Haque, Hung-Chun Liu and Fakhar-Un-Nisa (2010) for testing the Weak Form Efficiency of the Pakistani Stock Market, and also by Abu Towhid Muhammad Shaker (2013) for testing the weak- form of efficiency in the Finnish and Swedish stock markets. The following model presents The Ljung-Box (LB) statistics and LB test tests the null hypothesis that the data is independently distributed, and alternative hypothesis that the data is not independently distributed.

The statistical value of LB test is found by equation 3.3

$$Q_{LB} = N(N+2)\Sigma_{j=1}^{k}\frac{{p_j}^2}{N-j} \qquad 3.3$$

N -Represents number of observations

p_j- Represents given j^{th} autocorrelations

k- Indicates number of autocorrelations

3.2 Runs Test

This test will be required to inspect and understand if the sequence used in this testing is random or not. In order to prove that the series of data are random in this study, the number of observations need to be equal to numerical value of runs in this study. The runs test provides understanding whether or not the sequence is produced in a random manner, and the hypothesis is stated as following:

$$H_0: the\ sequence\ was\ produced\ in\ random\ manner$$

$$H_a: the\ sequence\ was\ not\ produced\ in\ a\ random\ manner$$

If the p-value of the Z statistic is greater than the significance level, 5% of the significance level in this study, the null hypothesis will be rejected. The test indicates that the stock index return series are not in random order.

This test can be explained as the categorization of repeated changes in stock price. There are three categories of stock price changes. The first category is a downward run that indicates that the price is decreasing. The second category is an upward run that shows that the prices is increasing. The third category is a flat run that is used to indicate that the prices are stable. The model below can be used to predict the total amount of runs in the empirical studies with null hypothesis that supports the randomness of price changes. This test was used in several imperial studies to obtain more knowledge about market efficiency in various marketplaces and stock exchanges throughout the world. A Runs test was used by Lim Kai Jie, Chadha, Lau and Potdar (2012) to test for the weak form Market Efficiency in the Mongolian stock market, and also a similar study was done by Gimba (2012) for the Nigerian stock market. Ma and Barnes (2001) used this model to test the Chinese stock market.

The Run test is formulated as:

$$M = \frac{(N(N+1) - \Sigma_{j=1}^{3} * n_j^2}{N} \quad 3.4$$

N- Indicates the total number of provide observations

n_i- represents the amount of changes in price for each group

Furthermore, if the study consists of a larger amount of observations, for example over 30 observations, the sampling distribution of given *m* can be considered normal. Hence, the standard error *m* can be produced by following the model:

$$\delta_m = \left(\frac{\Sigma_{j=1}^{3} n_i^2 \left(\Sigma_{j=1}^{3} n_i^2 + N(N+1)\right) - 2N\Sigma_{j=1}^{3} n_i^3 - N^3}{N^2(N-1)}\right)^{1/2} \quad 3.5$$

In addition to the standard run test to obtain verification on whether the actual number of given runs is constant with the hypothesis of independence, Z-stat can be used.

$$Z = (R \pm 0.5 - m)/\delta_m \quad 3.6$$

m- Indicates the expected number of runs

0.5- Indicates the continuity adjustment

$R \geq m$- Indicates that the continuity adjustment will be negative (-)

$R \leq m$- Indicates that the continuity adjustment will positive (+)

R- Indicates the actual number of runs; also, due to dependency between share returns when the number of runs is fewer or more, the test will be two tailed.

3.3 Variance Ratio Test

The Random walk theory indicates that the best predictor of a stock price is its current value since the information comes unpredictably. The unpredictability of current stock prices can be associated with the Random Walk Model. Being a non-stationary process, it indicates that the variance and mean will be increasing over time. For the given Variance Ratio Test, the null hypothesis and alternative hypothesis is stated as following:

$$H_0: the\ time\ series\ are\ random, if\ VR(q) = 0\ for\ each\ integer\ q$$

$$H_a: the\ time\ series\ are\ not\ randomly\ distibuted, if\ VR(q) \neq 0\ for\ each\ integer\ q$$

With assumption that the standard normal distribution is used to calculate the critical values. If the statistical value of Z from equation 3.13 and 3.14 is greater than the critical value at predetermined significance level, then the random walk hypothesis will be rejected.

Following equation represents Random walk model with a drift process:

$$p_t = p_{t-1} + \mu + \epsilon_t \qquad 3.7$$

p_t Is represented as the stock price at time t, μ - an arbitrary drift parameter and ϵ_t- a random error term. If the stock price is random, then its return randomly distributed. Therefore, we can consider the following random walk model with drift process in examining the behavior of the stock price index.

$$r_t = r_{t-1} + \mu + \epsilon_t \qquad 3.8$$

$$\Delta r_t = \mu + \epsilon_t \qquad 3.9$$

Where:

Δr_t- The changes in return

μ - An arbitrary drift parameter

ϵ_t- A random error term

Each random error term represents the arrival of new information and must be independent of each other. If a random error term is independent and normally distributed, then a significant fact comes from the random walk model. The time interval of a stock prices relationship with its variance is the principal of the straightforward specification test that was created by Lo and MacKinlay (1988). They created the test of random walk null hypothesis with the alternative assumption of homoscedastic and heteroscedastic disturbance.

With uncorrelated residuals and uncorrelated increments in p_t, the variance of these increments increases linearly in the observation interval.

$$Var(p_t - p_{t-q}) = qVar(p_t - p_{t-1}) \qquad 3.10$$

In order to obtain $VR(q)$, one will need to use the equation 3.5, and *VR(q)=1* under the null hypothesis or null hypothesis. The alternative hypothesis are stated that $H_0: VR(q) = 0$.and $H_1: VR(q) \neq 0$ for each integer q.

$$VR(q) = \frac{\frac{1}{q}Var(p_t - p_{t-q} - q)}{Var(p_t - p_{t-1})} = \frac{\delta^2(q)}{\delta^2(1)} \qquad 3.11$$

Taking into consideration the sample size, in order to compute $\delta^2(q)$ and $\delta^2(1)$, which is *nq+1* following the formulas will be used:

$$\delta^2(q) = \frac{\Sigma_{i=q}^{nq}(p_t - p_{t-q} - q\hat{u})^2}{h} \quad 3.12$$

Where h and $\hat{u}$ can be computed through following equations:

$$h = q(nq + 1 - q)(1 - \frac{q}{nq}) \quad 3.13$$

$$\hat{u} = \frac{1}{nq}\Sigma_{t=1}^{nq} * p_t - p_{t-1} = \frac{1}{nq}(p_{nq} - p_0) \quad 3.14$$

$$\delta^2(1) = \frac{\Sigma_{t=1}^{nq}(p_t - p_{t-1} - \hat{u})^2}{(nq - 1)} \quad 3.15$$

The following two equations that were created by Lo &MacKinlay (1988) will provide calculations for the standard normal test stats of $Z(q)$ and $Z^*(q)$, with the notion of homoscedasticity and heteroscedasticity.

$$Z(q) = \frac{VR(q) - 1}{(\emptyset(q))^{1/2}} \sim N(0,1) \quad 3.16$$

$$Z * (q) = \frac{VR(q) - 1}{(\emptyset * (q))^{1/2}} \sim N(0,1) \quad 3.17$$

In order to obtain $\emptyset\ (q)$ and $\emptyset^*(q)$, one must use equations 3.18 and 3.19. $\emptyset\ (q)$ which is an asymptotic variance in this variance ratio test with respect to homoscedasticity. $\emptyset^*(q)$ is on the other hand an asymptotic variance in this variance ratio test with respect to heteroscedasticity.

$$\emptyset(q) = \frac{2(2q - 1)(q - 1)}{3q(nq)} \quad 3.18$$

$$\emptyset * (q) = \Sigma_{j=1}^{q-1}(\frac{2(q - j)}{q})^2 * \delta(j) \quad 3.19$$

In order to obtain $\delta(j)$, which is the consistent estimator of heteroscedasticity in an asymptotic variance, one will need to use the following variance ratio test with respect to heteroscedasticity:

$$\delta(j) = \frac{\sum_{j+1}^{nq}(p_t - p_{t-1} - \hat{u})^2(p_{t-1} - p_{t-j-1} - \hat{u})^2}{(\sum_{t=1}^{nq}(p_t - p_{t-1} - \hat{u})^2)^2} \qquad 3.20$$

CHAPTER 4

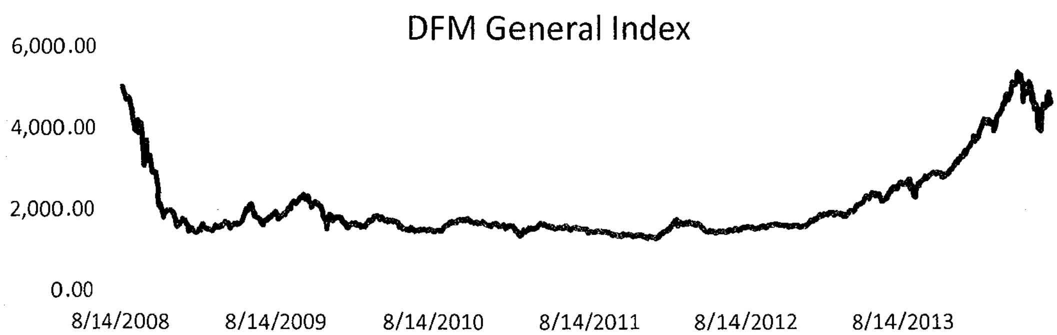
DATA COLLECTION AND PRESENTATION

Chapter four covers the performance of the Dubai Financial Markets General Index (DFMGI) in the period from 8/14/2008 to 7/24/2014. The closing prices that were used in order to compute price changes were obtained from the public website www.stocknod.com. DFMGI consists of the 61 companies that are currently listed on the Dubai Financial Market. This research tried to determine whether or not prices in the Dubai Financial Market follow the trail of Random Walk Model.

4.1. Market condition during the sample period

Subsequent Figures 4.1 and Figure 1 from the Appendix section present a visual picture of the daily market index price changes in accordance with daily returns, as calculated in the previous chapter using the Natural Log Alternation to produce a time series of continuously compound return. Figure 4.1 and Figure 1 in the Appendix section indicate that the DFM General Index suffered a rapid drop during 2008. The DFM began to show a market increase in late 2012 and early 2013. In 2013, the DFM recovered from the crisis of 2008. During that period of time, the index dropped to its lowest point on 2/5/2009 at 1,433.00 points. This indicates that it has dropped by 350% from the starting point on 8/14/2008 when the index was at 5,018 points. Such a rapid decrease could be caused by several reasons. Dubai had one of the strongest property price drops of 50% starting from 2008 (Deutsche Bank AG, n.d.). Furthermore, the World Financial Crisis caused losses in billions of dollars' worth of building projects that had to stop or were canceled, further causing a domino effect by revoking thousands of job positions in Dubai (Canadian Broadcasting Corporation [CBC], 2009.). This kind of outcome nearly pushed Dubai World, the largest state-owned company, into bankruptcy with outstanding debt of $59 billion (CBC, 2009.) Dubai World has several worldwide property acquisitions that did not turn out as profitable and beneficial as was planned. In the period from 2006 to 2008, Dubai World purchased a container terminal in Vancouver's inner harbor and acquired ownership of several major U.S. ports. The idea of U.S. ports being owned and maintained by a Middle Eastern company was not accepted by U.S. legislators due to concern for the national security. This caused Dubai World to sell its U.S. port assets during the global economy downturn (CBC, 2009). Another purchase worth 50 million pound that was made by Dubai World was the Turnberry Resort. This port was located in Scotland, however the resort was sold to the British in 2009. In 2007, one of the U.S. subsidiaries of Dubai World's made the acquisition of Barney's New York luxury retailer for nearly $1 billion; however, due to the period of crisis, this purchase of a luxury retailer turned out to very unprofitable and brought nothing but additional losses to Dubai World. Looking at Figure 4.1, it can be seen that similar to recovery of global market economy DFM General Index started to regain its pre-crisis position in 2013.

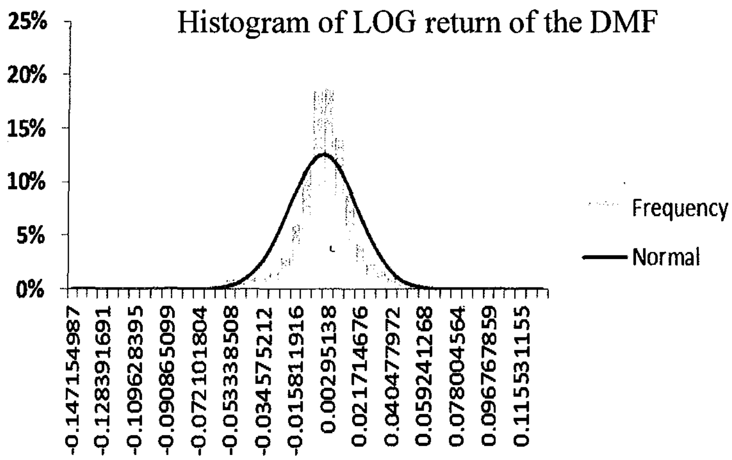
Figure 4.1: DFM General Index (Source: Stocknod.com)



4.2. Descriptive Statistics

Table 4.1 indicates that the DFM mean return was equal to 0.0057% and standard deviation is equal to 1.9% in the time period from 8/14/2008 to 7/24/2014. These factors provide proof that the Dubai Financial Market General Index has lower or close to average volatility when looking at other financial markets indexes that were previously studied. Knowing that lower volatility is an indicator of a smaller potential to receiving a higher rate of return, additionally it indicates reduced risk.

Table 4.1: Statistics for return



Series: R	
Sample 1 1320	
Observations 1320	
Mean	-5.74e-05
Median	0.000628
Maximum	0.131167
Minimum	-0.150282
Std. Dev.	0.019757
Skewness	-0.854079
Kurtosis	11.47836
Jarque-Bera	4114.018
Probability	0.000000

Table 4.1, indicates that in the time period from 8/14/2008 to 7/24/2014, the lowest and highest given values were -15% and 13%. The return series demonstrate a negative skewedness, which indicates that given distributions has a longer left tail. Another factor to be considered is excess value for kurtosis. Such excess kurtosis value indicates a leptokurtic distribution. A leptokurtic distribution indicates that future returns can turn out on either sides of extreme, large or small. The Jackque- Bera test results that were given in Table 4.1 demonstrate that it is not a normal distribution and rejects the null hypothesis that the returns are normally distributed. The results in returns are at the extreme ends of the distribution curve. The returns could be skewed to be very large or very small.

CHAPTER 5

DATA ANALYSIS

5.1 Autocorrelation Test

In order to test the weak form of efficiency in The Dubai Financial Market, one needs to first conduct an autocorrelation test with 15 lags for daily returns of the DFM General Index in a period from 8/14/2008 to 7/24/2014. The result from an autocorrelation test is presented in Table 1 in the appendix section. The following table 5.1 demonstrates the result from the autocorrelation test in terms of the first 10 lags.

Table 5.1: Autocorrelation test

Lags	1	2	3	4	5	6	7	8	9	10
Autocorrelation	0.108	0.059	0.003	-0.014	0.015	0.047	0.022	0.012	0.039	0.102
Partial autocorrelation	0.108	0.048	-0.008	-0.016	0.019	0.045	0.011	0.003	0.037	0.097
Q-Stat	15.458	20.116	20.131	20.381	20.679	23.556	24.2	24.392	26.403	40.224
Prob	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.000

Table 5.1 indicates that autocorrelation coefficients are significantly different from zero for all the lags. The results of the autocorrelation test provides sufficient evidence to reject the null hypothesis that the return is randomly distributed. The fact that p-values for the Q-test turned out to be lower than the significance level of 1%, indicates that the null hypothesis for each lag is rejected. It is important to mention that the positive

sign of autocorrelation coefficients provides understanding that sequential daily retunes are likely to have the same signs. For Example, a positive or negative return today will indicate that the return of the following days will turn out to be identically positive or negative. The results of the Ljung-Box Q test point out that the autocorrelation coefficients of all 15 lags are mutually significant at a given 1% level. The statistical value of the Ljung-Box test of 51 was found to be greater than the critical value of 30, the value of chi-squared distribution with 15 degrees of freedom and 1% of significance level. Therefore, the Ljung-Box test does not support the null hypothesis that all 15 lags of autocorrelation coefficients are equal to zero. The empirical results for the Autocorrelation test that were stated above, indicate that there is sufficient evidence to reject the null hypothesis that times series are randomly distributed in the DFM General Index.

5.2 Runs Test

The Runs test results are in Table 5.2. The Runs test converts the total number of runs into a Z statistic. The daily index's returns series are used to test the random walk, when the expected number of runs is significantly different from the observed number of runs. The test rejects the null hypothesis that the daily index return series are random.

Table 5.2: Runs test

Number of runs	653
Number of observations below average	705
Number of observations above average	615
Number of observations	1320
Expected value of runs	657.9318182
Variance of runs	326.6887657
Standard deviation of runs	18.07453362
Z=	-0.273
p-value	0.392

The *p* value is the probability of obtaining a *Z* statistic as extreme or more extreme (in absolute value) than the obtained value, if the order of ratings above and below the median is purely random. The negative z-values for all the indexes indicate that the actual number of runs fall short of the expected number of runs. The result of runs test indicate that there is sufficient evidence to reject the null hypothesis that the sequence was produced in random manner in both instances, where median and mean are used as the base.

5.3 Variance Ratio Test

The autocorrelation test shows that the values of the sample autocorrelation function are relatively not too high, but are different from zero. Additionally, the Ljung Box-test indicates that the daily time series for the DFM index is not random walk, as shown in the previous autocorrelation test section of chapter 5. The following table 5.3 shows the result of the variance test for q=2, 4, 8, and 16. In the table, q indicates randomly selected sampling interval periods at which variance ratio was tested. Sampling intervals that were used in this study are also used in the original study by Lo and MacKinlay (1988). For this test, the 1% of significance level was selected, that means the critical value of normal distribution, Z, is ±2.32. This indicates, if the statistical value of Variance Ratio test lies within the interval of -2.32 and +2.32, that the DFM General Index stock prices are following the trail of Random Walk Hypothesis. This also means that the null hypothesis cannot be rejected.

Table 5.3: The result of Variance ratio test for log return of DFM General Index

Period	q= 2	q= 4	q= 8	q= 16
z-Statistic	-8.815961	-7.358612	-5.802983	-4.348562

From the result of the variance ratio test shown in table 5.3, the Z-values calculated do not lie within the interval. The results of variance ratio test indicate that there is sufficient evidence to reject the null hypothesis, and that the variance ratio is random for each integer *q*. This further proves that the Dubai Financial Market General Index is not following the Random Walk Hypothesis according to Variance Ratio Test.

CHAPTER 6

CONCLUSION

In the research of three tests known as the Autocorrelation test, Runs test and Variance ratio test, were applied to test the Dubai Financial Market for weak form efficiency. The data that were used in the following tests were obtained through public websites and contain a collection of General Index price changes for approximately 6 years, ranging from 8/14/2008 to 7/24/2014. The results that were achieved through testing, indicate that all three tests provide sufficient evidence to reject the previously stated null hypothesis and therefore also reject the randomness of price changes in the DFM.

According to the results of the Autocorrelation Test, the autocorrelation coefficients are significantly different from zero for all the lags. This provides sufficient evidence to reject the null hypothesis stating that the returns are distributed in random manor. Furthermore, the results of the Ljung-Box Q test state that the statistical value of the Ljung-Box test of 51 was found to be greater than the critical value of 30. The results of The Runs Test illustrate that the actual number of runs fall short of the expected number of runs. The results of The Variance Ratio Test show that the calculated Z-values do not lay within the given interval of -2.32 and +2.32. All these factors indicate that the null hypothesis that was given for each test is rejected, which indicates the absence of weak for of efficiency in the DFM. Results of all the previously mentioned tests fail to support the Random Walk Hypothesis in Dubai Financial Market General Index and acceptance of alternative hypothesis. The results indicate weak form inefficiency of this financial market. After reviewing several other studies that had similar results, such as Gimba (2012) and Shukla & Sakhareliya (2013), it can be concluded that this kind of outcome is very common in emerging markets and financial markets with low frequency trading. In conclusion, for further studies on efficiency of the Dubai Financial Market it would be greatly beneficial to look into causes of inefficiency in Dubai Financial Market and try to add additional information to the body of knowledge regarding this matter.

APPENDIX

Table 1: Autocorrelation test

Date: 08/05/14 Time: 17:32
Sample: 1 1320
Included observations: 1320

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
|* |	|* |	1	0.108	0.108	15.458	0.000
| |	| |	2	0.059	0.048	20.116	0.000
| |	| |	3	0.003	-0.008	20.131	0.000
| |	| |	4	-0.014	-0.016	20.381	0.000
| |	| |	5	0.015	0.019	20.679	0.001
| |	| |	6	0.047	0.045	23.556	0.001
| |	| |	7	0.022	0.011	24.200	0.001
| |	| |	8	0.012	0.003	24.392	0.002
| |	| |	9	0.039	0.037	26.403	0.002
|* |	|* |	10	0.102	0.097	40.224	0.000
| |	| |	11	0.011	-0.014	40.378	0.000
| |	| |	12	0.009	-0.004	40.477	0.000
| |	| |	13	0.061	0.063	45.424	0.000
| |	| |	14	0.060	0.052	50.232	0.000
| |	| |	15	0.029	0.006	51.362	0.000

Table 2: The result of Variance ratio test for log return of DFM General Index

Null Hypothesis: R is a martingale
Date: 08/07/14 Time: 14:57
Sample: 1 1320
Included observations: 1319 (after adjustments)
Heteroskedasticity robust standard error estimates
User-specified lags: 2 4 8 16

Joint Tests	Value	df	Probability
Max |z| (at period 2)*	8.815961	1319	0.0000

Individual Tests

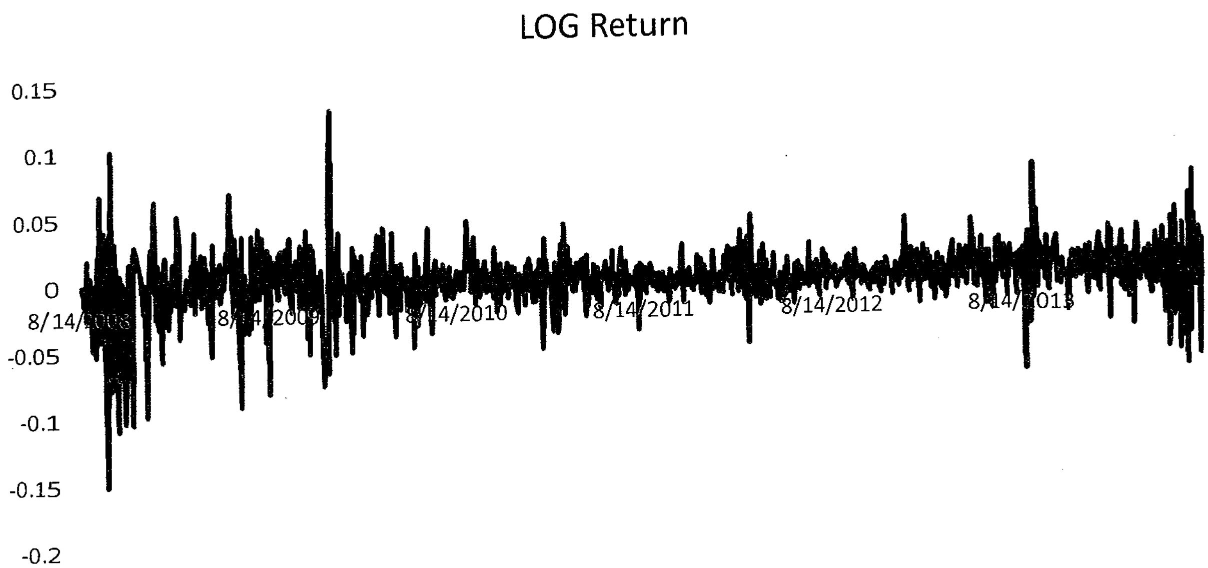
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.528145	0.053523	-8.815961	0.0000
4	0.285163	0.097143	-7.358612	0.0000
8	0.138906	0.148388	-5.802983	0.0000
16	0.067905	0.214346	-4.348562	0.0000

*Probability approximation using studentized maximum modulus with parameter value 4 and infinite degrees of freedom

Test Details (Mean = -1.6960340087e-06)

Period	Variance	Var. Ratio	Obs.
1	0.00070	--	1319
2	0.00037	0.52815	1318
4	0.00020	0.28516	1316
8	9.7E-05	0.13891	1312
16	4.7E-05	0.06790	1304

Figure 1: LOG Return of DFM General Index daily closing price, period from 8/14/2008 to 7/24/2014.



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