WEAK FORM MARKET EFFICIENCY DURING THE 2008 FINANCIAL CRISIS: EVIDENCE FROM THE MUSCAT SECURITIES MARKET

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ABSTRACT

This paper examines the weak-form market efficiency of the Muscat Securities Market in Oman before, during, and after the 2008 global financial crisis using daily observations from the Muscat Securities Market index. The data were divided into three different periods: pre-crisis from January 1, 2007 to June 8, 2008, crisis from June 9, 2008 to January 22, 2009 and post-crisis from January 23, 2009 to January 17, 2011. The parametric tests of serial correlation using the Ljung and Box (1978) Q-Statistics and the variance ratio test of Lo and Mackinlay (1988) were used to test weak-form market efficiency. Findings of both methodologies revealed that the Muscat Securities Market was inefficient at the weak form during all three time periods: pre-crisis, crisis and post-crisis for most lags. Moreover, using adjusted returns provided more efficient lags than using the raw data. The results from this period of volatility are consistent with previous research testing weak-form market efficiency.

JEL: G01

KEYWORDS: Muscat Securities Market, Financial Crisis, Serial Correlation, Variance Ratio Test, Weak-Form Market Efficiency

INTRODUCTION

The financial crisis started in the United States during 2007. When the mortgage crisis reached the stock market and other financial and non-financial sectors in 2008, it spread to the world. Asongu (2011) concluded that Asian markets were the worst hit, while Latin American countries were the least affected. The exception to this finding was India in Asia and Peru, Venezuela, and Columbia in Latin America. Other emerging markets in the Middle East and Africa followed the trends of the rest of the world. Dubai, Jordon, Lebanon, Morocco and Kenya, however, were exceptions in the Middle East and Africa, as these markets faced greater risks from their credit, real estate, and financial markets.

The collapse of the United States housing market created the financial crisis. The financial crisis, however, was also fueled by credit availability, toxic mortgages, artificially low interest rates, concern about whether there was sufficient regulation or transparency related to firm balance sheets and the risk of derivative financial assets created and marketed by major financial institutions.

The mortgage crisis was the result of diminishing homeowner equity, as housing prices softened following a period of easy money and excess demand. Banks provided the easy money though low, variable interest rate home loans to buyers who would not normally qualify. When home prices began to fall and interest rates started to increase, many borrowers defaulted in their loans and refinancing became much more difficult. Mortgage backed securities held by financial firms, foreign investors, and governments lost most of their value. The failure of Lehman Brothers, the near collapse of insurance giant American Insurance Group (AIG) and the concern over transparency of the balance sheets of major financial institutions were major events and created the players in the financial crisis. Taken together,

events caused credit policy to become more restrictive, resulting in slowing economic growth in the United States (The Financial Crisis Inquiry Reports, 2011).

Oman benefited with other Gulf Cooperation Council countries from the increase in oil prices, from their 2001 level of $20 per barrel, to a record high of $148 in the middle of 2008, when the financial crisis started to develop. Oman and other Gulf Cooperation Council members found their economic and financial sectors to not be fully protected from global events such as the financial crisis. The effects were felt more or less across all Gulf Cooperation Council markets, as these markets are highly correlated. Although the market demonstrated a strong level of resistance, policy makers managed to reduce the effect. However, the global financial crisis was still having an effect on these countries, after being transmitted from the United States. Sedik and Willams (2011) found the equity markets of Gulf Cooperation Council countries to be less than immune from regional and global financial shocks. Oman, as other countries, felt the effects of the financial crisis through the decline in oil prices, which were the main revenue generator for the country, and also through the decline in the stock market due to the credit crunch and the selling of real estate by foreign investors. Moreover, all Gulf Cooperation Council Sovereign Wealth Funds (SWFs) were affected by the financial crisis, but full disclosure is not available for these funds due to a lack of transparency (Ellaboudy, 2010).

This study examines the weak form market efficiency of the Muscat Securities Market during the 2008 financial crisis using three different market stages: pre-crisis from January 1, 2007 to June 8, 2008, crisis from June 9, 2008 to January 22, 2009 and post-crisis from January 23, 2009 to January 17, 2011. The Muscat Securities Market is characterized by infrequent trading for some listed companies, low trading volume, low liquidity and a small number of investors participating in the market. No short selling is allowed and no derivatives instruments are available for trading. All previous literature that has tested the weak-form of market efficiency has been conducted at different time periods and most of them find the Muscat Securities Market to be inefficient. But no work has considered the potential effect of the global financial crisis using both the serial correlation test and the variance ratio test.

This paper is organized as follows. Section 2 illustrates the literature review in weak form market efficiency from different markets. Section 3 presents the hypothesis and section 4 addresses the data and methodology. The statistical and empirical results are in section 5. Finally, the conclusion is in section 6.

LITERATURE REVIEW

Fama (1970) divided the efficient market hypothesis into three different hypotheses based on information: weak-form efficient market hypothesis, semi-strong-form efficient market hypothesis and strong-form efficient market hypothesis.

The weak form posits that historical information is fully reflected in current stock prices. Thus, investors cannot use technical analysis of pricing patterns to predict the intrinsic value of stock prices. Moreover, the weak form market efficiency test is specifically designed to show that successive price returns are random and independent. As a result, techniques do not exist that can be used by investors to achieve an abnormal return.

The semi-strong form states that historical and current available information are fully reflected in stock prices. It implies that investors can neither use technical analysis nor fundamental analysis to derive the investment value of stocks. Such information includes dividends announcements, mergers and acquisitions announcements, and earnings announcements. The semi-strong form of market efficiency implies that the market is also weak form market efficient.

The strong-form means that historical, current and insider trading is fully reflected in the stock prices at any point of time, which implies that technical analysis, fundamental analysis and even insider information, only available to the top the management of a company, provides no value to investors in predicting future prices. The strong-form market efficiency implies both the weak form market efficiency and the semi-strong market efficiency. Fama (1991) renamed the three categories of the efficient market hypothesis; weak-form, semi-strong-form and strong-form; to be defined by tests. The weak form is tested against the predictability of returns. If a market is weak-form efficient, the semi-strong form is test using event studies. Finally, for markets that are found to be both weak and semi-strong form efficient, the strong form is tested using information on private information.

Weak form market efficiency can be statistically tested, through empirically testing the random walk. The testing of the randomness of prices dates to 1900 when Louis Bachelier submitted his doctoral paper in mathematics to Sorbonne University. He was the first to mention that stock price movements and other commodities prices follow a random walk. He said: "*Past, present, and even discounted future events are reflected in market price,"* (Dimson and Mussavian, 1998). The work of Bachelier was not recognized until Working (1934) confirmed the result and Cowls and Jones (1937) produced the same results to support Bachelier (1900) and Working (1934).

Solnik (1973) investigated market efficiency using serial correlation for 234 securities in eight major European stock markets (France, United Kingdom, Germany, Italy, The Netherlands, Belgium, Switzerland, and Sweden). He used daily prices from March 1966 to April 1971. He found that the deviation of these markets from the random walk is more than what has been found in the United States but the correlation coefficient is small. At the limit, when the correlation is zero, the market is considered to be efficient at the weak form of market efficiency using the serial correlation test.

Another major study on market efficiency tested the weak form of market efficiency on data collected from 18 different nations from January 1961 through December 1992, a period of 32 years, using the unit root test (Chan, Gup and Pan, 1997). Their research included Australia, Belgium, Canada, Denmark, Finland, France, Germany, India, Italy, Japan, Netherlands, Norway, Pakistan, Spain, Sweden, Switzerland, the United Kingdom and the United States to test the weak form of market efficiency. The study showed that during the period of study, and using monthly returns, all markets in the eighteen nations were efficient at the weak form. The unit root test was used to test whether time series data are random or not.

Buguk and Brorsen (2003) tested the weak form of market efficiency on the Istanbul Stock Exchange (ISE). The data were collected on a weekly basis for the market index, industrial index and financial index from 1992 to 1999. They concluded that the market was weak form efficient under the variance ratio test. When using the rank- and sign-based variance ratio testing methodology, however, the ISE was not found to be weak form efficient. Similarly, Smith and Ryoo (2003) found Turkey to be an efficient market, whereas Greece, Hungary, Poland and Portugal were inefficient using the variance ratio test. Furthermore, they noticed that the Istanbul Stock Exchange was more liquid than the other four markets, which could be one of the explanations behind efficiency. They collected their data using weekly returns from the third week of April 1991 to last week of August 1998. Zychowicz, Binbasioglu and Kazancioglu (1995), however, found that the Istanbul stock exchange rejected the random walk using daily and weekly data but when using monthly data the market was efficient. Besides that, Dockery and Vergari (1997) found the Hungary market to be efficient using variance ratio test between January 1991 and May 1995.

Sharma and Kennedy (1977) studied the Bombay Stock Exchange in India, where they tested the random walk hypothesis using runs and serial correlation test. These they compared with stock markets in United States and United Kingdom. They concluded that the Bombay market followed a random walk similar to other advanced markets.

Ang and Pohlman (1978) used serial correlation to investigate weak form efficiency in five far eastern countries (Japan, Singapore, Hong Kong, Australia and Philippines). They used weekly prices from May 1970 to November 1974 for Australia, from September 1967 to November 1974 for Hong Kong, from May 1970 to November 1974 for Japan, from September 1973 to November 1974 for Philippines, and from May 1972 to November 1974 for the stocks of 54 companies. They concluded that these markets were inefficient during the time periods studied. Hong (1978) tested the same countries, except for the Philippines, using both serial correlation and runs test and also found that these markets to be predictable. Thus, they are weak form inefficient..

Abraham, Seyyed and Alsakran (2002) used variance ratio and runs test for the same three markets, between October 1992 and December 1998, and found that Saudi Arabia and Bahrain were weak-form efficient when using adjusted returns and inefficient for all three markets when using raw data. They corrected the data using the methodology developed by Beveridge and Nelson (1981).

Alam, Hasan and Kadapakkam (1999) investigated stock market efficiency in five Asian countries: Bangladesh, Hong Kong, Malaysia, Sri Lanka, and Taiwan using monthly stock returns and the variance ratio test. They found that all markets were efficient except Sri Lanka during the period from November 1986 to December 1995. Cheung and Coutts (2001), however, found the Hong Kong stock market to be inefficient using the variance ratio test between January 1985 and June 1997.

Another study of the Taiwan Stock Market conducted by Lock (2007) shows that the stock index was following a random walk. The period of study used to conduct their research was from 1996 to 2006. They employed weekly return data to conduct a Lo and Mackinlay variance ratio test as a means to test the random walk. Lock concluded that it was not only the index that follows a random walk but, also, the individual stocks within the index. Chang and Ting (2000) and Fawson, Glover, Fang and Chang (1996) confirmed the findings by finding the Taiwan Stock Market to be weak form efficient.

Hassan and Chowdhury (2008) found that the Dhaka Stock Exchange in Bangladesh was weak form efficient but the 46 actively traded individual stocks were not. They used monthly data from January 1991 to May 2003 while employing the variance ratio test. A similar study by Islam and Khaled (2005) found the Dhaka market to be efficient after the 1996 stock crash, but not before.

Hamid, Suleman, Shah and Akash (2010) looked at the weak form of market efficiency in Asian Pacific countries; including Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Taiwan, Japan and Australia. They used monthly observations from January 2004 to January 2009. The paper used Ljung-Box Q-statistic serial correlation test, runs test, unit root test and the variance ratio testing methodology to test the efficiency of these markets. The results found all markets to not be efficient in the weak form of market efficiency. Similarly Chakraborty (2006) and Bashir, Ilyas and Furrukh (2011) found the same result for Pakistan between January 1996 and November 2005 and June 1997-April 2009, respectively. Abeysekera (2001) also found Sri Lanka to be inefficient using autocorrelation, runs and variance ratio tests between January 1991 and November 1996.

Okpara (2010) investigated the Nigerian stock market for the period of January 1984 to December 2006 using the runs test and Ljung-Box Q-statistics serial correlation test. He found the Nigerian Stock Exchange to be efficient in the weak form and investors, therefore, could not predict the future prices using historical information. His finding was consistent with a previous study of the Nigeria Stock Exchange conducted between 1977 and 1979 by Samuels and Yacout (1981).

DATA AND METHODOLOGY

Research Hypothesis

This paper examines the weak form market efficiency during the 2008 financial crisis in Muscat Securities Market at three market stages: the pre-crisis from January 1, 2007 to June 8, 2008, the crisis from June 9, 2008 to January 22, 2009 and the post crisis from January 23, 2009 to January 17, 2011. The null hypothesis is:

H_0 : The Muscat Securities Market (MSM30) is efficient in the weak form of the efficient market hypothesis, during the three defined stages: pre-crisis (January 1, 2007-June 8, 2008), crisis (June 9, 2008-January 22, 2009) and post-crisis (January 9, 2009-January 17, 2011).

The data used in this paper were collected in 2012 from the Muscat Securities Market website: www.msm.gov.om. The data employed were for the daily stock price index for the MSM30 for three distinct market periods: pre-crisis from January 1, 2007 to June 8, 2008 with a total of 361 observations; crisis, from June 9, 2008 to January 22, 2009 with a total of 148 observations; and post crisis, from January 23, 2009 to January 17, 2011 with 490 observations. The serial correlation or the serial correlation test is used here to measure the correlation coefficient between the MSM30 daily return using different day lags (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, and 30). A zero correlation coefficient implies that the return of MSM30 is random and, therefore, efficient. A significant positive or negative correlation coefficient, however, implies that there is a trend in the daily price returns of the MSM30. The serial correlation is measured by calculating the beta coefficient from the following regression equation:

$$R_{i,t} = a_i + \beta_i R_{i,t-k} + \varepsilon_{i,t} \quad (1)$$

Where:

$R_{i,t}$ = The daily return of MSM30 at time t
a_i = Constant
β_i = The correlation coefficient of the current and lagged return
$\varepsilon_{i,t}$ = The random error

k = Represents different time lags in days, k=(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, and 30 days)
The random walk implies that a market is efficient when there is no significant correlation exists between stock prices. This means that:

$$\beta_1 = \beta_2 = \beta_3 = \cdots = \beta_j = 0 \quad (2)$$

The Ljung and Box (1978) Q-Statistics test is used to test for the serial correlation between stock prices. This test is first developed by Box and Pierce (1970). The Ljung and Box test is designed to find if there is any departure from the zero serial correlation at different time lags. The test statistic is calculates by:

$$Q = n(n+2)\sum_{k=1}^{h} \frac{\hat{\rho}_k^2}{n-k} \quad (3)$$

Where:

n = Sample size
h = Number of lags
$\hat{\rho}_k$ = Sample serial correlation at lag k

If the calculated value of Q $(in\ (3))$exceeds the critical value of Q from a χ^2distribution at a specific level of significance for the degrees of freedom in the sample, then the null hypothesis is rejected. The null hypothesis is that there is no significant serial correlation and thus the market is weak form efficient. The critical value at Q_{30} = 43.77 at 95% confidence interval.

When the serial correlation test shows statistical significance, it implies that the series of data do not follow the random walk theory and, thus, the market is not efficient. In other words, if B_1 is greater than zero then there is a positive serial correlation, however, if B_1 is less than zero then there is a negative serial correlation. If either result is found, then the MSM30 is assumed to be inefficient and the null hypothesis is rejected. The null hypothesis here is that the correlation coefficients are equal to zero. The alternative hypothesis is that the correlation coefficients are not equal to zero. The null hypothesis means the MSM30 is efficient and the alternative hypothesis means that the market is not efficient.

The second method to be employed is the variance ratio test, following the work of Lo and Mackinlay (1988). In the variance ratio test, the stock market is assumed to follow a random walk only if the variances of the q-period returns are equal to q times the variance of one period return. The assumption underlying the variance ratio test is that stock returns are identically distributed, if not normally, and the variance is linear in the sampling interval. The Lo and Mackinlay is the best fit for normally distributed data so adjusted return will be used to overcome the problem of thin and infrequent trading that is expected in Muscat Securities Market. The one period return, assuming it follows a random walk, is calculated by:

$$Var(p_t - p_{t-n}) = qVar(p_t - p_{t-1}) \quad (4)$$

This means that the variance of n-period return equals n times the variance of its first one period return. And for a multiple periods the variance ratio is calculated as:

$$VR(q) = \frac{\frac{1}{q}Var(p_t - p_{t-n})}{Var(p_t - p_{t-1})} = \frac{\sigma^2(q)}{\sigma^2(1)} \quad (5)$$

Where:

VR(q) = the variance of log prices from t to t-n.

$\sigma^2(q)$ = the unbiased estimator of $\frac{1}{q}$ of the variance of the q^{th} difference of$(p_t - p_{t-n})$ calculated by:

$$\sigma^2(q) = \frac{1}{Tq}\sum_{t=1}^{T}(Y_t - Y_{t-q} - q\hat{u})^2 \quad (6)$$

Where:

$$\hat{u} = \frac{1}{T}\sum_{t=1}^{T}(Y_t - Y_{t-1}) \quad (7)$$

$\sigma^2(1)$ = is the unbiased estimator of the first difference$(p_t - p_{t-1})$.

Lo and Mackinlay (1988) derived two test statistics and generated asymptotic distribution of the estimated variance ratios. The $Z(q)$ is for the null hypothesis of homoscedastic (time invariant variance) increments and $Z^*(q)$ is for the heteroscedasticity (time variant variance) increments. They are calculated as:

$$Z(q) = (VR(q) - 1) * [\hat{s}^2(q)]^{-1/2} \quad (8)$$

$$Z^*(q) = (VR(q) - 1) * [\hat{s}^{*2}(q)]^{-1/2} \quad (9)$$

Where $\hat{s}^2$ is the asymptotic variance of the variance ratio under the homoscedasticity and $\hat{s}^{*2}$ is the asymptotic variance of the variance ratio test under the heteroscedasticity calculated, respectively as:

$$\hat{s}^2 = \frac{2(2q-1)*(q-1)}{3qT} \quad (10)$$

$$\hat{s}^{*2} = \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q}\right]^2 * \hat{\delta}(j) \quad (11)$$

Where:

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{nq}(P_t - P_{t-1} - \hat{u})^2 * (P_{t-j} - P_{t-j-1} - \hat{u})^2}{[\sum_{t=1}^{nq}(P_t - P_{t-1} - \hat{u})^2]^2} \quad (12)$$

Given that Muscat Securities Market is in a developing country we expect the market experiences thin and infrequent trading. Given this, literature recommends adjusting the data for infrequent trading, as the results might differ. The data adjustment is done using the method devised by Miller, Muthuswamy and Whaley (1994). Non-trading day's adjustments are found by calculating the residuals as follows:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t \quad (13)$$

and then using it to calculate an adjusted return for thin trading.

$$R_t^{Adj} = \frac{\varepsilon_t}{1-\alpha_1} \quad (14)$$

RESULTS AND DISCUSSION

Results of Serial Correlation Test

Table 1 shows the result of the serial correlation test for Muscat Securities Market during the pre-crisis period. All lags coefficients are statistically significant at a 5% significance level except for lags 1, 2, 3, 4, 5 and 30. The Q-statistics show that all values of Q for all lags are lower than the critical value of 43.77 and thus are insignificant. Lags 1, 2, 3, 4, 5, 30 are insignificant using both statistics measure of significance and Q-statistics value. The Muscat Securities Market is efficient at these lags given that we fail to reject the null hypothesis.

Table 1: The Results of Serial Correlation Test for the MSM 30 (Pre-Crisis-Raw Data)

Lags	AC	PAC	Q-Stat	Probability
1	0.101	0.101	3.7135	0.054*
2	-0.009	-0.020	3.7462	0.154
3	-0.039	-0.037	4.3158	0.229
4	-0.061	-0.054	5.6874	0.224
5	0.041	0.053	6.3164	0.277
6	0.145	0.135	14.070	0.029**
7	0.054	0.024	15.132	0.034**
8	0.073	0.069	17.096	0.029**
9	-0.134	-0.138	23.800	0.005***
10	0.041	0.090	24.421	0.007***
15	0.013	0.039	30.705	0.010**
20	-0.031	-0.051	33.743	0.028**
25	-0.068	-0.088	39.651	0.032**
30	-0.059	-0.034	42.550	0.064*

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the raw data and during the pre-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 2 shows the result of the serial correlation test for Muscat Securities Market during the crisis period. All lags coefficients are statistically significant at the 5% significance level during the crisis period in Muscat Securities Market except for lag 3. The Q-statistics show that all values of Q for all lags are lower than the critical value of 43.77 and thus they are insignificant except for lags 15, 20, 25 and 30. Only lag 3 is efficient using both statistical measures of the serial correlation. Furthermore, for lags 15, 20, 25 and 30 the null hypothesis is rejected and the Muscat Securities Market is inefficient using both statistical measure of significance and Q-statistics.

Table 2: The Results of Serial Correlation Test for the MSM 30 (Crisis, Raw Data)

Lags	AC	PAC	Q-Stat	Probability
1	0.216	0.216	7.0350	0.008***
2	-0.003	-0.052	7.0367	0.030**
3	-0.065	-0.055	7.6770	0.053*
4	-0.178	-0.160	12.549	0.014**
5	-0.151	-0.088	16.091	0.007***
6	-0.019	0.022	16.146	0.013**
7	-0.112	-0.146	18.137	0.011**
8	-0.072	-0.063	18.958	0.015**
9	-0.154	-0.192	22.749	0.007***
10	-0.100	-0.077	24.364	0.007***
15	0.171	0.080	51.886	0.000***
20	-0.091	-0.067	61.493	0.000***
25	0.055	0.152	62.713	0.000***
30	-0.069	-0.002	68.853	0.000***

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the raw data and during the crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 3 shows the result of the serial correlation test for Muscat Securities Market during the pre-crisis period. All lags coefficients are statistically significant at the 5% significance level during the crisis period in Muscat Securities Market. The Q-statistics show that all values of Q for all lags are lower than the critical value of 43.77 and thus they are insignificant except for lags 10, 15, 20, 25 and 30. For these lags, the null hypothesis is rejected and Muscat Securities Market is inefficient at the weak form market efficiency.

Table 3: The Results of Serial Correlation Test for the MSM 30 (Post-Crisis, Raw Data)

Lags	AC	PAC	Q-Stat	Probability
1	0.151	0.151	11.178	0.001***
2	-0.174	-0.201	26.143	0.000***
3	0.047	0.116	27.225	0.000***
4	0.040	-0.027	28.033	0.000***
5	-0.043	-0.017	28.950	0.000***
6	-0.135	-0.134	38.012	0.000***
7	-0.084	-0.052	41.519	0.000***
8	-0.003	-0.026	41.523	0.000***
9	0.023	0.023	41.780	0.000***
10	0.110	0.120	47.851	0.000***
15	0.084	0.071	53.749	0.000***
20	0.002	0.019	59.555	0.000***
25	-0.043	-0.092	67.014	0.000***
30	0.028	0.081	75.319	0.000***

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the raw data and during the post-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

The return is adjusted based on the method of Miller, Muthuswamy and Whaley (1994). Table 4 shows the result of the serial correlation test for Muscat Securities Market during the pre-crisis period using adjusted return. All lags coefficients are statistically insignificant at the 5% significance in Muscat Securities Market except for lags 9, 10, 15, 20, and 25. The Q-statistics show that all values of Q for all

lags are lower than the critical value of 43.77 and thus they are insignificant. The serial correlation test under both significance statistics and Q-statistics value implies that lags from one to eight and lag 30 fail to reject the null hypothesis and thus the Muscat Securities Market is efficient.

Table 4: The Results of Serial Correlation Test for the MSM 30 (Pre-Crisis-Adjusted Return)

Lags	AC	PAC	Q-Stat	Probability
1	0.002	0.002	0.0022	0.963
2	-0.015	-0.015	0.0840	0.959
3	-0.035	-0.035	0.5206	0.914
4	-0.065	-0.066	2.0846	0.720
5	0.032	0.031	2.4638	0.782
6	0.138	0.136	9.4703	0.149
7	0.031	0.028	9.8224	0.199
8	0.082	0.085	12.308	0.138
9	-0.150	-0.140	20.675	0.014**
10	0.064	0.089	22.221	0.014**
15	0.015	0.038	28.156	0.021**
20	-0.033	-0.045	31.751	0.046**
25	-0.071	-0.086	37.896	0.047**
30	-0.053	-0.035	40.544	0.095*

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the adjusted return and during the pre-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 5 shows the result of the serial correlation test for Muscat Securities Market during the crisis period using adjusted return. All lags coefficients are statistically insignificant at the 5% significance in Muscat Securities Market except for lags 15, 20, 25 and 30. The Q-statistics show that all values of Q for all lags are lower than the critical value of 43.77 and thus they are insignificant except for lag 30. The serial correlation test under both significance statistics and Q-statistics value implies that lags from one to ten fail to reject the null hypothesis and thus the Muscat Securities Market is efficient. Lag 30 rejects the null hypothesis and the Muscat Securities Market is inefficient at this lag given that it is statistically significant and a Q-statistics value greater than the critical value.

Table 5: The Results of Serial Correlation Test for the MSM 30 (Crisis-Adjusted Return)

Lags	AC	PAC	Q-Stat	Probability
1	0.012	0.012	0.0204	0.886
2	-0.042	-0.042	0.2866	0.866
3	-0.032	-0.031	0.4466	0.930
4	-0.150	-0.152	3.8958	0.420
5	-0.122	-0.126	6.2002	0.287
6	0.038	0.024	6.4288	0.377
7	-0.103	-0.130	8.0902	0.325
8	-0.020	-0.053	8.1540	0.419
9	-0.130	-0.190	10.821	0.288
10	-0.047	-0.083	11.180	0.344
15	0.106	0.084	29.276	0.015**
20	-0.096	-0.069	39.855	0.005***
25	0.063	0.155	41.491	0.020**
30	-0.057	-0.010	45.698	0.033**

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the adjusted return and during the crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 6 shows the result of the serial correlation test for Muscat Securities Market during the post-crisis period using adjusted return. The coefficients for all lags are statistically significant at the 5% level except for the one day lag. The Q-statistics show that all values of Q for all lags are lower than the critical value of 43.77 and thus they are insignificant except for lag 25 and 30. The serial correlation test under both significance statistics and Q-statistics value implies that only lags 25 and 30 that rejects the null hypothesis and thus the Muscat Securities Market is inefficient. Lag 1 fails to reject the null hypothesis

and the Muscat Securities Market is efficient at this lag given that it is statistically insignificant and the Q-statistics is value less than the critical value.

Table 6: The Results of Serial Correlation Test for the MSM 30 (Post-Crisis-Adjusted Return)

Lags	AC	PAC	Q-Stat	Probability
1	-0.025	-0.025	0.3080	0.579
2	-0.153	-0.154	11.829	0.003***
3	0.082	0.075	15.116	0.002***
4	0.030	0.010	15.558	0.004***
5	-0.011	0.014	15.614	0.008***
6	-0.109	-0.113	21.534	0.001***
7	-0.063	-0.072	23.483	0.001***
8	-0.008	-0.047	23.517	0.003***
9	-0.007	-0.011	23.544	0.005***
10	0.114	0.126	30.059	0.001***
15	0.087	0.081	35.106	0.002***
20	-0.004	0.005	42.576	0.002***
25	-0.049	-0.064	53.534	0.001***
30	0.028	0.073	60.010	0.001***

*This table shows the results of the serial correlation test using Ljung and Box (1978) Q-Statistics for daily index return for MSM30 using the adjusted return and during the post-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Results of Variance Ratio Test

The second test is the variance ratio by Lo and Mackinlay (1988) using both homoscedastic and heteroscedastic. The variance ratio is calculated using intervals (lags) of q = 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, and 30 for daily data. A variance ratio that is equal to one suggests that Muscat Securities Market is random. A variance ratio of q that is less than one implies that the return series is negatively serially correlated, which is known as "mean-reversion". In contrast, if the variance ratio of q is greater than one, it implies that the return series is positively serially correlated, which is known as "mean aversion".

Table 7 shows the result of variance ratio test for Muscat Securities Market during the pre-crisis period using raw data under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level except for lags 20, 25 and 30 under heteroscedasticity. As a result the null hypothesis is rejected and the Muscat Securities Market is inefficient at the weak form of market efficiency during the pre-crisis period.

Table 7: The Results of Variance Ratio test for MSM 30 (Pre-Crisis-Raw Data)

		Homoscedasticity		**Heteroscedasticity**	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.564111	-8.270412	0.0000***	-2.275271	0.0229**
3	0.388534	-7.782694	0.0000***	-2.333992	0.0196**
4	0.299165	-7.107759	0.0000***	-2.323021	0.0202**
5	0.217056	-6.780494	0.0000***	-2.384925	0.0171**
6	0.162052	-6.431436	0.0000***	-2.406452	0.0161**
7	0.154780	-5.883942	0.0000***	-2.321286	0.0203**
8	0.133409	-5.558548	0.0000***	-2.295694	0.0217**
9	0.146122	-5.104398	0.0000***	-2.192394	0.0284**
10	0.111704	-4.991791	0.0000***	-2.215306	0.0267**
15	0.078528	-4.115869	0.0000***	-2.011867	0.0442**
20	0.063330	-3.575935	0.0003***	-1.855048	0.0636*
25	0.053803	-3.205863	0.0013***	-1.747778	0.0805*
30	0.045749	-2.936264	0.0033***	-1.668800	0.0952*

*This table shows the results of the variance ratio test using Lo and Mackinlay (1988) for the raw data under both homoscedasticity and heteroscedasticity for daily index return for MSM30 during the pre-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 8 shows the result of variance ratio test for Muscat Securities Market during the crisis period using raw data under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level except for lags 30 under homoscedasticity assumption and lags 15, 20, 25 and 30 under heteroscedasticity. As a result the null hypothesis is rejected and the Muscat Securities Market is inefficient at the weak form of market efficiency during the pre-crisis period.

Table 8: The Results of Variance Ratio Test for MSM 30 (Crisis-Raw Data)

		Homoscedasticity		Heteroscedasticity	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.641646	-4.344808	0.0000***	-2.312982	0.0207**
3	0.455358	-4.429720	0.0000***	-2.458910	0.0139**
4	0.382449	-4.002189	0.0001***	-2.315222	0.0206**
5	0.302937	-3.857538	0.0001***	-2.307789	0.0210**
6	0.225084	-3.800611	0.0001***	-2.339420	0.0193**
7	0.214595	-3.493813	0.0005***	-2.208564	0.0272**
8	0.183352	-3.347262	0.0008***	-2.170389	0.0300**
9	0.178482	-3.138145	0.0017***	-2.084590	0.0371**
10	0.155196	-3.033626	0.0024***	-2.061420	0.0393**
15	0.080411	-2.624705	0.0087***	-1.941813	0.0522**
20	0.085312	-2.231429	0.0257**	-1.725178	0.0845**
25	0.063559	-2.027455	0.0426**	-1.608827	0.1077
30	0.066531	-1.835438	0.0664*	-1.486219	0.1372

*This table shows the results of the variance ratio test using Lo and Mackinlay, 1988 for the raw data under both homoscedasticity and heteroscedasticity for daily index return for MSM30 during the crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 9 shows the result of variance ratio test for Muscat Securities Market during the post-crisis period using raw data under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level. As a result the null hypothesis is rejected and the Muscat Securities Market is inefficient at the weak form of market efficiency during the post-crisis period.

Table 9: The Results of Variance Ratio Test for MSM 30 (Post-Crisis-Raw Data)

		Homoscedasticity		Heteroscedasticity	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.678628	-7.106606	0.0000***	-3.642695	0.0003***
3	0.351394	-9.621473	0.0000***	-4.763920	0.0000***
4	0.265764	-8.678726	0.0000***	-4.280044	0.0000***
5	0.233887	-7.732615	0.0000***	-3.886375	0.0001***
6	0.214135	-7.029792	0.0000***	-3.630887	0.0003***
7	0.174665	-6.696258	0.0000***	-3.559182	0.0004***
8	0.140779	-6.423260	0.0000***	-3.511365	0.0004***
9	0.122008	-6.117058	0.0000***	-3.434157	0.0006***
10	0.099043	-5.900733	0.0000***	-3.396695	0.0007***
15	0.070061	-4.841024	0.0000***	-3.083270	0.0020***
20	0.059490	-4.184747	0.0000***	-2.831371	0.0046***
25	0.051511	-3.745403	0.0002***	-2.643361	0.0082***
30	0.040965	-3.439302	0.0006***	-2.505496	0.0122**

*This table shows the results of the variance ratio test using Lo and Mackinlay, 1988 for the raw data under both homoscedasticity and heteroscedasticity for MSM30 during the post-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 10 shows the result of variance ratio test for Muscat Securities Market during the pre-crisis period using adjusted return under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level except for lags 15, 20, 25 and 30 under heteroscedasticity. This is almost similar to what is found under the raw data with exception to lag 15. As a result the null hypothesis is rejected and

the Muscat Securities Market is inefficient at the weak form of market efficiency during the pre-crisis period.

Table 10: The Results of Variance Ratio Test for MSM 30 (Pre-Crisis-Adjusted Return)

		Homoscedasticity		Heteroscedasticity	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.511018	-9.264879	0.0000***	-2.455827	0.0141**
3	0.348383	-8.282200	0.0000***	-2.384093	0.0171**
4	0.270470	-7.388502	0.0000***	-2.311669	0.0208**
5	0.197420	-6.940890	0.0000***	-2.334657	0.0196**
6	0.147233	-6.536081	0.0000***	-2.338722	0.0193**
7	0.142756	-5.959348	0.0000***	-2.249403	0.0245**
8	0.118951	-5.643429	0.0000***	-2.231462	0.0257**
9	0.133390	-5.173310	0.0000***	-2.128725	0.0333**
10	0.098072	-5.061354	0.0000***	-2.153160	0.0313**
15	0.070417	-4.146327	0.0000***	-1.949357	0.0513*
20	0.056875	-3.595573	0.0003***	-1.799009	0.0720*
25	0.048132	-3.220595	0.0013***	-1.697029	0.0897*
30	0.040424	-2.948546	0.0032***	-1.622284	0.1047

*This table shows the results of the variance ratio test using Lo and Mackinlay, 1988 for the adjusted return under both homoscedasticity and heteroscedasticity for daily index return for MSM30 during the pre-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 11 shows the result of variance ratio test for Muscat Securities Market during the crisis period using adjusted return under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level except for lags 30 under homoscedasticity assumption and lags 15, 20, 25 and 30 under heteroscedasticity. This is exactly similar to what is found in the raw data. The use of adjusted return did not change the conclusion. As a result the null hypothesis is rejected and the Muscat Securities Market is inefficient at the weak form of market efficiency during the pre-crisis period.

Table 11: The Results of Variance Ratio Test for MSM 30 (Crisis-Adjusted Return)

		Homoscedasticity		Heteroscedasticity	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.530717	-5.670366	0.0000***	-2.735436	0.0062***
3	0.351692	-5.254892	0.0000***	-2.660390	0.0078***
4	0.297931	-4.534422	0.0000***	-2.413001	0.0158**
5	0.235793	-4.214704	0.0000***	-2.342355	0.0192**
6	0.169559	-4.059057	0.0000***	-2.342289	0.0192**
7	0.170163	-3.678890	0.0002***	-2.196547	0.0281**
8	0.139316	-3.515735	0.0004***	-2.166252	0.0303**
9	0.139751	-3.274900	0.0011***	-2.077619	0.0377**
10	0.118172	-3.155787	0.0016***	-2.056790	0.0397**
15	0.070732	-2.643295	0.0082***	-1.903279	0.0570*
20	0.070011	-2.261028	0.0238**	-1.713388	0.0866*
25	0.051912	-2.045678	0.0408**	-1.595941	0.1105
30	0.054362	-1.853030	0.0639*	-1.477100	0.1396

*This table shows the results of the variance ratio test using Lo and Mackinlay, 1988 for the adjusted return under both homoscedasticity and heteroscedasticity for daily index return for MSM30 during the crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

Table 12 shows the result of variance ratio test for Muscat Securities Market during the post-crisis period using raw data under both homoscedasticity and heteroscedasticity assumptions. The z-statistic shows that the variance ratios are all significantly different than one for all values of q at the five percent significance level except for lags 15, 20, 25 and 30. These four lags were significantly different than one and were inefficient but when using the adjusted return they become insignificant. As a result the null hypothesis is rejected and the Muscat Securities Market is inefficient at the weak form of market efficiency during the post-crisis period.

Table 12: The Results of Variance Ratio Test for MSM 30 (Post-Crisis-Adjusted Return)

		Homoscedasticity		Heteroscedasticity	
Period	**Var. Ratio**	**z-statistics**	**Probability**	**z-statistics**	**Probability**
2	0.543773	-10.07838	0.0000***	-2.735436	0.0062***
3	0.284807	-10.59837	0.0000***	-2.660390	0.0078***
4	0.227095	-9.126455	0.0000***	-2.413001	0.0158**
5	0.190051	-8.166705	0.0000***	-2.342355	0.0192**
6	0.175376	-7.368955	0.0000***	-2.342289	0.0192**
7	0.144173	-6.936542	0.0000***	-2.196547	0.0281**
8	0.119501	-6.575590	0.0000***	-2.166252	0.0303**
9	0.106418	-6.219301	0.0000***	-2.077619	0.0377**
10	0.083655	-5.995376	0.0000***	-2.056790	0.0397**
15	0.059183	-4.892640	0.0000***	-1.903279	0.0570*
20	0.050830	-4.218959	0.0000***	-1.713388	0.0866*
25	0.043939	-3.771442	0.0002***	-1.595941	0.1105
30	0.034768	-3.457984	0.0005***	-1.477100	0.1396

*This table shows the results of the variance ratio test using Lo and Mackinlay, 1988 for the adjusted return under both homoscedasticity and heteroscedasticity for daily index return for MSM30 during the post-crisis. ***, ** and * indicate the significance at 1, 5 and 10 percent levels respectively.*

CONCLUSION

This study tested the weak form market efficiency of Muscat Securities Market during the 2008 global financial crisis using daily price index of MSM30. The data were divided into three market stages: pre-crisis from January 1, 2007 to June 8, 2008; crisis, from June 9, 2008 to January 22, 2009; and post crisis, from January 23, 2009 to January 17, 2011. The serial correlation test and the variance ratio test were used to measure the weak form efficiency of MSM. The result indicates that the Muscat Securities Market is inefficient during the pre-crisis, crisis and post crisis with few exceptions for some lags. The limitation of the study is that both methods are parametric tests that best fit for normally distributed data. A further study is suggested to use the non-parametric test to measure the weak form market efficiency during the global financial crisis.

The inefficiency in emerging markets, including Muscat Securities Market, is due to low liquidity, lack of disclosure and transparency, infrequent and discontinuities of trading, overreaction to information, ineffective legal structure, and problems with insider trading. The developed market, however, tends to be efficient most of the time using most of the testing methodologies. These markets are mature with very sophisticated investors and financial institutions and every day research that looks for any opportunities to make abnormal return in a way, so it becomes very hard to beat the market.

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