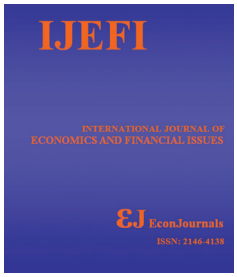

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Long Memory and Stock Market Efficiency: Case of Saudi Arabia

Rim Ammar Lamouchi[1,2,3]*

[1]Department of Finance, Faculty of Economics and Administration, King Abdulaziz University, Saudi Arabia, [2]Ministry of Education, Tunisia, [3]GEF-2A Laboratory, Higher Institute of Management of Tunis, Tunis University, Tunisia.
*Email: rlamouchi@kau.edu.sa

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ABSTRACT

This paper examines the market efficiency of Saudi Arabia stock exchange market namely Tadawul All Share Index, TASI, for the period from 1998 to 2020. To test the efficiency of stock market, we analyze the dependence structure of stock market index returns and volatility. The results demonstrate that Saudi stock market shows long memory. The long memory process of Saudi Stock Market offers evidence against efficient market hypothesis (EMH). The ARFIMA model supports the presence of long-run dependence in the historical volatility of the Saudi stock market, giving further support against the EMH.

Keywords: Market Efficiency, Long memory, Stock Market Index.
JEL Classifications: C13, C22, C53, G10, G17

1. INTRODUCTION

The efficient market hypothesis (EMH), advanced by Fama (1965; 1970. p383) affirms that "market prices immediately reflect all public and available information" at any given time. Thus, no one could possibly exceed the market by exploiting the same information accessible for all investors. In addition, future value of assets cannot be anticipated by exploring the trends of price movements. Hence, price movements are unpredictable and the returns represent a random process.

From a statistical point of view, Lardic and Mignon (1996) suggest that the EMH indicates that return series are differentiated by the absence of memory. In space-time, the long-run dependence implies a slow decrease in serial autocorrelation as the orders of a time series increase. The long memory also means lasting effects of an exogenous shock on that series. Therefore if financial returns series exhibits a long memory, changes in the market may be affected and explicated by past point.

From a financial perspective, long-memory in stock returns can be attributed to the expectation recurring cycles and hysteretic effect (De Peretti, 2007). From an economic point of view, the long memory phenomenon may be explained by the insolvency of a rational expectation hypothesis. According to Kirman and Teyssière (2007), this failure is related to the herding behavior of market operators and the outcome of "bubbles."

The presence of a long memory in stock market returns has a meaningful repercussion on the concept of market efficiency and destabilizes the hypothesis of the random walk pattern of stock returns. In fact, long memory is characterized by stationary processes with observations showing expressive dependence between very distant observations. The prediction of future returns movements may be made based on past returns, therefore, informed investors can make "abnormal" profits. Nevertheless, the EMH emphasizes the unpredictability of stock prices fluctuations and stipulates that this phenomenon could not remain in long run because all investors will imitate each other and extra returns

will be excluded. Indeed, the presence of long-memory excludes linear pricing approach, based on the capital asset pricing model (CAPM), employed for modeling future returns.

Although the long memory issue has been debated in finance since early seventies, it remains the topic of active research. Fama (1991. p1575) considers that "the literature is now so large that a full review is impossible'', moreover the number of recent studies has continued to grow as evidenced by the survey of Sewell (2011). The strength of this sharp debate can be highlighted in the same paper by the expression the "camp of devil" against the economists who have tried to challenge this assumption (Fama, 1991). Apart from possibilities of absence of long-memory, is an intermediary occurrence, namely short-memory. The difference between the two memories lies in autocorrelation convergence speed towards zero.

The long memory topic often quoted in the financial literature contains evidence regarding the long memory in defining financial data, mainly stock market returns (Mandelbrot and Taqqu, 1979; Cheung et al., 1993; Ding et al., 1993; Crato and de Lima, 1994; Cheung and Lai, 1995; Baillie, 1996; Granger and Ding, 1996; Henry, 2002; Kumar, 2004; Kirman and Teyssière, 2007; and Tan and Khan, 2010).

Andreano (2005) employs the spectral method of Bollerslev and Jubinski (1999) to find the evidence of long memory in the trading volume and absolute returns series in the Italian stock market. Assaf and Cavalcante (2005) demonstrate a strong dependence in absolute and squared returns series of Brazilian market among the period 1997- 2002. Moreover, Di Matteo et al. (2005) show that the long memory is directly related to the degree of market development. As a demonstration, they use Hurst exponent to compare stock returns of developed countries to less mature ones such as Russia, Indonesia and Peru. Besides, De Melo Mendes and Kolev (2006) examine the process conducting 12 emerging markets between 1995 and 2005. They find strong presence of long memory in the volatility series related to these markets. In addition, Assaf (2007) suggests a significant long memory in the volatility of MENA markets namely, Egypt, Jordon, Morocco and, Turkey. Cunado et al. (2008) study the process of the S&P 500 from August 1928 to December 2006; their results indicate that the squared returns display a long memory behavior; they also reveal that volatility tend to be further persistent in bear markets than in bull markets. Serletis and Rosenberg (2009) conduct a study on four US stock market indexes (SP500, Nasdaq, DJ and NYSE composite index) and they obtain that daily returns display persistence. Furthermore, McMillan and Thupayagale (2008) investigate the economic reforms in South Africa using the long memory in market volatility. They assume that the behavior of stock returns in South Africa, despite the reforms, continued to be driven by risk.

The empirical literature indicates the possibility to relate the long memory property to the level of development of stock markets. Fouquau and Spieser (2014) investigate the market efficiency concept through analyzing the dependence structure of stock market index returns. They employ different estimation methods to demonstrate the possible presence of long memory in 12 market indexes among three periods, namely (1960-2013), (1980-2013) and (1990-2013). Although, their findings vary regarding the degree of financial maturity of the market, they conclude that most emerging markets show the presence of long memory. However mature markets display an absence of long memory or a very short-memory process.

To investigate the presence of long memory in stock markets, numerous models were used in the empirical literature. Hassan et al. (2003) explore the market imperfection of Kuwait Stock Exchange from 1995 to 2000 by using the exponential GARCH and GARCH in mean to find a weak-form inefficient in this market. Then, Asiri (2007) employ an Auto Regressive Integrated Moving Average (ARIMA) model to demonstrate the presence of long memory and the weak-form efficiency of Kuwait's stock market for the daily stock prices for 2000-2002. They also, use a sector analysis to give strong support to the results. The findings approve the long memory dynamics for all share prices and by sector. Using another method to examine the presence of long memory in the volatility, Hiremath and Kamaiah (2010) examine the presence of long memory in the volatility of Indian stock market employing the fractionally integrated generalized autoregressive conditional heteroscedasticity (FIGARCH) model. The authors confirm the presence of long memory in volatility of all the index returns.

The empirical evidence associated with long memory in stock market is mixed in developed markets. The pattern of long memory may be less observable in developed markets, which can be explained by the efficiency of information. However, the findings from emerging stock markets support the evidence of long memory in volatility process (Sadique and Silvapulle, 2001 and Cajueiro and Tabak, 2004). Nevertheless, there are limited number of studies which have comprehensive investigation of long memory in the volatility of Saudi Arabia stock market as one of the most important Arab markets in addition to using such long time horizon period, about 22 years. During the considered period (1998-2020), several actions were implemented to develop the institutional and legal structure of Saudi stock markets, mainly in relation to information disclosure, foreign ownership, clearing listing supply and settlement systems. In this regards, few studies have investigated informational efficiency in Saudi Arabia (Limam, 2003). Therefore, the present paper is dedicated to study the issue of long memory in the series of returns and volatility Saudi stock exchange namely, Tadawul All Share Index (TASI).

The rest of this paper is organized as follows. The next section reports a description of the features of the Saudi Arabia stock market. The third section describes the methodology then Section 4 presents the Data. Section 5 is devoted to empirical results and the final section is assigned to concluding remarks.

2. SAUDI ARABIA STOCK MARKET

In the late 1970s, the Saudi Stock Exchange emerged with an increasing number of joint stock companies to reach about 14 public companies by 1975. In 1984, and in order to regulate and develop the market, the Saudi Arabian Monetary Agency (SAMA) was created. SAMA have represented the government

body dedicated to regulate and monitor the market activities until the creation of the Capital Market Authority (CMA) in July 2003. CMA's role was to safeguard investors and guarantee fairness and efficiency in the market. On March 19, 2007, the Saudi Stock Exchange (Tadawul) has been implemented as the only stock exchange in Saudi Arabia. The trading hours are from 10:00 AM to 3:00 PM, Sunday to Thursday an it is organized into 20 industry groups. Since 2010, a series of reforms have been undertaken to promote the Saudi Stock Market in relation to liberalization of the financial sector, information disclosure, listing requirements, moderation of foreign direct investment regulations, and foreign ownership.

The market capitalization for the year 2019 was $US496.353 million, corresponding to the World Bank collection of development indicators. Besides, the number of domestic listed companies -as another market size indicator- shows that Saudi stock markets has moved from 74 to 200 between 2000 and 2018. This number may not be considered as a source for relevant mobilizing capital and diversifying risk compared to other emerging and developed markets.

This study, examines the presence of long memory behavior in the Saudi stock market using different tests as shown in the following section.

3. METHODOLOGY

The first long memory process modeled in the literature was the Autoregressive Fractionally Integrated Moving Average (ARFIMA) model presented by Granger and Joyeux (1980) and Hosking (1981). A stationary series *Xt* follow an ARFIMA (*p, d, q*) process if:

$$\phi(L)(1-L)^{d} X_t = \theta(L)\varepsilon_t \quad (1)$$

where $d \epsilon[-0.5; 0,5]$, represents the order of fractional integration and L is considered as the lag operator i.e. $LX_t = X_{t-1}$ t. $\phi(L)$ and $\theta(L)$ are the autoregressive and the moving average polynomials of order p and q and is a white Gaussian noise. If $d \epsilon[-0.5; 0]$ the series is said antipersistent. If $d = 0$, the series has short memory and may be modeled by a standard ARMA model. If $d \epsilon[0; 0,5]$ the series is a stationary and exhibits a long memory behavior.

In order to estimate the ARFIMA model, we follow the study of Limam (2003). Firstly the estimation procedure implemented by Geweke and Porter-Hudak (1983), called GPH and based on the estimate of the parameter of long memory d has been used. Secondly, we use the estimation procedure of Robinson (1995). The third estimation used is performed by Sowel (1992) based on the exact and not the Whittle likelihood function. After that, we proceed to the Andrews and Guggenberger (2003) estimation, called AG. The choice of methods is motivated by the literature and especially the work of Fouquau and Spieser (2014) due to the sensitivity of the ARFIMA approach.

4. DATA AND DESCRIPTIVE STATISTICS

In this study, we use the daily closing stock price index of the Saudi stock market, named TASI. The data cover the period from 28 October 2007 to 20 February 2019 and is collected from Bloomberg database. The designated daily data frequency is aligned with the need for a considerable number of observations. Commonly, stock indices are considered as non-stationary and unpredictable and are not suitable for time-series analysis. Hence, the daily stock index returns series is computed the same as the log-difference of the daily stock price index and denoted by R_t, i.e., R_t=100Ln (P_t/P_{t-1}), P_t is the closing price on day t. Following French et al. (1987) and Kang et al. (2009), we assess the daily actual volatility series, denoted V_t, by the daily squared returns series, i.e., $V_t=R_t^2$.

Table 1 shows descriptive statistics for the daily returns and volatility series of TASI stock index in the Saudi Stock market. The skewness coefficients are negative for the return series, indicating a left-skewed distribution. For the volatility series, the skewness coefficients are positive, showing a right-skewed distribution. Besides, the excess kurtosis designates a leptokurtic distribution with values concentrated around the mean and fat tails for the two series. The non-linear behavior is confirmed by the rejection of the normality hypothesis using the Jarque–Bera statistics.

Figure 1 shows the evolution of the returns and the volatility of TASI. It demonstrates periods of high volatility shadowed by periods of high volatility, and periods of low volatility shadowed by periods of low volatility displaying volatility clustering. Different volatility spikes of have been noticed during 2006, 2008 and 2014.

The acceleration of volatility during the turbulent year 2006 is related to the country's first domestic stock market collapse. By the end of 2006, TASI had lost about 65 percent of its value according to the Capital Market Authority (CMA). The subprime crisis has affected also the Saudi stock market demonstrated in high volatility pattern during this period. The high volatility during 2014 can be attributed to the downward movement in international oil prices. In the case of the TASI, the reason behind the fall was due more to panic selling and investor sentiment.

We present stationarity tests in Table 2. Firstly, we test the null hypothesis of presence of unit root versus the alternative hypothesis of absence of unit root for the Augmented test of Dickey and Fuller (1981), ADF and the test of Phillips and Perron

Table 1: Descriptive statistics of Saudi stock data

Variables	Mean	Standard errors	Skewness	Excess Kurtosis	Min	Max	Jarque-Bera
TASI							
R_t	0.0002	0.0136	-0.8818	14.0045	-0.1032	0.0939	29401.62
V_t	0.0001	0.0006	8.5808	96.5008	0.0000	0.0106	2139116.

Figure 1: (a and b) Plots of daily returns and volatility

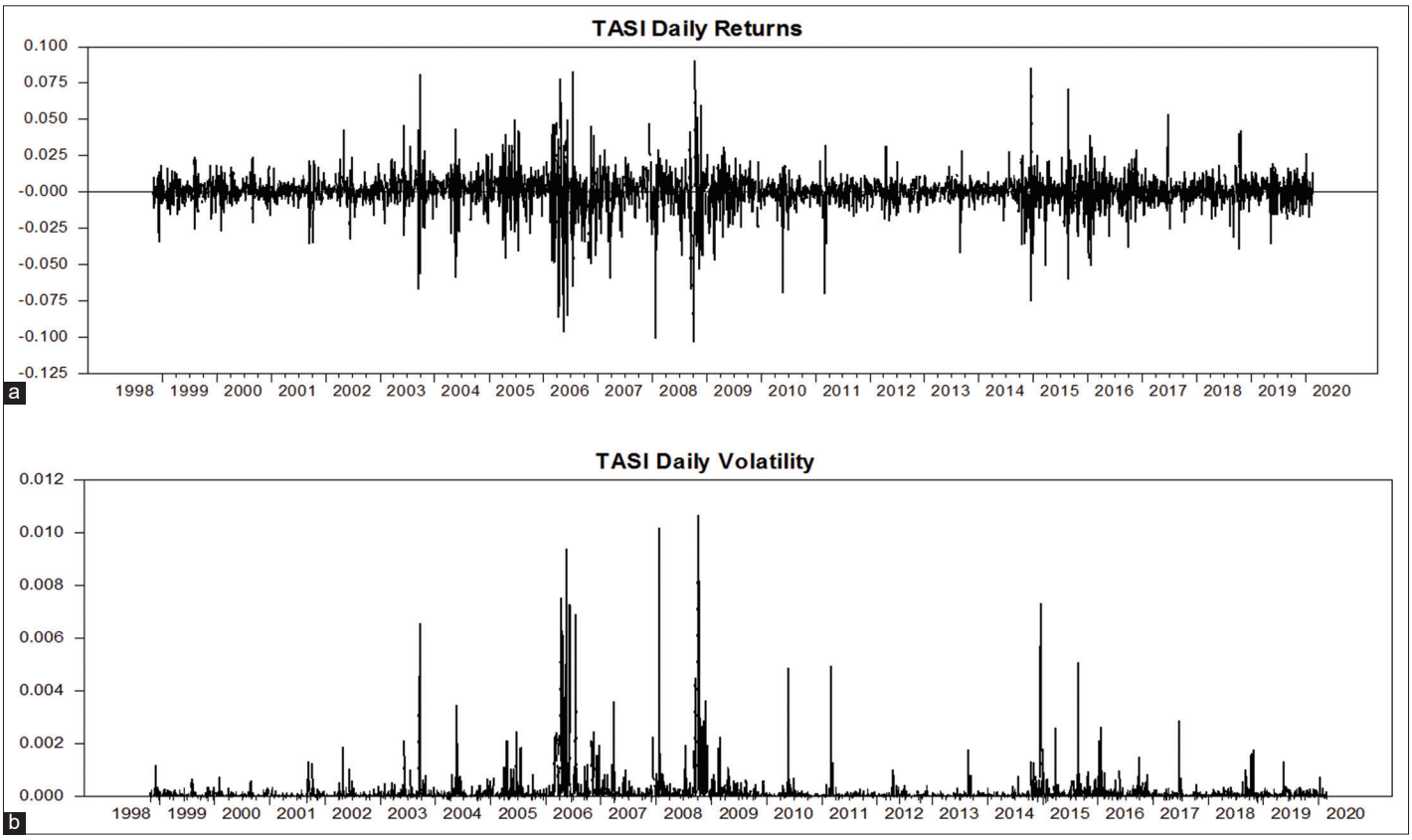

Table 2: Stationarity tests

Variables	ADF	PP	KPSS
TASI			
R_t	-69.6746	-41.2136	0.3471
V_t	-8.9075	-97.6208	0.5248
Critical value	-1.950	-2.863	0.146

Table 3: Long memory test results

Variables	GPH	Robinson	Sowell	AG
TASI				
R_t	0.1753	0.1743	0.1698	0.1787
V_t	0.3499	0.3454	0.3265	0.3511

(1988), PP, indicating a stationary process for returns and volatility series. However, the null hypothesis is the existence of stationarity process for the Kwiatkowski et al. (1992), KPSS test. For the series in presence, the different test results, indicate the rejection of non-stationarity hypothesis.

5. EMPIRICAL RESULTS

Table 3 reports the estimation results of the long memory fractional integration parameter *d*. The value of parameter *d* obtained using different estimation procedure which are very close to each other and belong to the interval [0; 0,5] for the two series in presence. Generally, the results demonstrate that long memory dependence process in stock returns and volatility is considered as a property of less developed, more than developed, stock markets. Hence, the long memory process of Saudi Stock Market offers evidence against efficient market hypothesis (EMH). The results are in coherence with previous studies, such as Fouquau and Spieser (2014).

The proof from the Saudi stock markets, as a less developped market, is in favor of the presence of long memory pattern. According to Sourial (2002), these characteristics of persistence can be related to the domination of individual investors. Despite the reforms undertaken, the Saudi Stock market prices are influenced and conducted by speculative behaviors of relevant individual investors with excess liquidity, limited investment opportunities and lack of a parallel market regulating small-and medium-sized entities (Lerner et al., 2017). The long memory can also be explained by the limited integration in international capital markets. This fact deviates the stock markets from the informational efficiency and the alliance with international standards (Limam, 2003). Furthermore, for oil-dependent countries, the most market activities are directly related to oil which may imply that the past oil prices movements may affect and can be transmitted to the future fluctuations of the stock returns (Khamis et al., 2018;Lamouchi and Alawi, 2020). Part of the Saudi vision 2020-2030 plan, is to promote a path for small and medium companies to list and boost the number of listed companies and to make reforms related to the liberalization of the financial sector, the information disclosure, listing requirements, moderation of foreign direct investment regulations, and foreign ownership.

6. CONCLUSION

In this paper, we explore the market efficiency of Saudi Arabia stock exchange market namely Tadawul All Share Index, TASI,

for the period 1998-2020. To do that, an investigation of the dependence structure of stock market index for returns and volatility series. We use different estimation methods with the ARFIMA model.

The results are in favor of presence of long memory in the Saudi Stock market in both returns and volatility series with different methods used. From a financial perspective, the findings are against the efficiency market hypothesis and allow predicting the future evolution of TASI index based on past evolution. For investors, the long-run dependent process may include information, which enable forecasting. Hence, investors can take advantage to aim abnormal returns. Also, market participants can exploit past volatility to predict future volatility. We can extend this paper by examining individual stocks in Saudi Arabia instead of TASI Index.

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